Recovery Plan

For Twelve Threatened Orchids in the Lofty Block Region of South Australia

2010

Australian Government

Government of South Australia

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Citation

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This recovery plan was prepared under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

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.

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Cover photographs: Top left: Caladenia macroclavia (J. Quarmby); top centre: volunteers caging (D. Bickerton); top right: volunteers weeding (P. Clark); bottom left: Pterostylis sp. 'Halbury' (J.Quarmby); bottom right: Caladenia woolcockiorum (J. Quarmby).

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Department for Environment and Heritage

Adelaide and Mount Lofty Natural Resource Management Board

Northern and Yorke Natural Resource Management Board

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Photographic Credits

Thanks to Doug Bickerton and Pat Clark for the use of their photographs of volunteers on the cover, and to Rob Bates for his photograph of *Caladenia xantholeuca* on page 87. All other photographs were taken by the author.

Thanks also to Gilbert Dashorst (State Herbarium of South Australia) for his line drawing of *Caladenia argocalla* (pp. 1, 29, 121 and 141).

Executive Summary

This plan provides the framework for the recovery of twelve nationally threatened orchid species that occur in the Lofty Block region of South Australia (refer to Table A). It was prepared to satisfy the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The plan is intended to guide the implementation of recovery actions.

Table A: Summary information for twelve threatened orchid species in the Lofty Block region.

Species	EPBC Act Listing	Est. Population Size	No. of sub-populations	Extent of Occurrence (km^2)	Key Threats
Caladenia argocalla (White Beauty Spider-orchid)	Endangered	1800	13	1666	Weed invasion, herbivory, lack of pollination and recruitment, road and track management
Caladenia behrii (Pink-lipped Spider-orchid)	Endangered	3440	32	598	Herbivory, weed invasion, lack of recruitment
Caladenia gladiolata (Bayonet Spider-orchid)	Endangered	780	4	317	Weed invasion, herbivory, lack of pollination
Caladenia intuta (Ghost Spider-orchid)	Critically Endangered	400	2	2.7	Weed invasion, grazing, vegetation clearance, trampling
Caladenia macroclavia (Large-club Spider-orchid)	Endangered	35	5	382	Herbivory, weed invasion, grazing, lack of pollination
Caladenia rigida (White Spider-orchid)	Endangered	5500	24	458	Herbivory, weed invasion, lack of recruitment
Caladenia woolcockiorum (Woolcock's Spider-orchid)	Vulnerable	5400	9	13	Weed invasion, herbivory, track management
Caladenia xantholeuca (Flinders Ranges Spider-orchid)	Endangered	Possibly extinct	-	-	Lack of recruitment, weed invasion
Pterostylis bryophila (Hindmarsh Valley Greenhood)	Critically Endangered	1140	3	72	Weed invasion, herbivory, fire, trampling
Pterostylis cucullata (Leafy Greenhood)	Vulnerable	6380	5	366	Weed invasion, herbivory, fire, recreation
Pterostylis despectans (Lowly Greenhood)	Endangered	600	4	79	Lack of pollination, grazing, weed invasion
Pterostylis sp. Halbury (Halbury Greenhood)	Endangered	9000	2	17	Weed invasion, herbivory, trampling

Note: The population and extent of occurrence data is based on 2006 figures.

Conservation Status

All twelve species in this recovery plan are listed as nationally threatened under the EPBC Act, and as threatened in South Australia under the *National Parks and Wildlife Act 1972* (refer to Table A). The conservation status of each species has also been reviewed using IUCN Red List Criteria Version 3.1 (IUCN 2001) as part of this planning process (refer to Table 1).

General species information

All of the species in this recovery plan have restricted and fragmented distributions (refer to Table A). Many of the species also have small population sizes and/or a limited number of sub-populations. Detailed information on the current distribution, population size, habitat, and ecology of each of the species is provided in Part B of this plan.

All of the species in this plan are at risk from numerous threats including climate change, vegetation clearance, weed invasion, herbivory, lack of pollination and recruitment, and road and track management activities (refer to Table A). The current threats to each species are also described in detail in Part B.

Recovery objectives and performance criteria

The overall recovery objective for each species in this recovery plan is to improve the conservation status within a specified timeframe, *e.g.* from Endangered to Vulnerable within 30 years (refer to Part B).

The following recovery objectives have been developed for the species in this plan:

1. To increase the known extent of occurrence of the species.
2. To increase the number of known sub-populations.
3. To maintain or increase the size of each sub-population.
4. To maintain or increase the area of occupancy of the species.
5. To maintain or improve quality of habitat critical to survival.
6. To safeguard against the risk of sub-population extinctions.
7. To increase the knowledge of the biology and ecology of the species.
8. To maintain or increase the level of community participation in the recovery process.

Each recovery objective is supported by performance criteria, which provide targets for measuring the achievement of recovery objectives (refer to Table 6). Specific recovery objectives and performance criteria for each species are listed in Part B of this plan.

Recovery strategies and actions

The following recovery strategies have been developed for the species in this plan:

A. Determine population size and trends.

B. Determine current extent of occurrence and number of sub-populations.

C. Mitigate the threats to sub-populations.

D. Protect and manage habitat critical to survival.

E. Preserve germplasm and mycorrhizal fungi *in vitro.*

F. Determine the feasibility of translocation and implement translocation proposals.

G. Undertake research related to the species.

H. Inform, encourage and support landholders and the community.

Each recovery strategy is supported by a number of recovery actions (refer to Table 7), which are justified and described in Section 3.3. Specific recovery actions for each species are listed in Part B of this plan, with associated timelines and delivery groups.

Each recovery action may contribute to achieving more than one recovery objective and performance criterion. The relationship between recovery objectives, performance criteria and recovery actions is shown in Appendix E.

Costs and evaluation

The resources required to implement this plan are estimated to be $968800, with an average cost of $138400 per year. The budget for the plan is outlined in Part C. Funding will be sought from Natural Resource Management Boards, the South Australian Department for Environment and Heritage, Australian Government Department of the Environment, Water, Heritage and the Arts, community grants, and other available sources.

Annual progress towards achieving the specific recovery objectives for each species in this recovery plan will be reported by the Lofty Block Threatened Orchid Recovery Teams. A major independent review of the recovery process will occur after the plan has been in operation for five years.

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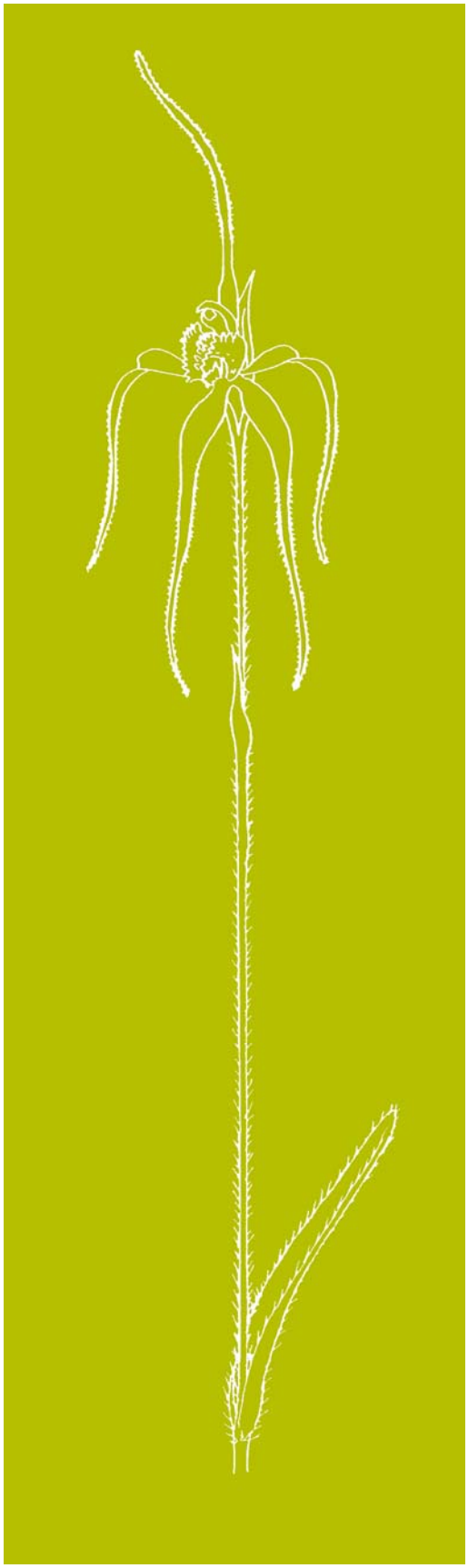
Confidential Appendices containing maps of the location of each sub-population, and habitat critical to survival are available from DEH (Threatened Species Unit, Adelaide).

Part A: Recovery Plan Overview



1. Introduction

This recovery plan covers twelve nationally threatened orchid species that occur in the Lofty Block region of South Australia (refer to Table 1). Ten of the twelve species are endemic to the Lofty Block region, while the other two (*Pterostylis cucullata* subsp. *sylvicola* and *P. despectans*) also have sub-populations in other states of Australia. This plan only deals with South Australian sub-populations, but is consistent with other national recovery plans currently in place or in preparation for these species (Coates et al 2002, Duncan 2007).

1.1 Regional Context

The Lofty Block (LB) region comprises the inland areas of the Adelaide and Mount Lofty Ranges (AMLR) Natural Resource Management (NRM) region and the Northern and Yorke (NY) NRM region (refer to Figure 1). It is a region of special biogeographical significance, characterised by temperate to semi-arid ranges, alluvial fans and plains and distinctive biological assemblages. It encompasses a broad range of vegetation types including forests, sclerophyll woodlands, open grassy woodlands, mallee, shrublands, heaths, and grasslands. Almost ninety percent of the native vegetation in the region has been cleared since European settlement, resulting in species decline, habitat loss and fragmentation. Most areas of remnant vegetation are small and isolated by agricultural or urban land, and are under significant pressure from threatening processes.

1.2 Conservation Status

Two of the species in this recovery plan are currently listed as Critically Endangered, eight as Endangered, and two as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (refer to Table 1).

Ten of the species are also listed as Endangered and two as Vulnerable in South Australia under the *National Parks and Wildlife Act 1972* (NP&W Act) (refer to Table 1). *Pterostylis despectans* is also listed as Endangered in Victoria under the *Flora and Fauna Guarantee Act 1988* (F&FG Act), and as Critically Endangered in New South Wales under the *Threatened Species Conservation Act 1995* (TSC Act). *P. cucullata* is also listed as Vulnerable in Victoria under the F&FG Act, and as Endangered in Tasmania under the *Threatened Species Protection Act 1995* (TSP Act).

The conservation status of each species in South Australia was reviewed as part of this planning process in 2006, following the IUCN Red List Criteria Version 3.1 (IUCN 2001), providing a more current conservation assessment for each species (refer to Table 1). Justifications for the reviewed conservation status of each species can be found in Part B of this plan.

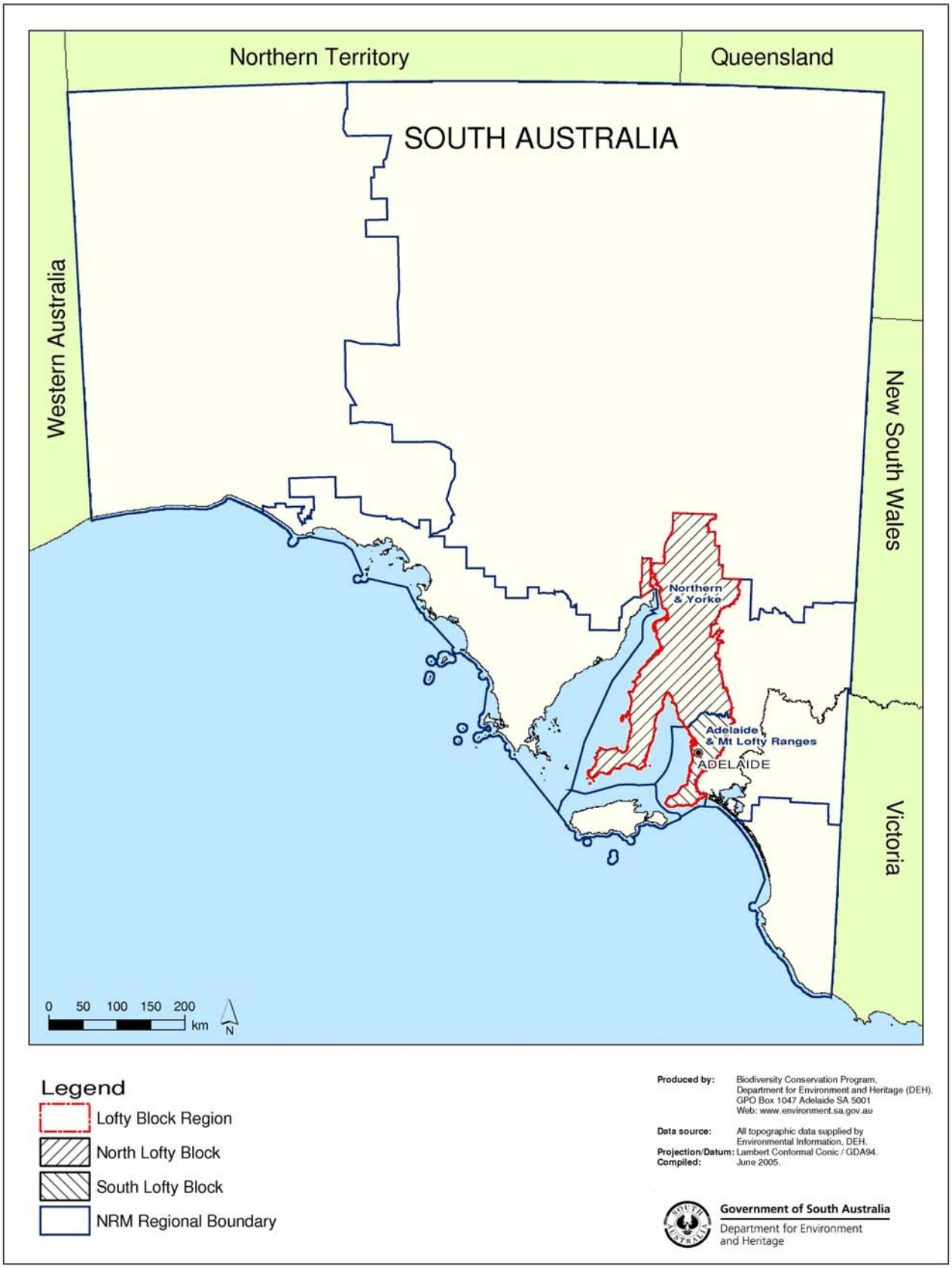
Table 1: List of species and current conservation status.

Species	Common Name	Distribution	Conservation Status		
			EPBC Act	NP&W Act	*IUCN 2001
Caladenia argocalla	White Beauty Spider-orchid	LB endemic	E	E	EN
Caladenia behrii	Pink-lipped Spider-orchid	LB endemic	E	E	EN
Caladenia gladiolata	Bayonet Spider-orchid	LB endemic	E	E	EN
Caladenia intuta	Ghost Spider-orchid	LB endemic	CR	E	CR
Caladenia macroclavia	Large-club Spider-orchid	LB endemic	E	E	CR
Caladenia rigida	White Spider-orchid	LB endemic	E	E	EN
Caladenia woolcockiorum	Woolcock's Spider-orchid	LB endemic	V	V	CR
Caladenia xantholeuca	Flinders Ranges Spider-orchid	LB endemic	E	E	CR
Pterostylis bryophila	Hindmarsh Valley Greenhood	LB endemic	CR	E	CR
Pterostylis cucullata ssp. *sylvicola*	Leafy Greenhood	SA, Vic, Tas	V	V	EN
Pterostylis despectans	Lowly Greenhood	SA, Vic, NSW	E	E	CR
Pterostylis sp. Halbury	Halbury Greenhood	LB endemic	E	E	EN

LB: Lofty Block, CR: Critically Endangered, E: Endangered, EN: Endangered, V: Vulnerable, N: Not Listed

* Conservation status of each species in South Australia reviewed against IUCN Red List Criteria Version 3.1 (IUCN 2001) in 2006.

Figure 1: Location map of the Lofty Block Region of South Australia



1.3 Existing Recovery Plans

Six of the twelve species previously had recovery plans prepared that were endorsed under the EPBC Act (refer to Table 2), and these were reviewed by DEH in 2007 (Waudby *et al* 2007), with the recommendations arising reaffirming the decision to prepare the current multi-species recovery plan. Appendix F summarises the findings and recommendations of the review of these recovery plans. Draft recovery plans were also prepared for *Caladenia gladiolata* and *Pterostylis bryophila* (refer to Table 2), but these were not endorsed by the Commonwealth. All of the plans listed in Table 2 are specific to South Australia, except for Coates *et al* (2002), a national recovery plan for 25 orchid species in Victoria, and Duncan (2007), a draft national recovery plan for *Pterostylis cucullata*.

This recovery plan is a revision of previous recovery plans, and provides current information and recovery actions for each of the twelve species in South Australia.

Table 2: Existing recovery plans for each species.

Species	Recovery Plans
Caladenia argocalla	(*Robertson & Bickerton 2000)
Caladenia behrii	(*Bickerton 1999), (Reynolds & Sorensen 1997), (Bates 1995[b])
Caladenia gladiolata	(Bickerton 2002[a]), (Bates 1996), (Bates 1995[a]), (Bates 1994)
Caladenia intuta	-
Caladenia macroclavia	(*Bickerton 2003[a])
Caladenia rigida	(Bates 1995[c])
Caladenia woolcockiorum	(*Bickerton 2003[b])
Caladenia xantholeuca	-
Pterostylis bryophila	(Bickerton 2001[a])
Pterostylis cucullata	(Duncan 2007)
Pterostylis despectans	(*Bickerton & Robertson 2000[b]), (*Coates et al 2002)
Pterostylis sp. Halbury	(*Bickerton & Robertson 2000[a]),

* Recovery plans endorsed under the EPBC Act

1.4 Lofty Block Threatened Orchid Recovery Project

The Lofty Block Threatened Orchid Recovery Project (LBTORP) was established in 1998 to plan and implement the recovery of nationally threatened orchids in the Lofty Block region. The LBTORP has been involved in the management of more than twenty-five orchid species, twelve of which are included in this recovery plan. The project is managed by the South Australian Department for Environment and Heritage (DEH) in partnership with the Threatened Plant Action Group (TPAG). Funding for the LBTORP has been primarily provided by the Australian Government. Subsequent to the establishment of regional Natural Resource Management Boards this funding was delivered through the Adelaide and Mount Lofty Ranges (AMLR) NRM Board and the Northern and Yorke (NY) NRM Board. In 2008 the two Boards elected to fund the implementation of the relevant actions in this recovery plan separately, effectively dividing the management of the project between the two regions.

There are two recovery teams that oversee the implementation of this recovery plan, namely the South Lofty Block Threatened Orchid Recovery Team (SLBTORT), which covers the AMLR NRM Region, and the North Lofty Block Threatened Orchid Recovery Team (NLBTORT), covering the NY NRM region. Both teams have been operating since 2000. The current membership of both recovery teams can be found in Appendix A. Both recovery teams have had significant input into the preparation of this recovery plan.

1.5 Legislative Context

1.5.1 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act regulates actions that may result in a significant impact on nationally listed threatened species and ecological communities. An action that is likely to have a significant impact on any of the nationally listed species in this recovery plan (refer to Table 1) must be referred to the Australian Government Minister for the Environment, Water, Heritage and the Arts for determination as to whether formal assessment and approval are required.

1.5.2 *National Parks and Wildlife Act 1972*

The *National Parks and Wildlife Act 1972* (NP&W Act) regulates the taking, possession and trading of prescribed species from crown land in South Australia. Any such actions require a permit from the South Australian Minister for the Environment. All of the species covered by this recovery plan are currently listed as either Endangered (Schedule 7) or Vulnerable (Schedule 8) under the NP&W Act.

1.5.3 *Native Vegetation Act 1991*

The *Native Vegetation Act 1991* (NV Act) regulates the clearance of native vegetation in South Australia. Generally it prohibits broad-scale clearance of native vegetation and imposes strict penalties for illegal clearance. Native vegetation can only be cleared legally in accordance with the exemptions in the regulations of the NV Act. The exemptions are designed to permit certain clearance for safety reasons (e.g. the establishment of firebreaks, tracks, and fence lines).

Under the Native Vegetation Regulations 2003, landholders wanting to build within areas of intact native vegetation must build in positions that minimise the need for the clearance of native vegetation. Any clearance of native vegetation must be undertaken in accordance with a management plan approved by the Native Vegetation Council (NVC), and must result in a significant environmental benefit.

The NV Act is also the legislative basis for the Heritage Agreement Scheme. Private land and some types of public land can be formally protected for conservation purposes under Heritage Agreement. A Heritage Agreement is a conservation covenant between the landholder and the state government that is registered on the land title in perpetuity, and which specifies management conditions for a designated area of land.

1.5.4 *Development Act 1993*

Under the *Development Act 1993*, local councils and the state Development Assessment Commission (DAC) seek advice from the NVC regarding applications for land sub-division, where the development may impact on native vegetation. However, the decisions made by local councils and the DAC may go against the advice of the NVC. Any approved development within an area of intact native vegetation is subject to the regulations of the NV Act.

1.5.5 *Crown Lands Act 1929*

The *Crown Lands Act 1929* (CL Act) regulates the use of crown land under the care of local government (*e.g.* cemetery reserves, water reserves, stone reserves, and parklands). Numerous sub-populations of the species in this recovery plan occur on CL Act reserves. Crown land under the care of local government can be proclaimed as Conservation Reserves under the CL Act, and managed for biodiversity conservation purposes.

1.5.6 *Forestry Act 1950*

The *Forestry Act 1950* (FA Act) regulates the use of land gazetted for the purpose of forestry. ForestrySA manages large areas of native vegetation in the Mount Lofty Ranges, which contain sub-populations of species in this recovery plan. Native Forest Reserves can be proclaimed under the FA Act for purposes relating to the conservation and management of land supporting flora and fauna.

1.5.7 *Native Title Act 1993*

Generally the *Native Title Act 1993* (NT Act) requires certain procedures to be followed prior to undertaking activities, known as future acts that may include certain recovery actions in this recovery plan, which may affect Native Title rights and interests. The relevant provisions of the NT Act will be considered before undertaking any future acts that might affect Native title. Procedures under the NT Act are additional to those required to comply with the *Aboriginal Heritage Act 1998*.

The requirements of the NT Act only apply to land where Native Title rights and interests may exist. When implementing any recovery actions in this recovery plan where there has been no Native Title determination, or where there has been no clear extinguishment of Native Title, there will be consideration of the possibility that Native Title may continue to exist. This recovery plan will be adopted and released subject to any Native Title rights and interests that may continue in relation to the land and/or waters. Nothing in this recovery plan is intended to affect Native Title.

1.6 International Obligations

1.6.1 Convention on International Trade in Endangered Species

All of the species covered by this recovery plan are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), except for *Caladenia intuta*, *Pterostylis bryophila*

and *P.* sp. Halbury. CITES has established a worldwide system of controls on international trade in threatened wildlife. The legislative basis for meeting Australia's responsibilities under CITES is now provided by Part 13A of the EPBC Act. All of the actions identified in this recovery plan are consistent with Australia's obligations under CITES.

1.6.2 Convention on Biological Diversity

Australia is a signatory to the *Convention on Biological Diversity* (CBD). The primary aims of CBD are the conservation and sustainable use of biological diversity. CBD emphasises the need for *in situ* conservation measures, and promotes the recovery of threatened species. The main implementation tools for the Convention are national strategies, plans or programs. This recovery plan is consistent with Australia's obligations under CBD.

1.7 Planning Context

This recovery plan contributes to the objectives of the following strategies and plans:

- *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996)
- *State Natural Resources Management Plan 2006* (DWLBC 2006)
- *No Species Loss: A Biodiversity Strategy for South Australia 2006-2016* (DEH 2007)
- *Creating a Sustainable Future: an Integrated Natural Resources Management Plan for the Adelaide and Mount Lofty Ranges Region* (AMLR NRMB 2008)
- *Draft Northern and Yorke NRM Plan* (N&Y NRMB 2008)
- *Biodiversity Plan for the Northern Agricultural Districts* (Graham *et al* 2001)
- *Regional Recovery Plan for Threatened Species and Ecological Communities of Adelaide and the Mount Lofty Ranges, South Australia* (Willson & Bignall 2009)

1.8 Affected Interests and Community Involvement

1.8.1 Affected interests

The twelve species covered by this recovery plan occur across a variety of land tenures, including NP&W Act reserves, CL Act reserves, road reserves, water reserves, forestry reserves, and private land. Consequently there are numerous public land management authorities and private landholders that will be affected by the implementation of this recovery plan (refer to Table 3). Further details on the landholders for each sub-population of the species in this plan are provided in Part B. There are also numerous government agencies and non-government organisations that may be involved in the implementation of this recovery plan (refer to Table 3). All affected interests have been invited to comment on a draft of this plan prior to endorsement.

This recovery plan recommends that landholders are encouraged to participate in the implementation of recovery actions for species in this plan, such as weed control, surveys, monitoring, herbivore control, caging, and fencing. It also recognises the effectiveness of integrated management and therefore recommends that other government agencies, non-government organisations and adjoining landholders be involved with the implementation of this recovery plan where possible. Suggested delivery groups for the implementation of recovery actions for each species have been provided in Part B of this plan.

1.8.2 Community involvement

Since 1998 members of community groups, tertiary students, and other individuals have contributed over three thousand voluntary hours per year to the LBTORP. This has significantly increased the operational capacity of the project. This recovery plan recommends that community groups, students and individuals are encouraged and adequately trained to participate in threatened species recovery, including weed control, surveys, monitoring, caging, fencing, hand pollination, translocation and research.

1.8.3 Research institutes and businesses

There are numerous research institutes and businesses that have assisted with implementing recovery actions for the species in this plan, such as *in vitro* seedling propagation, endophyte isolation, genetic analysis, and other areas of scientific research (refer to Table 3). Where possible the involvement of research institutes and businesses in implementing recovery actions for each species has been identified in Part B of this recovery plan.

A list of landholders, community groups and other project partners is provided in Table 3. The involvement of these parties in the implementation of this recovery plan is specified in Part B.

1.8.4 Indigenous interests

This recovery plan was referred to the Aboriginal Partnerships Section of DEH, which has undertaken consultation with the relevant indigenous communities, namely the Barngala, Kaurna, Narrunga, Ngadjuri, Ngarrindjeri, Nukunu and Peramangk people. The standard process adopted by Aboriginal Partnerships is to contact each community, inform them of the plan and provide fact sheets information on the relevant species. Comments are requested by a set date and if no comment is forthcoming a personal follow-up reminder is made. For this recovery plan no comments were received.

The recovery plan will be adopted and released subject to any Native Title rights and interests that may continue in relation to the land and/or waters. Nothing in this plan is intended to affect Native Title (refer to section 1.5.7).

1.9 Biodiversity Conservation Benefits

The implementation of this recovery plan has numerous potential benefits for broader biodiversity conservation. Principally this will be through the protection and management of habitat, and increasing community awareness and involvement in biodiversity conservation.

From 1998 to 2006 the LBTORP achieved the following management outcomes, which have had significant biodiversity conservation benefits:

- 42 sites had weed control programs implemented;
- 15 sites were fenced to exclude stock, and/or rabbits;
- 2 private properties were protected under Heritage Agreement;
- 13 community groups were actively involved in site management;
- Approximately 60 community volunteers were specifically trained in bush care, including minimal disturbance weed control and plant identification.

Many sub-populations of species in this recovery plan occur in sites of high conservation significance. Some sites contain other nationally threatened plant species, including *Acacia rhetinocarpa*, *Caladenia brumalis*, *C. conferta*, *C. tensa*, *Euphrasia collina* subsp*. osbornii* and *Glycine latrobeana.* Most sites also contain other species of state or regional conservation significance.

Many of the vegetation communities in which the species occur are recognised for their high conservation significance, including Peppermint Box (*Eucalyptus odorata*) Grassy Woodland, which is listed as a critically endangered ecological community under the EPBC Act. Therefore the protection and management of these habitats will have significant biodiversity conservation gains.

Orchids also have wide public appeal and can therefore be used as 'flagship' species for engaging the public and raising awareness. They are also useful indicators of ecological condition due to their sensitivity to environmental change and interrelationships with pollinators and mycorrhiza. This makes them particularly useful for highlighting the significance of environmental issues such as climate change, land clearance, habitat fragmentation, and weed invasion.

The implementation of this recovery plan is unlikely to have any negative impacts on other species or ecological communities.

1.10 Social and Economic Impacts

The implementation of this recovery plan will have numerous social and economic benefits. This will be mainly through increasing community awareness, involvement, and skills in natural resource management. Local community groups will be encouraged, supported and trained to undertake natural resource management activities in their region. This plan may also assist community groups in obtaining community grants for conservation projects. Other benefits include the control and prevention of spread of proclaimed weeds and other introduced plants and animals that have an impact on agricultural production.

The implementation of this plan is unlikely to cause significant adverse social and economic impacts. It is not expected to affect public land usage to any great extent, and any changes to private land management practices will occur at the land manager's discretion. Continued liaison with the community, affected landholders and land management agencies will address and minimise any unforeseen negative social impacts arising from the implementation of this plan.

Table 3: Affected interests – Government and non-government agencies and community groups.

National Stakeholders
Australasian Native Orchid Society
Australian National Herbarium
Australian Orchid Foundation
Australian Plant Society
Department of the Environment, Water, Heritage and the Arts (Australian Government) (DEWHA)
Botanic Gardens and Parks Authority (Western Australian Government)
State Stakeholders
Botanic Gardens of Adelaide (South Australian Government)
SA Country Fire Service
Department for Environment and Heritage (South Australian Government)
Department of Sustainability and Environment (Victorian Government)
Department for Transport, Energy and Infrastructure (South Australian Government)
Department of Water, Land and Biodiversity Conservation (South Australian Government)
Flinders University
ForestrySA (South Australian Government)
National Trust of South Australia
Native Orchid Society of South Australia
SA Water (South Australian Government)
State Herbarium of South Australia (South Australian Government)
Threatened Plant Action Group
Trees for Life
University of Adelaide
University of South Australia
Regional Stakeholders
Adelaide and Mount Lofty Ranges Natural Resource Management Group
Adelaide Hills Council
Asparagus Weeds Working Group
Barossa Council
City of Playford
Clare and Gilbert Valleys Council
City of Victor Harbor
District Council of Yorke Peninsula
Friends of Belair National Park
Friends of Brentwood Cemetery
Friends of Bushland Park
Friends of Halbury Parklands
Friends of Kaiserstuhl Conservation Park
Friends of Mount Billy Conservation Park
Friends of Scott Creek Conservation Park
Friends of Spring Gully Conservation Park
Northern and Yorke Natural Resource Management Group
Port Julia Progress Society
Regional Council of Goyder
South Para Biodiversity Project
Tiers Biodiversity Project
Wakefield Regional Council
Western Orchid Laboratories

2. General Species Information

2.1 Nomenclature

Orchidaceae is a taxonomically complex family, and many South Australian orchid species have been subject to name changes and reclassifications in recent years. Several of the species included in this recovery plan have been described as distinct taxa in the last twenty years (refer to Table 4). For example *Caladenia argocalla* and *C. behrii* were previously grouped under *Caladenia patersonii*, but are now recognised as distinct species (Jones 1991). Similarly *Caladenia macroclavia* was previously included under *C. dilatata*, but is now recognised as a separate species (Jones 1991). Several new orchid species have also recently been discovered in South Australia, including *Caladenia intuta*.

In 2001 and 2002 major taxonomic revisions of the genera *Caladenia* (Jones *et al* 2001) and *Pterostylis* (Jones & Clements 2002[a]) were published. However, there is ongoing dispute about these revisions, and therefore many of the new genera have not been accepted by the Council of Heads of Australasian Herbaria or the State Herbarium of South Australia, and are consequently not used in this recovery plan.

Orchid nomenclature used in this plan follows the names accepted by the Council of Heads of Australasian Herbaria, as published in the Australian Plant Census (CHAH 2009), and the State Herbarium of South Australia (DEH 2009). (Refer to Table 4 for the currently accepted nomenclature, authority and synonyms for each species.)

Table 4: Current nomenclature for each species.

Current Name and Authority	Synonyms
Caladenia argocalla D.L.Jones	*Arachnorchis argocalla* (D.L.Jones)D.L.Jones & M.A.Clem. *Caladenia patersonii* auct.non R.Br.: J.Z.Weber & R.J.Bates(1986), partly
Caladenia behrii Schltdl.	*Arachnorchis behrii* (Schltdl.)D.LJones & M.A.Clem. *Caladenia patersonii* auct.non R.Br.: J.Z.Weber & R.J.Bates(1986), partly
Caladenia gladiolata R.S.Rogers	*Arachnorchis gladiolata* (R.S.Rogers)D.L.Jones & M.A.Clem.
Caladenia intuta (D.L.Jones)R.J.Bates	*Arachnorchis intuta* D.L.Jones *Caladenia* sp. Brentwood (R.J.Bates 53510) R.J.Bates
Caladenia macroclavia D.L.Jones	*Arachnorchis macroclavia* (D.L.Jones)D.L.Jones & M.A.Clem. *Caladenia dilatata* auct.non R.Br.: J.Z.Weber & R.J.Bates(1986), partly
Caladenia rigida R.S.Rogers	*Arachnorchis rigida* (R.S.Rogers)D.L.Jones & M.A.Clem. *Caladenia huegelii* Rchb.f. var. *rigida* (R.S.Rogers)J.Z.Weber & R.J.Bates
Caladenia woolcockiorum D.L.Jones	*Arachnorchis woolcockiorum* (D.L.Jones)D.L.Jones & M.A.Clem.
Caladenia xantholeuca D.L.Jones	*Petalochilus xantholeucus* (D.L.Jones)D.L.Jones & M.A.Clem. *Caladenia carnea* R.Br. var. *A* R.J.Bates & J.Z.Weber(1990)
Pterostylis bryophila D.L.Jones	*Diplodium bryophilum* (D.L.Jones)D.L.Jones & M.A.Clem. *Pterostylis obtusa* auct.non R.Br.: J.Z.Weber & R.J.Bates(1986)
Pterostylis cucullata R.Br. ssp. *sylvicola* D.L.Jones	*Pterostylis cucullata* R.Br., partly
Pterostylis despectans (Nicholls)M.A.Clem. & D.L.Jones	*Oligochaetochilus despectans* (Nicholls)Szlach. *Pterostylis rufa* R.Br. var. *despectans* Nicholls
Pterostylis sp. Halbury (R.Bates 8425)	*Oligochaetochilus lepidus* D.L.Jones *Pterostylis* aff. *boormanii* Rupp R.J.Bates & J.Z.Weber(1990)

2.2 Distinguishing Morphological Features

The morphological features that distinguish each of the species in this plan are summarised in Table 5, along with the flowering times of each of the species. More detailed information on each species is provided in Part B of this plan.

Table 5: Morphological features and flowering for each species.

Species	Distinguishing Morphological Features	No. Flowers	Flowering Time
Caladenia argocalla	Large white flowers, with long deflexed to drooping lateral sepals and petals. Labellum usually white, sometimes crimson. Tips of perianth segments are thickened, glandular and filiform (not clubbed). Flowers not perfumed.	One or two	Sept-Oct
Caladenia behrii	Large creamy white and pink flowers, with long spreading then drooping lateral sepals and petals. Labellum apex is bright reddish-pink. Perianth segments have thickened, filiform, dark, glandular tips (no clubs). Flowers have strong musky fragrance.	One or two	Aug–Sept
Caladenia gladiolata	Small green and red-striped flowers, with spreading, decurved segments. Perianth segments are drooping, with large, bayonet-shaped, glandular clubs. Flowers have strong musty fragrance.	One or two	Aug-Sept
Caladenia intuta	Small white flowers, with stiffly spreading segments. Perianth segments with short, blackish osmophores, or sometimes sepals have thin imperfect clubs.	One or two	Aug-Sept
Caladenia macroclavia	Moderately small yellowish-green and red flowers, with obliquely decurved segments. Sepals with large, thick, brown glandular clubs. Labellum margins have thin green teeth.	One (rarely two)	Aug-Sept
Caladenia rigida	Moderately large crystalline white flowers, with stiffly spreading segments. Sepals with red, glandular clubs. Perianth segments with red stripe beneath.	One or two (rarely three)	Aug-Sept
Caladenia woolcockiorum	Moderately large cream to yellowish flowers, with long deflexed to drooping perianth segments. Perianth segments with thickened, filiform, dark glandular tips (no clubs). Labellum apex is rose-red. Flowers have strong musky fragrance.	One or two	Aug-Sept
Caladenia xantholeuca	White flowers with yellow calli on the labellum and margins. Lateral lobes of labellum are large and entire. Green column.	One to four	Sept-Oct
Pterostylis bryophila	Small erect, shiny green and white striped flowers. Sinus prominent, with broad, out-curved margins. Labellum tip blackish, just visible above the sinus. Dorsal sepal sharply pointed.	One	May-June
Pterostylis cucullata ssp *sylvicola*	Large green and white flowers with red-brown lateral sepals and petals on long stem. Large, dark green, fleshy leaves in loose rosette, spiralling up stem. Sinus deeply notched, not bulging. Labellum broad, not protruding when set.	One (rarely two)	Sept-Oct

Species	Distinguishing Morphological Features	No. Flowers	Flowering Time
Pterostylis despectans	Small green, white and brown flowers on short spike with long decurved pedicels, often placed near ground. Lateral sepals tapered into long, free filiform tips, often horizontal or touching ground. Labellum with acute apex, and two prominent basal bristles.	One to six	Nov-Dec
Pterostylis sp. Halbury	Moderately small green, brown and white flowers, Lateral sepals wider than the hood, with few cilia along basal margins and long filiform tips. Labellum is short and broad.	One to twelve	Sept-Oct

2.3 Biology

All of the orchid species covered in this recovery plan are deciduous terrestrial geophytes, which produce leaves and flowers from underground tubers in an annual growth cycle. At the beginning of the growing season, which for most species is autumn, a new shoot is produced by the tubers, which grows to the surface of the soil and develops into leaves and a flower spike through winter and spring. All of the species in this plan produce a new tuber during winter to spring each year which replaces the old tuber. The replacement tuber in some species is formed deeper in the soil each year. *Pterostylis bryophila* is also capable of asexual reproduction through the production of multiple new tubers, and can often form large colonies. All of the species in this plan are dormant over the dry and hot summer months.

Mature plants do not necessarily produce leaves and flowers each year, and can remain dormant or sterile for one or more consecutive years. All of the species tend to flower more profusely if there is high rainfall during the growing season (particularly in autumn and winter), however most species will still produce leaves and a reduced number of flowers in drought years.

The *Caladenia* species covered by this recovery plan generally produce a single flower, but some will occasionally produce two or three, with the exception of *C. xantholeuca* which is always multi-flowered. *Pterostylis bryophila* and *P. cucullata* subsp. *sylvicola* produce a single flower (or occasionally two), while *Pterostylis despectans* and *P.* sp. Halbury are multi-flowered (refer to Table 5). Peak flowering time for most of the *Caladenia* species is spring, whereas peak flowering time for the *Pterostylis* species varies considerably from winter to summer (refer to Table 5). The longevity of flowers can range from a few days to many weeks depending on the species, pollination success, and climatic conditions. Seed capsules take five to seven weeks to mature following pollination, and contain thousands of tiny dust-like seeds that are dispersed by wind.

In natural conditions very few orchid seeds germinate and develop into mature plants. Orchid seed has minimal reserves and is short-lived under natural conditions (i.e. less than 12 months). Germination is strongly dependent on infection by specialised mycorrhizal fungus and also requires favourable climatic conditions in the following growth season (refer to Section 2.3.2). Development of seedlings into mature plants can take up to three or more years depending upon the growing conditions and the species involved. Once maturity is reached the orchids are capable of surviving for many years, provided conditions are favourable.

2.3.1 Pollination

All of the species in this recovery plan are pollinated by insects, which are attracted by deception. Sexual deception is used by some of the *Caladenia* species in this plan to attract male thynnid wasps (e.g. *Caladenia behrii*, *C. gladiolata*, *C. macroclavia* and *C. woolcockiorum*). These orchids emit a chemical substance known as a kairomone or allomone, which is similar to the sexual pheromone produced by the female wasp. The sepals of known wasp-attracting *Caladenia* species have enlarged, glandular tips which are thought to be the source of the kairomone (Bates & Weber 1990). Male thynnid wasps attempt to mate with the labellum or labellum calli and in doing so collect pollinia on the head, thorax or abdomen where it cannot be easily removed by the insects. When the insects visit another flower the sticky pollinia is transferred to the receptive stigma at the base of the column. *Caladenia* species that use sexual deception to attract male wasps usually exhibit highly specific, usually one-to-one relationships with their pollinators (Bower 1992).

Some of the *Caladenia* species in this recovery plan are thought to be pollinated by native bees (e.g. *Caladenia rigida, C. intuta* and *C. xantholeuca*). These species are generally white in colour and are thought to use food deception to attract pollinators, as there is no obvious source of liquid nectar. Little is known about the glandular structures of such flowers. It is thought that they may produce superficial nectar, oil or other unidentified secretions that are collected by the insects (Bates & Weber 1990), in fact Faast *et al* (unpublished) was able to detect minute amounts of nectar on *Caladenia rigida* flowers.

The *Pterostylis* species in this recovery plan are pollinated by flies belonging to the families *Mycetophilidae* and *Culicidae* (Bates & Weber 1990, Bates 2008). Exactly what attracts the insects to the flowers is unknown, as the flowers are generally dull green or brown, rarely scented, and do not offer nectar. Sexual deception is thought to be involved in attracting insects to some *Pterostylis* species (Jones & Clements 2002[b]). When insects land in the vicinity of the labellum it is triggered, rapidly pushing the insect towards the column where it is momentarily trapped, and is forced to exit through the column wings. The insects incidentally collect and transfer pollinia in the process.

2.3.2 Mycorrhiza

Orchids are generally known to grow in symbiosis with mycorrhizal soil fungi. Mycorrhiza play a crucial role in enabling seedling germination and growth in many orchid species, by facilitating the absorption of nutrients, carbohydrates, water, amino acids, and vitamins (Zettler *et al* 2003). Following germination, seed reserves are only sufficient to sustain the development of corm-like structures known as protocorms until mycorrhizal infection is established. The fungi infect the cells of protocorms, as well as the tubers, roots and stem collars of mature plants, forming hyphal coils within the cells. This symbiotic relationship with fungi, whose hyphae are digested during growth, exists with all species and may persist throughout the life cycle of the orchid.

Orchid fungi relationships are complex. *In vitro* studies have shown that some species of orchids germinate in association with several different species of fungi, while other species have been found to only germinate in association with a specific species of fungus (Zettler *et al* 2003). Furthermore, fungal succession has been found to occur in some orchid species, with sequential changes in mycorrhizal association at different growth stages. Most fungi that form orchid mycorrhiza belong to the form-genus *Rhizoctonia*.

Mycorrhizal fungi have been isolated from *Caladenia behrii*, *C. gladiolata*, *C. intuta*, *C. woolcockiorum, Pterostylis despectans* and *P.* sp. Halbury. Seedlings of *Caladenia behrii*, *C. gladiolata* and *Pterostylis* sp. Halbury have been germinated in symbiosis with the fungi *in vitro*, but none of the fungi have been identified. Given the complexity of orchid-fungi interactions it may be necessary to collect a variety of isolates from each of the species in this recovery plan.

2.3.3 Response to fire and disturbance

None of the species in this recovery plan require fire to flower, however most are known to survive summer fires which coincide with the dormancy phase of the orchids. Some orchid species are known to flower more prolifically in the years immediately after hot summer fires. Anecdotal evidence suggests that *Caladenia rigida* and *C. xantholeuca* can flower prolifically in the years immediately following summer fires, and it is possible that some of the other *Caladenia* species in this plan may also increase flowering after summer fires, but this is yet to be verified.

Pterostylis bryophila and *Pterostylis cucullata* subsp. *sylvicola* are both known to decline after fire, and to gradually increase vegetatively with time since fire. It is presumed that the tubers of these species are destroyed or damaged by fire because they occur close to the soil surface. Similarly orchid seedlings that occur near to the surface are likely to be destroyed by fire.

Fire during the active growth season of the orchids is likely to have a detrimental impact on all of the species in this plan, especially during winter and spring. It is thought the orchids are most vulnerable when they are actively growing and replacing the parent tubers (April – November).

Caladenia gladiolata populations in Mount Remarkable National Park have been known to respond favourably to vegetation clearance and soil disturbance, with large increases in the number of flowering plants and seedling recruitment (Bates 1996). However, disturbance trials aimed at replicating this response failed to promote increased emergence, flowering and recruitment of *C. gladiolata* (Quarmby et al 2008). It is presumed that prolonged drought conditions in the years following the disturbance treatments may have influenced the results of the trial.

There is also some anecdotal evidence to suggest that *Caladenia behrii*, *C. rigida* and *C. woolcockiorum* may respond to soil disturbance, with many populations occurring in disturbed sites

along roadsides and tracks. It is thought that seedling recruitment in these species may be enhanced by soil disturbance, as has been shown with other *Caladenia* species (Batty 2005; Wright et al. 2007).

2.4 Threats

All of the species in this recovery plan are subject to a wide range of threats, which are collectively contributing to species decline. General information regarding each of the threats to the species in this plan is provided below. The specific threats to each of the species are listed in Part B.

2.4.1 Climate change

Climate change is a significant long-term threat to all of the species in this recovery plan. While these species have evolved to cope with large year-to-year climatic variability, they have limited capacity to adapt to predicted long-term changes in the average climate, especially decrease in annual average rainfall, and increase in average annual temperature and number of extreme hot days.

Small population sizes, habitat fragmentation, limited ranges, specific habitat requirements, and/or complex interrelationships with mycorrhiza and pollinators may further reduce the species ability to adapt to climate change. Many of the other threats listed below may also increase in frequency and severity with climate change (*e.g.* weed invasion, wildfire, lack of pollination, and lack of recruitment).

2.4.2 Vegetation clearance

The broad-scale clearance of native vegetation that has occurred in the Lofty Block region since European settlement has resulted in habitat loss and population decline for many of the species. Broad-scale vegetation clearance has also resulted in habitat fragmentation, with many sub-populations confined to smaller, isolated remnants of native vegetation with little or no potential for out-crossing. These sub-populations have a restricted capacity for expansion, and are more susceptible to climate change, stochastic events, and edge effects.

Native vegetation clearance has been restricted in South Australia since 1983, and is currently regulated under the *Native Vegetation Act 1991.* While this largely prevents the clearance of remnant native vegetation in South Australia, legal and illegal incremental vegetation clearance for purposes such as residential development, road and track construction and maintenance, firebreak construction, and fencing is still a significant threat to some species. Clearance of habitat critical to the survival of any of the species in this recovery plan could have a significant impact on their long-term survival.

2.4.3 Weed invasion

Weed invasion is a significant threat to all of the species covered by this recovery plan. The weed species listed in Appendix D have been identified as having significant impact on habitat quality for the species in this plan through direct competition for resources including light, nutrients, space and moisture. They may also cause secondary impacts, which include the alteration of hydrological cycles, fire regimes, and microclimate conditions such as soil pH and nutrient levels. Weed invasion has already contributed to the extinction of numerous sub-populations of species in this plan, including *Caladenia gladiolata*, *C. woolcockiorum, Pterostylis cucullata* subsp. *sylvicola* and *P. bryophila* (Bickerton 2001[a]; 2002[a]; 2003[b], Davies 2004).

2.4.4 Herbivory

Herbivory by native and introduced animals (*e.g.* macropods, rabbits, hares, deer, possums, birds, and invertebrates) is a threat to many sub-populations. Herbivory does not necessarily kill mature individuals, unless the tubers are eaten or dug out, but it has the capacity to significantly reduce or prevent flowering and seed set. Seedlings are at extreme risk from herbivory, especially by rabbits and hares. While the level of herbivory tends to vary between years, high rates of herbivory are a frequent occurrence for some sub-populations. Herbivory is particularly threatening for small sub-populations.

2.4.5 Livestock grazing

Grazing by livestock, especially sheep is a significant threat to some sub-populations. Regular grazing by livestock, particularly during the active growing season of the species, can significantly reduce reproductive success and recruitment. Hard-hoofed livestock can also cause significant damage to sub-populations by trampling. Livestock grazing may also contribute to weed incursion, through seed dispersal and soil disturbance.

2.4.6 Lack of pollination

Lack of pollination is a threat to many sub-populations. While there is often yearly variation in pollination levels, many sub-populations have consistently low levels of pollination. The decline or extinction of pollinators is thought to be the main cause of the lack of pollination. Habitat loss, modification and fragmentation, pesticide drift, and competition from Honeybees (*Apis mellifera*) are thought to be potential causes for pollinator decline or extinction. Small sub-populations often tend to be at risk from lack of pollination, due to their reduced ability to attract pollinators.

2.4.7 Lack of recruitment

Lack of recruitment is a threat to many sub-populations. While many of the threats listed in this section are known to affect recruitment (*e.g.* herbivory and lack of pollination) there are potentially other unknown contributing factors. These may include low seed viability, mycorrhizal fungi, and other germination requirements (*e.g.* disturbance). Further research is needed to determine the causes for lack of recruitment, and the requirements for recruitment.

2.4.8 Inbreeding and loss of genetic diversity

Many of the species have small population sizes, or consist of numerous, isolated small sub-populations. Small sub-populations unable to effectively exchange genetic material with other sub-populations are at risk from decreased levels of genetic variation, inbreeding depression and higher rates of deleterious mutations. This may have impacts on reproduction, recruitment, susceptibility to disease, and ability to adapt to environmental change, all of which may eventually lead to a decline in the number of individuals over time.

2.4.9 Road and track management activities

Many sub-populations of species occur within road reserves, or near vehicle tracks on public land. Many road and track management activities have the potential to impact on sub-populations in adjacent vegetation, including grading unsealed roads, widening, bituminising, stock-piling materials, constructing turnout drains, pruning vegetation, and spraying herbicide. Not only can these activities have a direct impact on sub-populations, they can also induce weed and pathogen incursion. The construction of management vehicle tracks is also a potential threat to some sub-populations.

2.4.10 Utilities management

Some sub-populations of species occur within power, water and telecommunication easements. Management activities associated with these utilities, (*e.g.* trench digging, vegetation pruning, vegetation clearance, and herbicide spraying) pose a threat to some sub-populations. Not only can these activities have a direct impact on sub-populations, they can also induce weed and pathogen incursion.

2.4.11 Fire management activities

Fire management activities such as prescribed burning are a threat to some of the species in this recovery plan. *Pterostylis bryophila* and *Pterostylis cucullata* subsp. *sylvicola* are known to be fire sensitive because their tubers are relatively shallow, and therefore prescribed burning in habitat critical to the survival of these taxa is likely to damage the tubers. For the same reason these taxa would also be sensitive to bushfire and other mitigating actions such as bushfire protection at selected sites may be required.

Furthermore, prescribed burning and slashing firebreaks during the active growth period of any of the orchids in this plan (April – November) is likely to damage or destroy orchids, especially during winter and early spring. It is also likely that overly frequent burning or slashing (i.e. <5 years intervals), especially during the orchids' growth period could reduce flowering and recruitment. Burning can also increase the proliferation of fire-stimulated weeds.

2.4.12 Recreational activities

Recreational activities including walking, orienteering, horse riding, mountain biking, motorbike riding, and off-road vehicle driving are a threat to some orchid sub-populations. These activities can cause direct damage to plants on or adjacent to tracks and trails (*e.g.* trampling, crushing, uprooting *etc*). They also cause soil compaction and habitat degradation, and are also potential vectors for weeds and pathogens. Many existing tracks, trails, and foot paths used for recreation dissect sub-populations, and other legal and illegal recreational trails have been constructed through sub-populations in recent years.

2.4.13 Trampling

People visiting orchid sites can accidentally damage orchids by trampling, especially the smaller, less visible species (*e.g. Pterostylis despectans*). Sub-populations on public land that are visible from roads, tracks, and walking trails tend to be more susceptible to trampling by the general public. While trampling may not necessarily kill the orchids it can prevent them from flowering and setting seed. Trampling may also have indirect impacts such as soil compaction, and reducing soil moisture by removing litter and bryophyte cover. Some of the habitats are highly sensitive to trampling (*e.g.* fern and lily-rich understoreys, microphytic crusts *etc*). Macropods and hard-hoofed animals such as sheep, cattle and deer also cause significant damage to some sub-populations by trampling.

2.4.14 Illegal collection

All of the species are potentially at risk from illegal collection. Illegal collection of species in this recovery plan has occurred in recent years, and is thought to have contributed to the decline or extinction of small sub-populations of *Caladenia argocalla* and *C. behrii*. The exact locations of each sub-population are not provided within this plan, in an attempt to provide protection against the threat of illegal collection.

2.4.15 *Phytophthora*

Phytophthora are soil and waterborne fungi that cause disease and death in a wide variety of native plant species. *Phytophthora* are a potential threat to some of the species in this recovery plan; however it is unknown whether any of the species are susceptible to *Phytophthora*. According to Velzeboer *et al* (2005), five of the species (*Caladenia argocalla*, *C. behrii*, *C. rigida*, *Pterostylis bryophila, Pterostylis cucullata* subsp. *sylvicola*) are potentially under threat from *Phytophthora* because they occur in Moderate or Low Risk Zones for *Phytophthora*.

2.5 Habitat critical to survival

Regulation 7.09 of the EPBC Act sets out criteria that must be considered in identifying habitat critical to survival of a taxon. For the purposes of this recovery plan habitat critical to survival of each species covered by the plan comprises all of the known locations of the species, including historical locations, and any native vegetation within a 500 metres buffer.

3. Recovery Objectives, Performance Criteria and Actions

3.1 Overall Recovery Objective

The overall recovery objective for each of the species in this recovery plan is to improve the conservation status within a specified timeframe, (*e.g.* from Endangered to Vulnerable within 30 years). The IUCN Red List Criteria Version 3.1 (IUCN 2001) has been used as the measure of conservation status.

3.2 Recovery Objectives and Performance Criteria

Eight recovery objectives and ten performance criteria have been developed for the species in this plan (refer to Table 6). These are primarily based on IUCN Red List Criteria Version 3.1. Specific recovery objectives and performance criteria for each species are listed in Part B of this plan.

Table 6: List of recovery objectives and performance criteria for all species.

Recovery Objectives	Performance Criteria
1. To maintain or increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is maintained, or increased by at least X percent within five years.
2. To maintain or increase the number of extant sub-populations.	2.1 There are at least X extant sub-populations after five years.
3. To maintain or increase the population size of the species.	3.1 The population size of the species is maintained, or increased by at least X percent within five years.
	3.2 At least X sub-populations contain >X mature individuals after five years.
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species is maintained, or increased by at least X percent within five years.
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least X sub-populations are actively managed to improve habitat condition.
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least X private landholders and X public land management authorities are involved in implementing recovery actions for the species during the term of this recovery plan.
	8.2 At least X community groups and X volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.

Note: X represents a variable, which is quantified for each species in Part B of this plan.

3.3 Recovery Strategies and Actions

Eight recovery strategies have been developed for the species in this recovery plan, under which thirty-three recovery actions are grouped (refer to Table 7). Justifications and descriptions of all recovery actions are provided in this section. Specific recovery actions for each species are listed in Part B of this plan, with associated timelines and delivery groups.

Each recovery action may contribute to achieving more than one recovery objective and performance criterion. The relationship between recovery objectives, performance criteria and recovery actions is shown in Appendix E.

3.3.1 Recovery Strategy A: Determine population size and trends

- **Recovery Action A.1 Survey the number and location of flowering plants in each sub-population.**

Justification

Surveying the number and location of flowering plants is vital for determining population size and trends, and for measuring the success of recovery actions. Regular surveys can also result in the discovery of additional plants, and an associated increase in the number of known mature individuals.

Methods
Population surveys involve systemically counting the number of flowering plants and using a GPS to record the location of patches of plants in each sub-population. The recommended methods for undertaking population surveys are described in Quarmby (2005). It is recommended that all sub-populations be surveyed at least once every five years. Population data needs to be entered into the Biological Databases of South Australia (refer to Recovery Action B.3).

- **Recovery Action A.2 Monitor the demographics of selected sub-populations.**

Justification
Annual monitoring of population demographics is vital for determining the rates of flowering, pollination, seed set, recruitment, and herbivory. It will also provide plant longevity data, which is important for devising conservation measures.

Methods
Annual demographic data should be collected for selected sub-populations following the procedure described in Quarmby (2005). Generally this involves permanently tagging individual plants and recording their life history stages (*e.g.* leaf, bud, flower, pollinated, capsule, eaten *etc*) at regular intervals throughout the flowering season each year.

- **Recovery Action A.3 Update database, and analyse demographic data for relevant sub-populations.**

Justification
Demographic data (refer to Recovery Action A.2) should be entered into the Lofty Block Orchid Database (LBODB) so that it can be analysed and compared to previous years. Analysis of demographic data is needed to determine rates of herbivory, pollination, seed set, recruitment etc. It will also indicate the success of particular recovery actions (e.g. reducing herbivory, increasing seed set etc).

Methods
Demographic data for the species in this plan is currently stored in the LBODB, which is managed by DEH. Analysis of demographic data generally involves calculating the number of leaves, buds, flowers, pollinated flowers, and seed capsules for relevant sub-populations, and comparing this data to previous years.

3.3.2 Recovery Strategy B: Determine current extent of occurrence and number of extant sub-populations

- **Recovery Action B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.**

Justification
It is important to search historical locations to determine the presence or absence of the target species. While many historical locations will no longer be suitable due to habitat destruction or degradation, some locations may still contain extant sub-populations. Discovery of additional sub-populations may also increase the known number of mature individuals and extent of occurrence. Some historical locations may contain habitat that is suitable for future translocations, if required.

Methods
Historical locations need to be thoroughly searched for the target species. This may require a methodical approach (*e.g.* transects) and numerous people if the area to be searched is large. It may also require several visits to allow for dormancy. If the target species is located then specimens will need to be collected for the State Herbarium of South Australia and population data will need to be updated in the BDSA (refer to Recovery Action B.3). If the species is not located then the condition of the habitat should be evaluated in terms of suitability for translocation.

- **Recovery Action B.2 Search potential habitat for the species, and evaluate habitat suitability.**

Justification
Searches of potential habitat may result in the discovery of additional sub-populations, and may also increase the known number of mature individuals and extent of occurrence. Some potential habitat may be suitable for future translocations, if required.

Methods
Potential habitat needs to be searched, preferably utilising maps generated by GIS modelling. This may require a methodical approach (*e.g.* transects) and numerous people if the area to be searched is large. It may also require several visits to allow for dormancy. If the target species is located then specimens will need to be collected for the State Herbarium of South Australia, and population data will need to be recorded in the Biological Database of South Australia (refer to Recovery Action B.3). If the species is not located then the condition of the habitat should be evaluated in terms of suitability for translocations.

- **Recovery Action B.3 Update herbarium and BDSA records for the species.**

Justification
It is important to collect accurate records for the State Herbarium of South Australia and Biological Database of South Australia (BDSA) to ensure that current information on the location, habitat type, population size, threats and management requirements of sub-populations is captured. Where relevant, updated survey information should also be supplied to other agencies such as ForestrySA and SA Water for planning and management purposes.

Methods
Specimens should be collected from all sub-populations that are not already adequately represented in the State Herbarium of South Australia. Collections need to be made in accordance with Herbarium standards. Information for the BDSA should be collected using the datasheets for the Plant Population Database and provided to DEH and the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA). Updated information should be regularly supplied to other agencies.

3.3.3 Recovery Strategy C: Mitigate the threats to sub-populations

- **Recovery Action C.1 Control threatening weeds in selected sub-populations.**

Justification
Weed control is needed in and around many sub-populations to prevent weeds from displacing orchids and modifying habitat critical to survival.

Methods
In all situations best-practice 'bush care' techniques should be used to control weeds (refer to Appendix C). These are highly specialised minimal-disturbance weed control techniques (e.g. hand-pulling, cut and swab, drill and fill) that use minimal herbicide and avoid off-target damage. Extra care is needed when working within orchid sub-populations, due to the high susceptibility of orchids to herbicide, especially during the growth season.

- **Recovery Action C.2 Prepare site action plans for selected sub-populations.**

Justification
Site action plans are an important planning tool, which provide detailed recommendations for mitigating threats to a particular site, and can be used by government agencies, landholders, community groups, and volunteers to assist with site management. Site action plans are particularly valuable for sites with more complex management issues.

Methods
TPAG has developed a template for site action plans, which has been used by the LBTORP in the past, and is the recommended template for future site action plans. Generally site action plans include detailed information about the site (*e.g.* location, biota, soils, aspect, hydrology *etc*), threats to the target species, and recommended management actions including timing.

- **Recovery Action C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.**

Justification
Mesh wire cages are an effective means of protecting plants in small sub-populations from vertebrate herbivores. They reduce the number of plants eaten, and therefore contribute to a higher survivorship of flowers and seed capsules.

Methods

Wire cages should be made to fit over a mature individual, or a closely grouped cluster of orchids. It is preferable to enclose the top, and support the sides with stakes. It may be necessary to remove cages during summer to allow some biomass reduction, or to remove weeds from around the orchids. Consideration also needs to be given to the possibility of cages attracting public attention, which may result in trampling, collection, and/or site damage. It is also preferable to avoid products made of galvanised iron because the zinc may have a detrimental impact on the orchids. Many sub-populations already have cages installed that require repair or replacement.

- **Recovery Action C.4 Identify and control threatening herbivores.**

Justification
There is a need to actively control threatening herbivores in and around some sub-populations, where the impacts of herbivores are clearly evident.

Methods
Herbivore control will generally involve introduced species such as rabbits, hares, and deer. There are many management options for controlling these species, such as baiting, warren fumigation and destruction, and shooting. Macropods may also need to be culled in some areas. It is best to approach control programs at a scale appropriate to the species and the landscape. This usually requires an integrated approach across different land tenures. It is also recommended to involve the local NRM officers, where possible.

- **Recovery Action C.5 Erect fences and remove stock from sub-populations.**

Justification
Fences need to be erected around some sub-populations on private land to prevent stock from grazing and trampling orchids, and degrading habitat. In some instances fences may cause an increase in biomass that is unsuitable for orchids, in which case slashing or pulse grazing may need to be considered.

Methods
It is essential that the erection and maintenance of stock-proof fences causes minimal soil disturbance and clearance of native vegetation. Removal of stock from some areas may result in weed proliferation and significant increases in surrounding biomass, which would need to be managed appropriately. All fences will require regular inspection, and need to be repaired when necessary.

- **Recovery Action C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.**

Justification
Artificial pollination can be used to enhance natural levels of seed set. It is particularly useful for ensuring seed set in sub-populations where natural pollination is extremely low or non-existent.

Methods
A Hand Pollination Protocol has been developed for use with the species in this plan (Bickerton 2001[b]) (refer to Appendix B). This protocol provides guidelines for all aspects of artificial pollination. It should be emphasized that artificial pollination should only be performed when there is an observed lack of pollination, or a sub-population is in decline or at high risk of extinction, and with the endorsement of the recovery team or project officer.

- **Recovery Action C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.**

Justification
Some sub-populations are dissected by recreational trails and are threatened by recreational activities (*e.g.* walking, horse riding, mountain biking, motorbike riding, and off-road vehicle driving). These activities can cause direct damage to plants (*e.g.* trampling, crushing, uprooting *etc*) and are also potential vectors for weeds and pathogens.

Methods
Some recreational trails that dissect sub-populations require total closure, while others could be re-routed. Trail closures will generally involve erecting barriers, fences and signs to prevent access, and covering the existing trail with branches, logs, rocks etc. Consideration should be given to the possibility of new trails being created by users to compensate for the trail closure, which may be more of a threat than the existing trail.

- **Recovery Action C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.**

Justification
Phytophthora species are soil and waterborne fungi that cause disease and often death to a wide variety of native plant species. Hygiene procedures need to be adopted by all groups and individuals involved in on-ground recovery actions for species that occur in *Phytophthora* risk zones to prevent the introduction or spread of *Phytophthora*.

Methods
The Phytophthora Threat Management Procedure (DEH 2002) should be used as the basis for implementing hygiene protocols.

3.3.4 Recovery Strategy D: Protect and manage habitat critical to survival

- **Recovery Action D.1 Encourage private landholders to enter into Heritage Agreements.**

Justification
A Heritage Agreement is a conservation covenant between a landholder and the state government that is registered on the land title in perpetuity. Reserving private land under Heritage Agreement provides an additional level of legal protection for sub-populations, and ensures that any future landholders will be sympathetic to conservation. It also provides additional funding opportunities for fencing and on-ground works (*e.g.* weed control, rabbit control).

Methods
All owners of unreserved private land containing sub-populations need to be informed of the benefits of the Heritage Agreement Scheme. There is published information available about the Heritage Agreement Scheme that could be provided to landholders.

- **Recovery Action D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.**

Justification
Some areas of public land could be formally reserved for conservation purposes to provide an additional level of legal protection for sub-populations. It also ensures that land managers are more sympathetic and supportive of biodiversity conservation.

Methods
All managers of unreserved public land need to be encouraged to gazette or zone areas containing sub-populations for conservation purposes under relevant legislation.

- **Recovery Action D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.**

Justification
The Roadside Marker Scheme (RMS) is a state-wide program used by the Department for Transport, Energy and Infrastructure (DTEI) and some local councils to register and protect significant roadside vegetation. A register of significant sites is held in DTEI's Roadside Significant Sites Database (RSSD) or local government databases. The information is used to inform staff, contractors and service authorities involved in works in road reserves. Roadside Markers can also be installed to assist personnel working in road reserves (road authorities, contractors and utilities) in the recognition of significant sites.

Methods
All known sub-populations that occur within DTEI managed road reserves need to be registered as part of the RMS. It is also recommended that all local councils within the AMLR adopt the RMS and maintain an internal database of significant sites. Roadside Markers need to be installed for all sub-populations within all DTEI and council managed road reserves.

- **Recovery Action D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.**

Justification
Protocols for the management of roadside vegetation containing sub-populations are needed to minimise the potential impacts of road management activities. These should be included in the RSSD and local government databases to inform DTEI staff and contractors, councils, and service authorities of the management requirements.

Methods
Protocols for road management activities (*e.g.* bituminising, widening, grading, herbicide spraying, stock-piling *etc*) need to be developed in association with DTEI (Environmental Operations Unit) and local councils. The protocols should be included in the RSSD, roadside vegetation management plans, and local council databases. The protocols also need to be incorporated into the contract specifications for contractors undertaking road management activities.

- **Recovery Action D.5 Develop protocols for track management activities on public land.**

Justification
Protocols for the management of tracks adjacent to sub-populations are needed to minimise the potential impacts of track management activities.

Methods
Protocols for track management activities (*e.g.* grading, slashing, herbicide spraying, stock-piling *etc*) need to be developed in association with relevant land management authorities. The protocols should be incorporated into the contract specifications for contractors undertaking track maintenance.

- **Recovery Action D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.**

Justification
There is need to identify all sub-populations that occur within utility easements, and to develop protocols for utilities management (*e.g.* digging trenches, vegetation clearance, herbicide spraying *etc*) to minimise potential impacts.

Methods
Sub-populations that occur within utilities easements need to be identified using GIS. Protocols for the management of utilities in or adjacent sub-populations need to be developed in association with land management authorities and utilities authorities. The protocols need to be incorporated into the contract specifications for contractors undertaking utility maintenance near sub-populations.

- **Recovery Action D.7 Work with fire management authorities to develop appropriate fire management protocols.**

Justification
Fire management activities (*e.g.* prescribed burning and clearing firebreaks) are potential threats to some of the species in this plan (see Section 2.4.11). There is need to liaise with fire management authorities to minimise potential impacts.

Methods
Liaise with fire management officers within the relevant land management authorities regarding proposed fire management activities within areas containing sub-populations. Devise strategies to prevent potential impacts where necessary (e.g. burning when orchids are dormant). Ensure that there is a commitment to follow-up weed control, where necessary.

3.3.5 Recovery Strategy E: Preserve germplasm and mycorrhizal fungi *in vitro*

- **Recovery Action E.1 Collect seed from each sub-population, and preserve *in vitro*.**

Justification
Orchid seed is short-lived and does not persist in the soil seed bank for more than a few months. Therefore, *in vitro* preservation of seed is an important strategy to preserve genetic diveristy and safeguard against population extinctions. It is possible to propagate large numbers of seedlings *in vitro* using symbiotic or asymbiotic techniques which could be used in the future for translocations or

maintained as *ex situ* populations. Seed can also be preserved over the summer months *in vitro* and then redispersed into populations in autumn to reduce seed dissection rates.

Methods
Seed should be collected according to current best-practice techniques (Ramsay & Dixon 2003). Seed needs to be cleaned, dried to its optimum moisture content, and tested for viability before being stored using current best-practice techniques (Seaton & Pritchard 2003, Ramsay & Dixon 2003). It is generally recommended that orchid seed is stored under cryogenic conditions to maximise long-term viability. This is currently available at the Botanic Gardens of Adelaide, but options for duplicate storage facilities should also be explored.

- **Recovery Action E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.**

Justification

All of the species in this recovery plan are thought to require the presence of mycorrhizal fungi to enable germination and subsequent seedling growth in their natural habitat. Therefore, the mycorrhizal fungi need to be preserved in association with germplasm to enable symbiotic propagation.

Methods

Stem collars need to be collected from relevant sub-populations for isolating mycorrhizal fungi. It may be necessary to collect a section of stem tissue, rather than a whole collar, to avoid the destruction of flowering plants in small sub-populations. It is anticipated that the BGA will undertake fungi isolations using the current best-practice techniques (Ramsay & Dixon 2003, Batty 2005). At least 5 – 10 plates of fungi isolates should be preserved from relevant sub-populations at the Adelaide Botanic Gardens. It is currently recommended to store the fungi isolates under cryogenic preservation.

- **Recovery Action E.3 Undertake *in vitro* seed germination and plant cultivation.**

Justification

There is a need to undertake symbiotic seed germination and plant cultivation *in vitro* to evaluate the effectiveness of fungi isolates (refer to Recovery Action E.2), and to determine the most effective methods of *in vitro* plant propagation. Maintaining *in vitro* populations from sub-populations at risk of extinction also provides a further safeguard against extinction.

Methods
Methods for symbiotic propagation of terrestrial orchid seed are reasonably well developed (Ramsay & Dixon 2003, Batty 2005). These should be tested on the species in this plan to determine which are most effective in collaboration with BGA and Western Orchid Laboratories.

3.3.6 Recovery Strategy F: Determine the feasibility of translocation and implement translocation proposals

- **Recovery Action F.1 Prepare a translocation feasibility assessment for the species.**

Justification
In threatened plant recovery, translocation can be a useful method of a) increasing the size of a sub-population in decline, b) re-establishing a site that has become extinct, or c) establishing a new site for a species with a declining number of sub-populations. However, orchid trasnslocations can be demanding on time, labour and resources. A translocation feasibility assessment for all species in this recovery plan is needed to determine the need, feasibility and methods of translocation over the next five to ten years.

Methods
A translocation feasibility assessment should be prepared according to the guidelines in Vallee *et al* (2004). It should aim primarily to determine whether translocation is necessary and appropriate. It should identify the types of translocation that could be utilised (*e.g.* seed re-dispersal, symbiotic seedling propagation *etc*), and the associated benefits, risks, and costs involved. It should also identify suitable sub-populations for the types of translocation, and potential recipient sites where appropriate.

- **Recovery Action F.2 Prepare and implement translocation proposals for selected sub-populations.**

Justification
If translocation is recommended as part of the translocation feasibility assessment (refer to Recovery Action F.1) then translocation proposals need to be prepared for relevant sub-populations.

Methods
Translocation proposals should be prepared according to Vallee *et al* (2004), and need to be endorsed by DEH and the relevant recovery teams prior to implementation. A translocation proposal has already been prepared and endorsed for *Caladenia gladiolata* at Scott Creek CP (Bickerton 2002[d]), and should be implemented as part of this plan.

3.3.7 Recovery Strategy G: Undertake research related to the species

- **Recovery Action G.1 Encourage, direct and support universities and other researchers to study the biology and ecology of the species.**

Justification
There is urgent need to increase the knowledge of the biology and ecology of each species to provide a better understanding of the factors contributing to species decline, and to inform recovery planning. Knowledge gaps include the understanding of pollination, population dynamics, recruitment, population genetics and response to fire.

Methods
Universities and other research institutes need to be encouraged and supported to undertake necessary research on the species in this plan. Knowledge gaps and research opportunities are identified for each species in Part B of this recovery plan.

- **Recovery Action G.2 Establish and monitor disturbance trials for selected sub-populations.**

Justification
There is need to investigate the response of some of the species to various types of disturbance (*e.g.* fire, soil disturbance, and biomass reduction). It is possible that many of the *Caladenia* species may flower more profusely after fire and vegetation slashing, and that soil disturbance may enhance recruitment.

Methods
Disturbance trials need to be established using scientific design and methodology, with replicated treatments and controls. Treatments may involve fire, soil disturbance, and/or vegetation clearance. Numbers of leaves, flowers, and capsules of the target species should be monitored annually, both prior to the treatments and for at least five years after. The density of other vegetation should also be monitored annually.

- **Recovery Action G.3 Undertake genetic analysis of selected sub-populations.**

Justification
There is a need to determine population genetics of some species in this recovery plan. The genetic variability within and between sub-populations of most species is currently unknown, and studies of other terrestrial orchids have not found any general patterns of genetic variability that can be applied to the species in this plan (Fay & Krauss 2003). Genetic analysis could assist in determining which sub-populations are most important for conserving genetic diversity and identifying sub-populations that are at risk of inbreeding.

Methods
DNA-based methods for undertaking genetic analysis are reasonably well developed (Fay & Krauss 2003), and are already being used on some of the species. The primary aim of genetic analysis should be to determine the levels and partitioning of genetic variability within and between sub-populations of each species, and to analyse gene flows.

3.3.8 Recovery Strategy H: Inform, encourage and support landholders and the community

- **Recovery Action H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.**

Justification
Landholders and land management authorities need to be aware of the location and management requirements of orchid sub-populations on their land. This could prevent accidental damage to sub-populations, and assist in the protection and management of the species. There may also be conflicting management activities (*e.g.* grazing, recreational activities *etc*) that need to be resolved with landholders and management authorities.

Methods

All private landholders and public land management authorities need to be shown the locations of sub-populations, and advised of any management issues and requirements. They should also be encouraged to participate in the implementation of on-ground recovery actions (*e.g.* surveys, monitoring, weed control *etc*). Liaison with landholders and land management authorities should occur regularly, especially prior to the implementation of any on-ground recovery actions.

- **Recovery Action H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.**

Justification
Landholder and community participation is crucial to the successful operation of the LBTORP. The current level of landholder and community involvement needs to be maintained or increased in order to achieve many of the recovery actions in this plan.

Methods
Private landholders and public land management authorities should be encouraged to assist with the implementation of recovery actions (*e.g.* surveys, monitoring, weed control, fencing, herbivore control, caging *etc*). Field-based training may be required to provide landholders and land managers with the necessary skills to undertake recovery actions. Private landholders should also be encouraged and assisted in applying for grants (*e.g.* NRM On-grounds Works Fund) to assist with the implementation of recovery actions where applicable.

Community groups and other volunteers should also be encouraged to participate in the implementation of recovery actions. Field-based training may be required to provide volunteers with the necessary skills to undertake recovery actions. Community groups should also be encouraged and assisted in applying for community grants to assist with the implementation of recovery actions where applicable.

- **Recovery Action H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.**

Justification
There is need to increase public awareness and appreciation of all of the species covered by this plan, and of the LBTORP. This will directly assist in increasing community participation in the recovery project.

Methods
A range of methods can be used to provide information about the species and the recovery project to the public. These include writing articles for newspapers, community newsletters and journals, providing information on websites, and giving public presentations. Attending regional shows is also an effective means of providing information to target areas.

- **Recovery Action H.4 Prepare or update a fact sheet for each species, and disseminate to the public.**

Justification
Fact sheets are an effective means of providing information about threatened plant species to the public. They include information on how to identify the species, suitable habitat, threats, and management requirements. The dissemination of fact sheets can also assist with the discovery of additional sub-populations, especially on private land.

Methods
Fact sheets need to be prepared or updated for all of the species. There are a number of templates available for the design of fact sheets that could be used. Updated fact sheets should be made available to the public through DEH, local governments, NRM boards, community groups, websites, displays, and other means.

Table 7: List of recovery strategies and recovery actions for each species.

Recovery Actions	*C. argocalla*	*C. behrii*	*C. gladiolata*	*C. intuta*	*C. macroclavia*	*C. rigida*	*C. woolcockiorum*	*C. xantholeuca*	*P. bryophila*	*P. cucullata*	*P. despectans*	*P.* sp. Halbury
Recovery Strategy A: Determine population size and trends												
A.1 Survey the number of flowering plants in each sub-population.	x	x	x	x	x	x	x	x	x	x	x	x
A.2 Monitor the demographics of selected sub-populations.	x	x	x	x	x	x	x		x	x	x	x
A.3 Update database, and analyse demographic data for relevant sub-populations.	x	x	x	x	x	x	x		x	x	x	x
Recovery Strategy B: Determine current extent of occurrence and number of sub-populations												
B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	x	x	x		x	x	x	x	x	x	x	x
B.2 Search potential habitat for the species, and evaluate habitat suitability.	x	x	x	x	x	x	x	x	x	x	x	x
B.3 Update herbarium and BDSA records for the species.	x	x	x	x	x	x	x	x	x	x	x	x
Recovery Strategy C: Mitigate the threats to sub-populations												
C.1 Control threatening weeds in selected sub-populations.	x	x	x	x	x	x	x		x	x	x	x
C.2 Prepare site action plans for selected sub-populations.	x	x		x	x	x			x	x		
C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	x	x	x		x	x				x		
C.4 Identify and control threatening herbivores.	x	x	x	x	x	x	x		x	x	x	x
C.5 Erect fences and remove stock from sub-populations.				x							x	
C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	x	x	x		x	x			x	x	x	x
C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.	x	x		x		x			x	x		x
C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	x	x	x	x	x	x	x	x	x	x	x	x
Recovery Strategy D: Protect and manage habitat critical to survival												
D.1 Encourage private landholders to enter into Heritage Agreements.	x	x		x	x	x					x	
D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	x			x	x	x						x
D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	x	x				x					x	x

Recovery Actions	*C. argocalla*	*C. behrii*	*C. gladiolata*	*C. intuta*	*C. macroclavia*	*C. rigida*	*C. woolcockiorum*	*C. xantholeuca*	*P. bryophila*	*P. cucullata*	*P. despectans*	*P.* sp. Halbury
D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.	x	x				x					x	x
D.5 Develop protocols for track management activities on public land.	x	x	x			x	x			x		
D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.	x	x				x					x	
D.7 Liaise with fire management authorities regarding fire management activities.	x	x	x			x	x	x	x	x		
Recovery Strategy E: Preserve germplasm and mycorrhizal fungi *in vitro*												
E.1 Collect seed from each sub-population, and preserve *in vitro*.	x	x	x	x	x	x	x		x	x	x	x
E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	x	x	x	x	x	x	x		x	x	x	x
E.3 Undertake *in vitro* seed germination and plant cultivation.	x	x	x	x	x	x	x		x	x	x	x
Recovery Strategy F: Determine the feasibility of translocation and implement translocation proposals												
F.1 Prepare a translocation feasibility assessment for the species.	x	x	x	x	x	x	x		x	x	x	x
F.2 Prepare and implement translocation proposals for selected sub-populations.[1]	x	x	x	x	x	x	x		x	x	x	x
Recovery Strategy G: Undertake research related to the species												
G.1 Encourage, direct and support universities and other researchers to study the biology and ecology of the species.	x	x	x	x	x	x	x	x	x	x	x	x
G.2 Establish and monitor disturbance trials for selected sub-populations.	x	x	x	x	x	x						x
G.3 Undertake genetic analysis of selected sub-populations.	x	x	x		x	x			x			
Recovery Strategy H: Inform, encourage and support landholders and the community												
H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	x	x	x	x	x	x	x	x	x	x	x	x
H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	x	x	x	x	x	x	x	x	x	x	x	x
H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	x	x	x	x	x	x	x	x	x	x	x	x
H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	x	x	x	x	x	x	x	x	x	x	x	x

[1] Action F.2 is contingent on Action F.1 resulting in translocation being recommended.

3.4 Management Practices

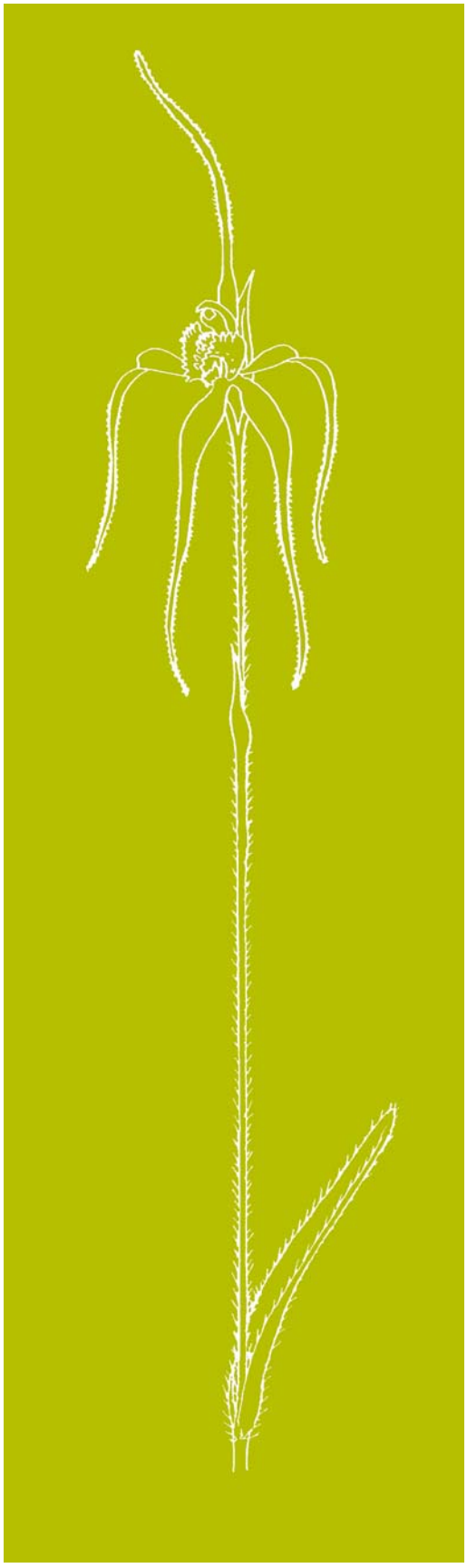
It is important that any management practices that are likely to have a significant adverse impact on habitat critical to the survival of the species in this recovery plan are carefully considered. Generally, it is recommended that any activities that promote or contribute to the threats identified within this plan be avoided where possible. Activities that may result in a significant impact are listed below.

- Clearance of vegetation or earthmoving within habitat critical to survival.
- Inadequate control of weed species in habitat critical to survival.
- Incautious spraying of herbicide within habitat critical to survival, especially during the growth period of the species.
- Inadequate control of pest vertebrates in habitat critical to survival.
- Grazing of livestock in habitat critical to survival.
- Insecticide use in the vicinity of habitat critical to survival.
- The placement of beehives in the vicinity of sub-populations.
- Slashing or burning vegetation in habitat critical to survival more frequently than every five years.
- Slashing or burning vegetation within habitat critical to survival during the growth period of the species (April - November).
- Failure to protect habitat critical to survival from wildfire.
- Construction of management tracks or recreational trails through habitat critical to survival.
- Road and track management activities (*e.g.* grading, bituminising, stockpiling, constructing turnout drains *etc*) within habitat critical to survival.
- Utilities management activities (*e.g.* trench digging) within habitat critical to survival.
- Activities that inadvertently contribute to the spread of *Phytophthora*.
- Dumping vegetation prunings, soil, and other waste within habitat critical to the survival of the species.
- Activities that contribute to excessive foot traffic through habitat critical to survival.
- Excessive collection of plant material from the wild (*e.g.* tubers, flowers, seeds *etc*).

This recovery plan prescribes numerous recovery actions that aim to protect sub-populations from current and potential threats. For example sub-populations within roadside vegetation have been highlighted for protection under the Roadside Marker Scheme, and protocols will be developed to prevent the potential impacts of road management activities on habitat critical to survival.

This plan recognises the importance of informing land management authorities and landholders of the location and recommended management practices for particular sites, and encourages their involvement in the implementation of recovery actions.

Part B: Species Profiles



4. *Caladenia argocalla* (White Beauty Spider-orchid)

4.1 Description

Caladenia argocalla has a single leaf 12 - 22 cm long, linear-lanceolate, and hairy. It has a slender scape (30 – 60 cm tall). It produces one, or sometimes two, flowers up to 9 cm in diameter. Its perianth segments are white to greenish white with narrow, dark central stripes. Its petals and lateral sepals are spreading then drooping, and the dorsal sepal is incurved. The sepals are 9 – 15 cm long, and the petals are 8 cm long, tapering, with dark red glandular filiform tips that are not perfumed. The labellum is ovate-cordate and strongly recurved (2 - 2.5 cm long). The lamina is white-green or crimson, and has margins fringed with teeth. It has 6 to 8 rows of crimson, red or white club-shaped calli extending nearly to apex (Jones 1991, Bates 2008).

Type: South Australia, Kapunda Hills, near Barossa Valley, 16 Sept 1988, R. Bates 15516.

Caladenia argocalla, Spring Gully CP, J Quarmby

4.2 Conservation Status

Caladenia argocalla is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

4.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia argocalla* was assessed according to IUCN Red List Criteria Version 3.1 (IUCN 2001) in 2006 as part of this planning process, and met the criteria for Endangered (EN B1ab(i, iii, iv)c(iv).

Table 8: IUCN Red List Criteria for *Caladenia argocalla*.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km².
EN B1a	Sub-populations are severely fragmented.
EN B1b(i)	There is a projected continuing decline in the extent of occurrence.
EN B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
EN B1b(iv)	There is a projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

4.3 Distribution and Population Size

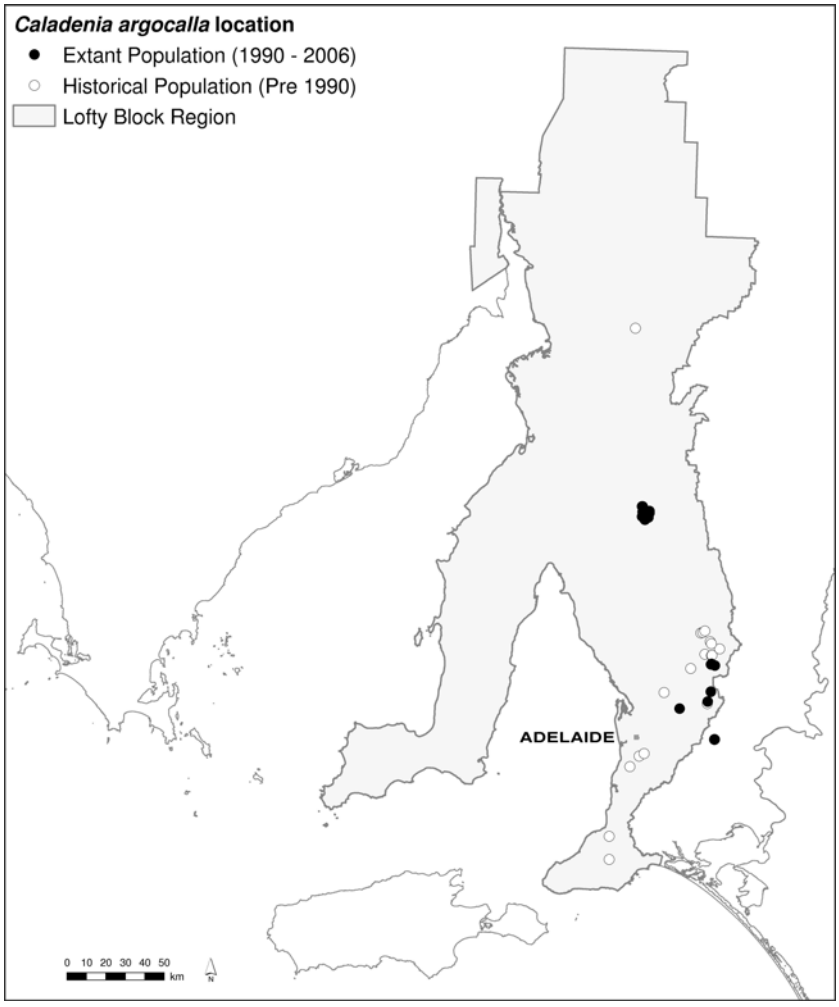
4.3.1 Extent of occurrence

Caladenia argocalla is endemic to South Australia (refer to Figure 2). In 2006 the species was known from 13 sub-populations in the Northern Lofty and Southern Lofty herbarium regions (refer to Table 9). The extent of occurrence of *C. argocalla* in 2006 was 1666 km², and the area of occupancy was 4.3 hectares.

Since the preparation of the previous recovery plan for *Caladenia argocalla* in 2000 (Robertson & Bickerton 2000) up until 2006, an additional eight sub-populations were discovered (1, 2, 4, 6, 7, 8, 11 and 12). This increased the known extent of occurrence and population size considerably. However, four of the additional sub-populations are extremely small and are at high risk of extinction.

Historically, *Caladenia argocalla* was known from sixteen additional sub-populations in the Southern Lofty and Northern Lofty regions (refer to Figure 2). The former extent of occurrence of *C. argocalla* based on historical records is 8171 km². This indicates that the extent of occurrence has declined by at least eighty percent in the last fifty to one-hundred years.

Figure 2: Current and historic distribution of *Caladenia argocalla*.



4.3.2 Population size

The population size of *Caladenia argocalla* was estimated to be approximately 1800 mature plants in 2006, based on the average number of flowering plants in each sub-population per year (refer to Table 9). However, the number of flowering plants in many sub-populations is known to fluctuate extremely from year to year, which makes determining population size very difficult. This is well demonstrated by comparing the total number of flowering plants recorded in 2006 (176) with the highest number of plants recorded from 1998 - 2006 (4687). The main cause of these fluctuations is thought to be rainfall, but other unknown factors may also contribute. Sub-population 1 appears to be in decline and at risk of extinction.

It is assumed that the population size of *Caladenia argocalla* has decreased significantly over the last 50 to 100 years, due to the extinction of historical sub-populations. It is also assumed that many of the extant sub-populations have contracted in size over the last 50 to 100 years.

4.3.3 Important sub-populations

While all sub-populations of *Caladenia argocalla* are important, the four largest sub-populations (5, 7, 8 and 9) are considered to be the most important for conservation of the species because they are most likely to contain high levels of intra-population genetic diversity and are therefore least likely to suffer from loss of genetic diversity through genetic drift and inbreeding. All of these sub-populations are situated within 10 km² of Clare, and comprised ninety-four percent of the total population size in 2006.

Sub-populations 13 and 2 are also very important for conservation because they are the largest sub-populations in the Southern Lofty region, and may contain genetic diversity not found within the sub-populations in the Northern Lofty region.

Sub-populations 1, 3 and 4 are also important because of their outlying distribution. Loss of any of these sub-populations would result in a significant reduction in the extent of occurrence, and potential loss of genetic diversity.

4.4 Land Ownership and Reservation Status

Caladenia argocalla occurs across a variety of land tenures including reserved and unreserved, private and public land (refer to Table 9). Five sub-populations occur within lands reserved for conservation purposes under legislation. Sub-populations 6, 9, 10 and 11 occur within NP&W Act reserves, and sub-population 13 occurs within land under Heritage Agreement.

Sub-populations 1, 2, 3, 5 and 7 occur wholly or partially within road reserves that are managed by Clare and Gilbert Valleys Council, Adelaide Hills Council, or Barossa Council (refer to Table 9). Sub-

population 2 also occurs partially within ForestrySA land (conservation zone). Sub-populations 4, 5, 7, 8 and 12 occur wholly or partially within unreserved private land.

Table 9: Sub-population numbers, trends and threats for *Caladenia argocalla*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Bagshaw Rd	AHC (unreserved)	0 (05)	6 (01)	3	Decline	Road management, lack of recruitment, lack of pollination, herbivory
2	Cricks Mill Rd / Altmann Rd	FSA/BC (unreserved)*	14 (04)	22 (03)	17	Fluctuating	Weed invasion, herbivory, road management
3	Emu Flat	C&GVC (unreserved)	2 (06)	26 (00)	15	Fluctuating	Road management, weed invasion, lack of pollination
4	Harrogate	Private (unreserved)	4 (06)	7 (05)	4	Fluctuating	Herbivory, lack of recruitment, weed invasion, lack of pollination
5	Hughes Park Rd	C&GVC/Private (unreserved)	20 (06)	688 (05)	371	Fluctuating	Weed invasion, trampling, road management
6	Kaiserstuhl CP	DEH (reserved)	2 (05)	2 (05)	2	Fluctuating	Lack of recruitment, collection, lack of pollination, road management
7	Leighton Rd	C&GVC/Private (unreserved)	50 (06)	784 (05)	151	Fluctuating	Weed invasion, herbivory, lack of pollination, road management
8	Sevenhill	Private (unreserved)	20 (06)	2768 (05)	1029	Fluctuating	Weed invasion, herbivory
9	Spring Gully CP	DEH (reserved)	45 (06)	263 (03)	153	Fluctuating	Herbivory, weed invasion, road management
10	Spring Gully CP	DEH (reserved)	2 (06)	27 (03)	17	Fluctuating	Herbivory, trampling
11	Spring Gully CP	DEH (reserved)	1 (02)	1 (02)	1	Unknown	Herbivory, lack of recruitment, lack of pollination
12	Springton	Private (unreserved)	2 (04)	2 (04)	1	Fluctuating	Weed invasion, lack of recruitment, lack of pollination, herbivory
13	Tanunda	Private (reserved)	14 (06)	91 (04)	46	Fluctuating	Herbivory, trampling.
		TOTAL	**176**	**4687**	**1810**	Source: DEH 2006[a], DEH 2006[b]	

*Cricks Mill Road Reserve is not gazetted as a Native Forest Reserve; however ForestrySA manages it as a Conservation Zone.

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix A, which is available from DEH, Threatened Species Unit.

4.5 Habitat

Caladenia argocalla grows in a diversity of *Eucalyptus* woodland communities, usually containing *Eucalyptus leucoxylon.* The sub-populations in the Northern Lofty region typically grow in *E. leucoxylon*

subsp. *pruinosa, E. goniocalyx,* and *Allocasuarina verticillata* open woodland. The understorey vegetation is predominantly herbaceous, often comprising of *Lomandra densiflora*, *Arthropodium strictum*, *Plantago gaudicaudii, Austrostipa* spp., and *Austrodanthonia* spp. The shrub layer is typically sparse and often includes *Acacia pycnantha*, *Bursaria spinosa*, *Exocarpos cupressiformis* and *Hibbertia exutiacies*.

The sub-populations in the Southern Lofty region grow in *Eucalyptus leucoxylon* subsp. *leucoxylon, E. fasciculosa, E. goniocalyx, and E. camaldulensis* woodland. Common understorey species include *Acacia pycnantha, Xanthorrhoea semiplana*, *Hibbertia exutiacies*, *Plantago gaudicaudii*, *Austrostipa* spp., and *Austrodanthonia* spp.

Caladenia argocalla generally grows on gentle hill slopes, often with a southerly aspect. Soils are typically clay loams with high humus content in the surface layer.

4.5.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix A contains maps of habitat critical to the survival of *Caladenia argocalla*, and is available for legitimate purposes from DEH.

4.6 Ecology

4.6.1 Biology

Caladenia argocalla usually produces a leaf in April or May, coinciding with the onset of cool, wet weather. However, it has been found that *C. argocalla* does not always produce a leaf or spike every year (DEH 2006[a]), and the number of flowering plants can fluctuate extremely from year to year. During mid August to mid September *C. argocalla* produces buds, followed by flowering in late September to October. By late October the leaves shrivel and the pollinated flowers develop into seed capsules. In November the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. argocalla* is not known, but is assumed to be more than fifteen years.

4.6.2 Pollination

The pollination of *Caladenia argocalla* has not been properly studied, but it is thought that thynnid wasps and native bees may be possible pollinators. *C. argocalla* is known to hybridise with *C. behrii*, *C. cardiochila* and *C. tensa*. Some of the hybrids are known to have been fertile and will backcross with *C. argocalla*. Often the progeny of such crosses will have a red tip to the labellum (Bates 2008).

4.6.3 Mycorrhiza

Caladenia argocalla grows in symbiosis with mycorrhizal fungi, however fungal isolation and identification is yet to be attempted for *C. argocalla*. Mycorrhizal fungi are known to play an important role in seedling germination and plant growth in many *Caladenia* species.

4.6.4 Response to fire

Caladenia argocalla does not require fire to flower, and there is anecdotal evidence from a fire at Harrogate in January 2007 that suggests the species may be fire sensitive.

4.6.5 Research opportunities

Adelaide University has undertaken research involving *Caladenia argocalla,* including genetic analysis and pollinator baiting. The results of this research are yet to be published.

There is significant need for further research into the aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – including identifying the pollinator;
- Population genetics – determining genetic diversity and population viability;
- Demographics – identifying the causes of population fluctuations;
- Seed ecology – determining *in situ* germination requirements.
- Response to disturbance – determining the effect of soil disturbance, fire, and biomass reduction.

4.7 Threats

4.7.1 Weed Invasion – HIGH

Weed invasion is the most significant threat to *Caladenia argocalla*. Topped Lavender is a serious threat to all sub-populations in the Northern Lofty region, especially 3, 5, 7 and 8. Bulbil Watsonia, Cape Tulip, Soursob, and St John's Wort are also threats to sub-populations in the Northern Lofty region. Gorse, Salvation Jane, Quaking Grass, Bearded Oat, and other introduced grasses are threats to Sub-populations 2 and 4 in the Southern Lofty region.

4.7.2 Lack of pollination – HIGH

Lack of pollination is a significant threat to *Caladenia argocalla*. While natural pollination has been observed in most sub-populations, the average rate of pollination is low (less than ten percent). Sub-populations 3, 4 and 7 have the lowest known levels of pollination. Sub-populations 1, 6, 11 and 12 are also considered to be at risk from lack of pollination due to their small size.

4.7.3 Lack of recruitment – HIGH

None of the sub-populations are known to have increased in size as a result of seedling recruitment. However, it is difficult to assess recruitment due to fluctuations in the number of mature individuals. An attempt to enhance recruitment in Sub-population 10 by re-dispersing seed in 2003 is yet to result in any seedling recruitment.

4.7.4 Herbivory – Moderate

The herbivory of *Caladenia argocalla* by kangaroos, rabbits and hares is a threat to many sub-populations. Sub-populations 1, 2, 9 and 12 are known to be under most threat from high levels of herbivory (DEH 2006[a]). Cages have been placed around plants in Sub-population 12, but are frequently damaged by kangaroos. Kangaroos are thought to be responsible for most of the herbivory based on field observations of kangaroo numbers, scats and tracks. Rabbits and hares are also known to occur widely throughout the areas occupied by *C. argocalla* and are likely to be responsible for some herbivory.

4.7.5 Road and track management activities – Moderate

Five sub-populations occur in road reserves (1, 2, 3, 5 and 7) and are all at risk from road management activities (*e.g.* upgrades, grading, turnout drains) and roadside management activities (*e.g.* herbicide spraying). In recent years the Clare and Gilbert Valleys Council has considered bituminising the road adjacent to Sub-population 3, and in 2009 the road was widened. These activities have the potential for significant impact on this important sub-population.

Sub-populations 6 and 9 occur near park management tracks and are at risk from management activities (*e.g.* grading, turnout drains, vegetation pruning, slashing).

4.7.6 Fire management activities – Moderate

Some sub-populations of *Caladenia argocalla* occur on public land that may be burnt or slashed as part of fire management activities. It is currently thought that burning during the active growth season of *C. argocalla* (April – Nov) could destroy or damage plants. Burning during winter or spring is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations).

4.7.7 Vegetation clearance – Moderate

Incremental native vegetation clearance is a potential threat to sub-populations in road reserves (1, 2, 3, 5 and 7) and on unreserved private land (4, 5, 7, 8 and 12). Legal and illegal vegetation clearance is a potential threat (*e.g.* clearance for residential development, fencing, fire management, grazing, utilities maintenance, and road management activities).

4.7.8 Inbreeding and loss of genetic diversity – Moderate

Some of the very small sub-populations are at risk from inbreeding depression and loss of genetic diversity. While population genetics has not been analysed, it is assumed that isolated sub-populations consisting of less than five mature individuals (1, 4, 6, 11 and 12) are at risk of inbreeding.

4.7.9 *Phytophthora* – Moderate

It is currently unknown whether *Caladenia argocalla* is susceptible to *Phytophthora*, however it is regarded as a potential threat to the species. According to Velzeboer *et al* (2005), *C. argocalla* is regarded as potentially under high threat from *Phytophthora* with fourteen percent of sub-populations occurring within a Moderate Risk Zone for *Phytophthora*, and eighty-six percent occurring within a Low Risk Zone. Many of the plants that grow in association with *C. argocalla* are known to be susceptible to *Phytophthora*.

4.7.10 Trampling – Low

All sub-populations of *Caladenia argocalla* are at risk from accidental trampling, especially during the leaf and early bud stages. Most of the *C. argocalla* sub-populations occur in dense herbaceous understorey vegetation, which makes it difficult to detect *C. argocalla* until it flowers. The herbaceous understorey is also highly sensitive to trampling caused by excessive foot traffic.

4.7.11 Illegal collection – Low

Illegal collection is a potential threat to *Caladenia argocalla*. It is thought that collectors have removed plants from Sub-population 6 in recent years, and other sub-populations are potentially at risk due to their proximity to public roads and tracks. *In vitro* cultivation of this species by orchid enthusiasts is documented (Bates & Weber 1990).

4.7.12 Utilities management – Low

Sub-population 2 is potentially at risk from maintenance of utility services, due to its close proximity to underground powerlines.

4.8 Previous Recovery Actions

The following recovery actions were implemented for *Caladenia argocalla* prior to December 2007.

- *C. argocalla* was included in the LBTORP project in 1998.
- A fact sheet for *C. argocalla* was prepared in 2001 (DEH 2001[f]), and has been publicly disseminated.
- A recovery plan was prepared for *C. argocalla* in 2000 (Robertson & Bickerton 2000). The following recovery actions were achieved prior to 2007:
  - 6.1.2 - Weed control programs were implemented at Sub-populations 3, 5, 8, 9 and 10 since 2000.
    - Bush for Life sites were established at Sub-populations 3 and 5 in 2002.
    - TPAG and NOSSA held annual weeding days at Sub-population 7 since 2002.
    - A site action plan was prepared for Sub-population 7 (Bickerton 2002[b]).
  - 6.3 - Seed was collected from Sub-populations 2, 3, 5, 7, 9, 10 and 13 since 2000, and is stored at BGA.
  - 6.4.1 - Plants in Sub-populations 2, 3, 4, 7, 12 and 13 were artificially pollinated since 2000.
  - 6.5.1 - Plant lists and habitat information were compiled for all known sub-populations.
  - 6.5.2 - Searches of potential habitat were undertaken since 2000, resulting in the discovery of eight additional sub-populations (1, 2, 4, 6, 7, 8 and 11).
  - 6.6 - Annual surveys and monitoring of all sub-populations were undertaken since 2000. Permanent monitoring quadrats were established in Sub-populations 3, 5, 7, 9, 10 and 13 in 2004.
  - 6.7 - Biannual recovery team meetings (NLBTORT and SLBTORT) were held since 2000.
- Rabbit-proof cages were installed around plants in Sub-population 13 since 2001.
- On-going liaison with Clare and Gilbert Valleys Council regarding the proposed upgrade of Benny's Hill Road since 2001.
- Seed was collected, stored and re-dispersed at Sub-population 10 in 2003.
- A fence was erected to protect Sub-population 2 in 2005.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

4.9 Recovery Objectives, Performance Criteria and Recovery Actions

4.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia argocalla* is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Caladenia argocalla* are listed in Table 10.

Table 10: Specific recovery objectives and performance criteria for *Caladenia argocalla*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 10 percent within five years.	EN B1 EN B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 15 extant sub-populations after five years.	EN B1a EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 10 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 8 sub-populations contain >20 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species increased by at least 10 percent within five years.	EN B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 10 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 5 private landholders and 7 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 6 community groups and 20 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

4.9.2 Specific recovery actions

The specific recovery actions for *Caladenia argocalla* are listed in Table 11. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 11: Specific recovery actions for *Caladenia argocalla*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	2, 3, 4, 5, 7, 8, 9, 10, 11, 12	DEH, NOSSA, TPAG, TFL, FSG, BEST
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	4, 12, 13	DEH, NOSSA
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	1, 4, 6, 11, 12	DEH, NOSSA, FSG, FKS
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	8, 13	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
2	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, FSG, FKS
2	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	2, 3, 4, 5, 6, 7, 9, 10, 13	DEH, NOSSA, FSG, FKS
2	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	2, 3, 4, 5, 6, 7, 9, 10, 13	DEH
3	C.2 Prepare site action plans for selected sub-populations.	Years 1 to 3	2, 3, 5, 7, 8, 9	DEH, TPAG, TFL
3	D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Year 1	1, 2, 3, 5, 7	DEH, DTEI, CGVC, AHC, BC
3	D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.	Year 1	1, 2, 3, 5, 7	DEH, DTEI, CGVC, AHC, BC
3	D.5 Develop protocols for track management activities on public land.	Year 1	6, 9	DEH
3	D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.	Year 1	TBD	DEH
3	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	6, 9, 10, 11	DEH
3	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	All	DEH, AHC, C&GVC, BC, FSA, NOSSA, TFL, TPAG
3	D.1 Encourage private landholders to enter into Heritage Agreements.	Years 1 to 7	4, 5, 7, 8, 12	DEH

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
3	D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	Years 1 to 7	2, 3, 5	DEH
3	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH, BGA, WOL, NOSSA
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, UA, USA, FU
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7		DEH, UA
5	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	2	DEH, NOSSA
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

5. *Caladenia behrii* (Pink-lipped Spider-orchid)

5.1 Description

Caladenia behrii has a single, hairy narrow lanceolate leaf (5-10 cm long). It has a slender scape to 60 cm tall. It produces a single flower, or sometimes two, up to 10 cm in diameter. The flowers have a strong musky fragrance, which is especially noticeable in warm conditions. The segments are 5 – 8 cm long, first spreading then drooping, creamy white with red filiform tips, which are glandular but not clavate. The labellum is ovate-lanceolate (10 cm long), with green to white lamina, and a bright red or pink apex, which is prolonged and curled under. Labellum margins are fringed with teeth. The calli are linear to club shaped, red, in 4 – 6 loose rows, and reaching nearly to the apex (Bates & Weber 1990).

Type: South Australia, Mt Lofty Range, H.H. Behr 1850's. Neotype: Chandlers Hill, Sept 1953, R.C. Nash.

Caladenia behrii, Blackham, J Quarmby

5.2 Conservation Status

Caladenia behrii is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

5.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia behrii* was assessed according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) in 2006 as part of this planning process, and met the criteria for Endangered (EN B1ab(I, iii, iv)c(iv)).

Table 12: IUCN Red List Criteria for *Caladenia behrii*.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km².
EN B1a	Sub-populations are severely fragmented.
EN B1b(i)	There is a projected continuing decline in the extent of occurrence.
EN B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
EN B1b(iv)	There is a projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

5.3 Distribution and Population Size

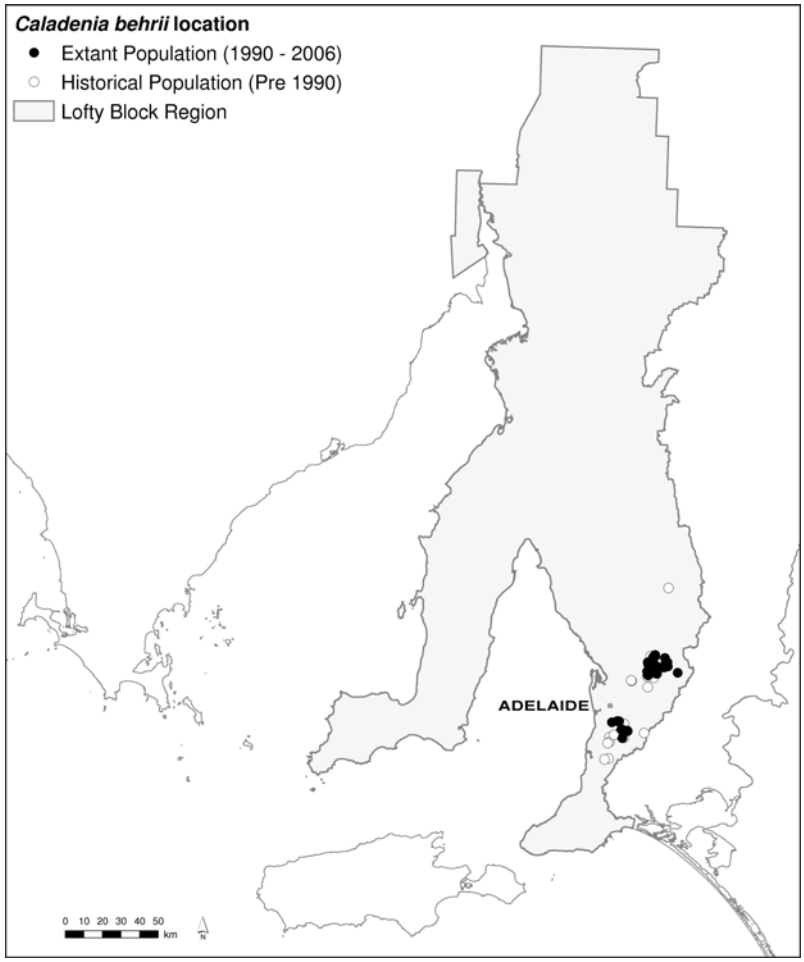
5.3.1 Extent of occurrence

Caladenia behrii is endemic to the Mount Lofty Ranges of South Australia. In 2006 the species was known from 32 sub-populations in the Southern Lofty herbarium region (refer to Figure 3), and the extent of occurrence of *C. behrii* was 598 km². However, many sub-populations are small and are at high risk of extinction, and further decline in the extent of occurrence is projected. The area of occupancy of *C. behrii* was 10 hectares in 2006.

In 2003 there was a report of *Caladenia behrii* being sighted near Meadows, but this is yet to be confirmed. There may also be additional sub-populations in the Kersbrook region, especially in reserves managed by ForestrySA and SA Water.

The historical extent of occurrence of *Caladenia behrii* was estimated to be 1395 km², with additional sub-populations in the Southern Lofty and Northern Lofty regions (refer to Figure 3). Based on historical records the extent of occurrence of *C. behrii* has declined by at least fifty-seven percent over the last 50 to 100 years. The main cause of this historical decline is attributed to broad-scale vegetation clearance and the resulting habitat loss, fragmentation, and degradation.

Figure 3: Current and historic distribution of *Caladenia behrii*



5.3.2 Population size

The population size of *Caladenia behrii* was estimated to be approximately 3440 mature individuals in 2006, based on the average number of flowering plants in each sub-population (refer to Table 13). However, the number of flowering plants in many sub-populations is known to fluctuate extremely from year to year, which makes determining population size very difficult. This is demonstrated by comparing the total number of flowering plants recorded in 2006 (2614) with the highest number of plants recorded from 1998 - 2006 (6153). Rainfall is thought to be the main cause of fluctuations, but other factors may also contribute.

Sixteen sub-populations appear to be in decline, including 1, 3, 7, 8, 13, 25 and 31 which are under high risk of extinction.

It is assumed that the population size of *Caladenia behrii* has decreased significantly over the last fifty to one-hundred years, due to the extinction of historical sub-populations.

Table 13: Sub-population numbers, trends and threats for *Caladenia behrii*

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Belair	Private (unreserved)	0 (05)	2 (98)	1	Decline	Weed invasion, lack of pollination, lack of recruitment
2	Belair NP	DEH (reserved)	10 (06)	12 (05)	8	Increase	Weed invasion, inbreeding
3	Belair NP	DEH (reserved)	0 (06)	3 (98)	1	Decline	Weed invasion, lack of recruitment
4	Cromer	Private (reserved)	5 (02)	5 (02)	5	Unknown	Lack of recruitment
5	Hale CP	DEH (reserved)	1 (06)	18 (98)	7	Decline	Herbivory, lack of recruitment
6	Ironbank	Private (unreserved)	15 (06)	58 (98)	32	Fluctuating	Weed invasion
7	Ironbank	Private (reserved)	23 (06)	35 (05)	25	Fluctuating	Herbivory, weed invasion
8	Kersbrook	DTEI (reserved)	0 (06)	1 (02)	1	Decline	Lack of pollination, collection, weed invasion

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1998-2006)	Sub-population Trend	Key Threats
9	Kersbrook NFR	FSA (reserved)	275 (04)	560 (01)	343	Steady	Herbivory
10	Kersbrook NFR	FSA (reserved)	35 (04)	134 (00)	85	Decline	Herbivory
11	Kersbrook NFR	FSA (reserved)	15 (05)	61 (00)	38	Decline	Herbivory, lack of recruitment
12	Kersbrook NFR	FSA (reserved)	1 (05)	58 (00)	30	Decline	Herbivory, lack of recruitment
13	Kersbrook NFR	FSA (reserved)	0 (05)	6 (00)	3	Decline	Herbivory, lack of recruitment
14	Mt Gawler NFR	FSA (reserved)	15 (05)	98 (98)	43	Decline	Herbivory, recreation
15	Mt Gawler NFR	FSA (reserved)	20 (05)	150 (99)	59	Decline	Recreation, herbivory, lack of recruitment
16	Mt Gawler NFR	FSA (reserved)	33 (05)	127 (99)	60	Unknown	Herbivory
17	Mt Gawler NFR	FSA (reserved)	8 (02)	8 (02)	7	Unknown	Herbivory, lack of recruitment
18	Mt Gawler NFR	FSA (reserved)	15 (04)	190 (99)	126	Decline	Herbivory, recreation
19	Para Wirra	Private (unreserved)	14 (00)	14 (00)	12	Unknown	Herbivory, *Phytophthora*
20	Para Wirra RP/Bassnet Rd	DEH (reserved) / AHC, CYP (unreserved)	700 (05)	1450 (04)	782	Fluctuating	Road management, collection
21	Para Wirra RP/Bassnet Rd	DEH (reserved) /CYP (unreserved)	11 (06)	27 (02)	20	Fluctuating	Herbivory, road management
22	Para Wirra RP/Blackham	DEH (reserved) /Private (unreserved)	563 (05)	2003 (99)	911	Fluctuating	Herbivory, track management
23	Roachdale	NTSA (reserved)	220 (06)	309 (04)	172	Increase	Herbivory
24	Scott Creek	Private (unreserved)	7 (06)	25 (97)	9	Decline	Lack of recruitment
25	Scott Creek CP	DEH (reserved)	0 (06)	2 (05)	1	Unknown	Herbivory, lack of pollination, track management
26	Tower Hill NFR	FSA (reserved)	58 (05)	58 (05)	58	Unknown	Grazing, track management
27	Tower Hill NFR	FSA (reserved)	55 (01)	86 (99)	58	Fluctuating	Track management
28	Warren CP	DEH (reserved)	461 (04)	519 (99)	469	Fluctuating	Herbivory
29	Warren CP	DEH (reserved)	15 (04)	15 (04)	15	Unknown	Herbivory
30	Warren CP	DEH (reserved)	27 (99)	27 (99)	16	Unknown	Herbivory
31	Warren Reservoir	SAW (unreserved)	1 (01)	2 (98)	1	Decline	Weed invasion, herbivory
32	Wongalere/ Para Wirra Rd	Private (reserved) /AHC (unreserved)	11 (06)	90 (02)	41	Decline	Weed invasion, herbivory, road management
		TOTAL	**2614**	**6153**	**3439**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix B, which is available from DEH, Threatened Species Unit.

5.3.3 Important sub-populations

While all sub-populations of *Caladenia behrii* are important, Sub-populations 9, 18, 20, 22, 23 and 28 are considered to be the most important for conservation of the species because they are most likely to be self-sustaining, and to have the highest levels of intra-population genetic diversity.

Sub-populations 2, 6, and 7 are also considered to be important because they are the largest sub-populations in the Belair area, and may contain genetic diversity not found within the northern sub-populations.

Sub-populations 1, 4, 5, 19, 25, 31 and 32 are also important because of their outlying distribution. Extinction of these sub-populations would result in a decline in the extent of occurrence.

5.4 Habitat

Caladenia behrii grows in a diversity of *Eucalyptus* woodlands and forests. These typically include *Eucalyptus obliqua, E. fasciculosa*, *E. leucoxylon, E. goniocalyx,* and *E. microcarpa*. The understorey generally includes *Xanthorrhoea semiplana*, *Acacia pycnantha*, *Hibbertia exutiacies, Pultenaea largiflorens, P. daphnoides*, *Spyridium parvifolium*, and *Hakea carinata*.

Caladenia behrii generally grows on the upper slopes and crests of moderate to steep hills. Soils are generally sandy loams.

5.4.1 Habitat critical to survival

All native vegetation within 500 metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within 500 metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix B contains maps of habitat critical to the survival of *C. behrii*, and is available for legitimate purposes from DEH.

5.5 Reservation Status and Management Responsibility

Caladenia behrii occurs across a variety of land tenures including reserved and unreserved, private and public land (refer to Table 13). Twenty-seven sub-populations occur either wholly or partially within land that is formally reserved and managed for conservation purposes under legislation. Twelve of these occur within Native Forest Reserves, nine occur within NP&W Act reserves, and three occur within private land under Heritage Agreements.

Five sub-populations occur within unreserved private land, three occur within road reserves, and one in a water reserve, none of which are formally reserved for conservation purposes.

5.6 Ecology

5.6.1 Biology

Caladenia behrii usually produces a leaf in April or May, coinciding with the onset of cool, wet weather. However, it has been found that plants do not always produce a leaf or flowers every year, and can remain dormant for several years (DEH 2006[a], Petit & Dickson 2005). During August to early September buds are produced, followed by flowering in mid September to October. By late October the leaf shrivels and the pollinated flowers develop into seed capsules. In November the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. behrii* is not known, but is assumed to be more than 15 years.

5.6.2 Pollination

Caladenia behrii is thought to be pollinated by male thynnid wasps. A male thynnid wasp, *Tachynomyia* sp. has been identified as a probable pollinator (Petit & Dickson 2005). It is thought that sexual deception is used to attract the male wasps. *C. behrii* is known to hybridise with *C. argocalla* and *C. tentaculata*.

5.6.3 Mycorrhiza

Caladenia behrii grows in symbiosis with mycorrhizal fungi, which have been isolated *in vitro* but are yet to be identified. *C. behrii* seedlings have been successfully propagated in symbiosis with the mycorrhizal fungi *in vitro*. It is currently unknown whether a specific mycorrhizal fungus, or multiple fungi are associated with the species.

5.6.4 Response to fire and disturbance

Caladenia behrii is known to survive summer fires, but does not require fire to flower. There is currently no evidence to suggest that this species is stimulated by fire; however there is urgent need to properly investigate the fire response of this species.

There is some anecdotal evidence to suggest that *Caladenia behrii* responds to soil disturbance, because it is often found flowering in recently disturbed sites (*e.g.* along track verges), which suggests that soil disturbance may enhance seedling recruitment.

5.6.5 Research opportunities

The biology and ecology of *Caladenia behrii* have been studied since 2001 by University of SA. Subsequent papers produced include:

- Petit and Dickson (2005) - grasstree facilitation of *Caladenia* behrii;
- Feuerherdt *et al* (2005) - distribution of mycorrhizal fungus associated with *Caladenia behrii,* and;
- Dickson and Petit (2006) – the effect of individual height and labellum colour on the pollination of *Caladenia behrii*.

The following areas have been identified as important for further research:

- Response to disturbance – determining the effect of fire, soil disturbance, and vegetation slashing.
- Pollination biology – clarifying the identity of the pollinator and causes for limited pollination;
- Population genetics – determining intra-population genetic diversity;
- Demographics – identifying the causes of extreme population fluctuations;
- Germination – determining *in situ* germination requirements.

5.7 Threats to Recovery

5.7.1 Herbivory – HIGH

Herbivory by kangaroos, hares, rabbits, deer, snails, caterpillars and other invertebrates is a threat to *Caladenia behrii*. Kangaroos were generally thought to be responsible for most of the herbivory of *C. behrii.* However, Petit & Dickson (2005) found that herbivory of sub-populations in the Kersbrook region has increased since 2001 despite a regional kangaroo-culling program, which has significantly reduced kangaroo numbers. Also, high levels of herbivory have been recorded within several kangaroo/rabbit proof exclosures. It is therefore suggested that birds or possums may be responsible for much of the browsing.

Rabbits and hares are known to occur at most of the sites, but their numbers fluctuate between years, especially since the release of the Rabbit Calici Virus. Petit & Dickson (2005) found very little evidence of rabbit herbivory on *Caladenia behrii* in the Kersbrook region, despite other evidence of their presence. Feral deer are also known to occur over a large range in the South Para/Mt Crawford area, and are regarded as a potential threat. Snails, caterpillars and other invertebrates are thought to be responsible for low levels of herbivory, and are most problematic in the Belair area.

5.7.2 Weed invasion – HIGH

Weed invasion is an immediate threat to eight sub-populations (1, 2, 3, 6, 7, 8, 31 and 32). Weeds are present in all other sub-populations, but are currently not perceived to be a significant threat. Threatening weeds include Bridal Creeper, Boneseed, Montpellier Broom, Blackberry, Pine, South African Daisy, Sparaxis, Quaking Grass, and other introduced grasses.

5.7.3 Lack of recruitment – Moderate

Lack of recruitment is a threat to sixteen small, declining sub-populations of *Caladenia behrii* (Sub-populations 1, 3, 4, 5, 8, 11, 12, 13, 15, 17, 18, 19, 21, 24, 25 and 31). It is presumed that this is related to low rates of pollination (see below), but other factors may also be contributing.

5.7.4 Lack of pollination – Moderate

Lack of pollination is a threat to some sub-populations of *Caladenia behrii.* Sub-populations 1, 8, 25 and 31 in particular are known to have low levels of pollination. Pollination levels tend to fluctuate in most sub-populations from year to year, and most sub-populations have average pollination levels of less than 15 % of flowers.

5.7.5 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to many sub-populations of *Caladenia behrii*. Thirteen sub-populations contain less than 15 mature plants, and are generally very isolated. Some of the small outlying sub-populations (1, 2, 3, 4, 5, 6, 7, 24 and 25) are likely to contain genetic diversity not found within the larger sub-populations.

5.7.6 Road and track management activities – Moderate

Sub-populations 20, 21 and 32 occur within road reserves and are potentially at risk from road management activities (*e.g.* bituminising, widening, grading, constructing turnout drains, slashing and pruning vegetation, and weed control).

All sub-populations in ForestrySA reserves and NP&W Act reserves are potentially at risk from track management activities (*e.g.* grading, constructing turnout drains, slashing and pruning vegetation, and weed control).

5.7.7 Recreational activities – Moderate

Recreation activities including motorbike, mountain bike and horse riding are a threat to several sub-populations of *Caladenia behrii* particularly in Mt Gawler NFR, Kersbrook NFR and Belair NP. These activities are illegal in Native Forest Reserves, and continue to occur despite efforts by ForestrySA to manage and restrict access. They are causing direct damage to plants and habitat, and are acting as a potential vector for weeds and *Phytophthora.*

5.7.8 *Phytophthora* – Moderate

It is currently unknown whether *Caladenia behrii* is susceptible to *Phytophthora*; however according to Velzeboer *et al* (2005) the species is regarded as potentially under high threat from *Phytophthora,* with 84 percent of sub-populations occurring within a Moderate Risk Zone for *Phytophthora*, and 16 percent occurring within a Low Risk Zone. Many of the plants that commonly grow in association with *C. behrii* are highly susceptible to *Phytophthora*. *Xanthorrhoea semiplana* has been found to have an important role in protecting *C. behrii* from herbivory (Petit & Dickson 2005) and therefore dieback in this species may result in higher levels of herbivory.

5.7.9 Fire management activities – Moderate

Many sub-populations of *Caladenia behrii* occur on public land that may be burnt or slashed as part of fire management activities. It is currently thought that burning during the active growth season of *C. behrii* (April – Nov) could destroy or damage plants. Burning during winter or spring is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations).

5.7.10 Illegal collection – Low

Illegal collection is a threat to *Caladenia behrii.* Plants are thought to have been illegally collected from Sub-population 8 and 20 in recent years. Small sub-populations near public roads and tracks are most at risk from illegal collection.

5.8 Previous Recovery Actions

Prior to 2007 the following recovery actions had been implemented for *C. behrii.*

- From 1993 to1997 R. Bates and TPAG received funding from the Endangered Species Program to prepare and implement recovery plans for *Caladenia behrii*. Recovery plans were completed in 1995 (Bates 1995[b]) and 1997 (Reynolds & Sorensen 1997), and the following recovery actions were implemented.
  - Surveys for *C. behrii* in Warren CP in 1993.
  - Monitoring of Warren, Wongalere and Para Wirra populations in 1996.
  - Weed control at Wongalere in 1996.
  - Seed collection and re-dispersal in Sub-populations 22 and 23 from 1993 to 1994. Some seed was germinated in Paget's Nursery. Seed from Scott Creek CP was also germinated and seedlings were re-introduced into Scott Creek CP in 1994.
- *C. behrii* was included in the LBTORP in 1998.
- A national recovery plan was prepared and adopted for *Caladenia behrii* (Bickerton 1999), and the following recovery actions were implemented between 1999 and 2006.

4.1.1 - Wire cages have been placed around plants in Sub-populations 2, 6, 8, 20, 23, 24, 25 and 28 since 2000.

4.1.2 - Weed control has been undertaken at Sub-populations 2, 3 and 28 since 1999.

4.6 - Seed has been collected from Sub-populations 2, 5, 6, 9, 17, 18, 19, 22, 23, 24, 25, 26, 27, 29, 31, 32, 33 and 34 since 1999.

4.3.1 - Plants have been artificially pollinated in Sub-populations 2, 3, 5, 6, 17, 18, 21, 22, 24, 25, 27, 30, 31, 33 and 34 since 1998.

4.3.2 - Seed has been collected and re-dispersed into Sub-populations 2, 5, 6, 7, 9, 14, 16, 17, 18, 19, 20, 21,22, 23, 24, 26, 27, 28, 30, 31 and 32 since 1998.

4.3.3 - Kangaroo proof exclosures were erected around Sub-populations 9, 14, 22 and 23 in 2001 and 2002.

4.4.1 - Extensive searches of known and potential habitat were undertaken in 2000, 2001 and 2005.

4.4.2 - Weed control has been undertaken at Sub-populations 2, 14 and 32 since 1999. A site action plan was prepared for Sub-population 32 in 2003 (Bickerton 2003[c]).

4.6 - Annual surveys and monitoring of all sub-populations have been implemented since 1999.

4.7 - Biannual recovery team meetings (SLBTORT) have been held since 1998.

- A fact sheet was prepared for the species in 2001 (DEH 2001[d]), and has been publicly disseminated.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

5.9 Recovery Objectives, Performance Criteria and Recovery Actions

5.9.1 Recovery objectives and performance criteria

The overall recovery objective for *C. behrii* is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *C. behrii* are listed in Table 14.

5.9.2 Specific recovery actions

The specific recovery actions for Caladenia behrii are listed in Table 15. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 14: Specific recovery objectives and performance criteria for *Caladenia behrii*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is maintained, or increased by at least 10 percent within five years.	EN B1 EN B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 35 extant sub-populations after five years.	EN B1a EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 10 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 25 sub-populations contain >20 mature individuals after five years.	
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species increased by at least 10 percent within five years.	EN B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 8 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 10 private landholders and 7 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 5 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Table 15: Specific recovery actions for *Caladenia behrii*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/S
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA, TPAG
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA, TPAG
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	1, 2, 3, 6, 7, 32	DEH, NOSSA, TPAG, SPBP, FB, FSC
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	1, 2, 3, 4, 5, 6, 7, 12, 13, 15, 21, 23, 24, 25, 29, 30, 31	DEH, NOSSA
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH, SPBP
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	1, 2, 3, 4, 5, 8, 12, 13, 14, 15, 17, 18, 19, 21, 24, 25, 31	DEH, NOSSA
1	C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.	Years 1 & 2	14, 15, 22	FSA, DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, FB
2	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	2, 6, 7, 9, 14, 22, 23, 25, 28, 32	DEH, FB, USA
2	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	2, 6, 7, 9, 14, 22, 23, 25, 28, 32	DEH
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA, NOSSA, FB
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	6, 20, 28	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	2, 3, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 25, 26, 27, 28, 29, 30, 31, 32	DEH
3	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	All	DEH, FSA, AHC, CYP, NOSSA, SPBP
3	C.2 Prepare site action plans for selected sub-populations.	Years 1 to 3	2, 3, 7	DEH
3	D.1 Encourage private landholders to enter into Heritage Agreements.	Years 1 to 7	6, 19, 22	DEH
3	D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Year 1	20, 21, 32	CYP, AHC, DEH
3	D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.	Year 1	20, 21, 32	DEH, CYP, AHC

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/S
3	D.5 Develop protocols for track management activities on public land.	Year 1	2, 3, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 25, 26, 27, 28	DEH, FSA
3	D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.	Year 1	TBD	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 3 to 7	TBD	DEH, BGA, WOL
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, USA, AU. FU
4	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	9, 17	DEH, NOSSA
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH, AU
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH, NOSSA, TPAG
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

6. *Caladenia gladiolata* (Bayonet Spider-orchid)

6.1 Description

Caladenia gladiolata has a single, hairy, broadly lanceolate leaf, varying in size. It has a hairy and often dwarfed scape (8 – 20 cm high). It produces one or rarely two flowers, 3 – 4 cm in diameter. The flowers are strongly scented with a spicy or musky odour. Perianth segments are 15 – 30 mm long, greenish-yellow with a longitudinal red line, terminating in large, flat, reddish-brown glandular clubbed tips (8 – 15 mm x 1 – 3 mm). The clubbed tips are separated from the basal part of the segments by a constriction, producing a bayonet shape. The labellum is ovate to 1 cm long, yellowish-green with a dark brown to maroon tip, and recurved. Lamina margins are fringed with short blunt teeth. Calli are large, fleshy, pyriform, dark red-brown, in 4 crowded rows, not extending to the tip (Weber and Bates 1986, Bates & Weber 1990).

Caladenia gladiolata, Mt Remarkable NP, J Quarmby

Type: South Australia, Hornsdale near Appila-Yarrowie, Sept 10 1907, E. Keyes ex R. Rogers 527.

Notes: Plants from Scott Creek CP have shorter, lighter coloured clubs than plants from Mount Remarkable NP. Genetic analysis of plants from both localities using allozyme electrophoresis concluded that they are the same species (Bickerton & Adams 2001). However, further analysis using molecular techniques is recommended.

6.2 Conservation Status

Caladenia gladiolata is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

6.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia gladiolata* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Endangered (EN B1ab(I, iii, iv)c(iv)).

Table 16: IUCN Red List Criteria for *Caladenia gladiolata*.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km².
EN B1a	Sub-populations are severely fragmented, and known to exist at less than five locations.
EN B1b(i)	There is a projected continuing decline in the extent of occurrence.
EN B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
EN B1b(iv)	There is a projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

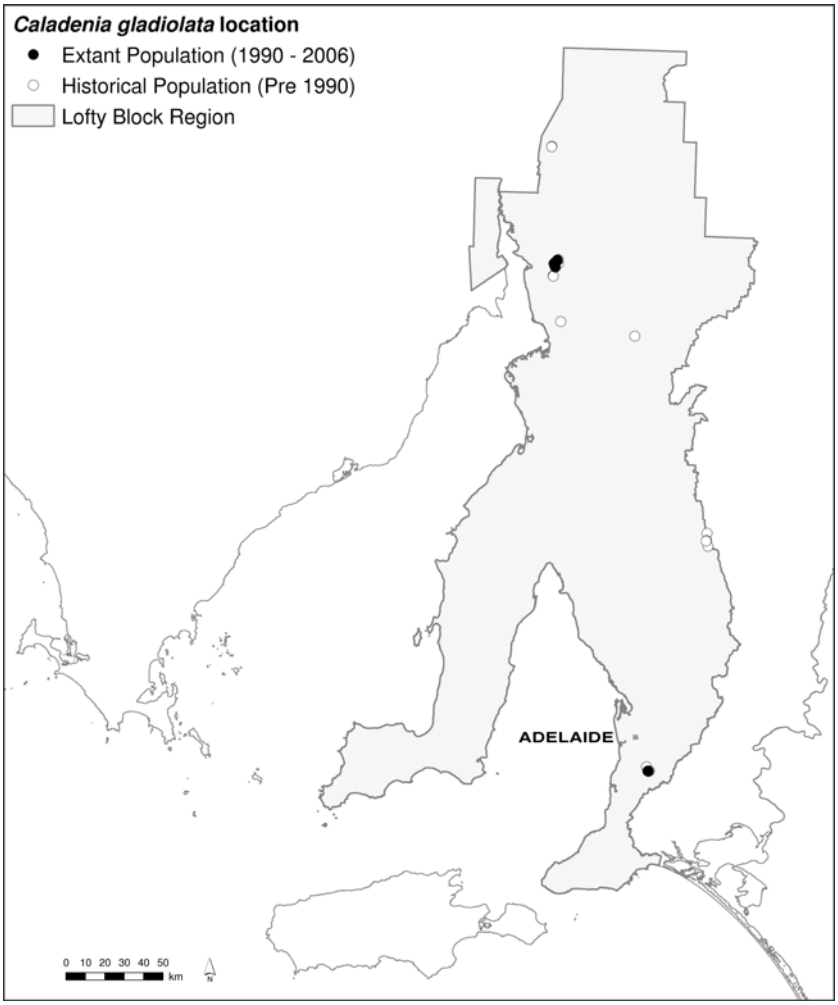
NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

6.3 Distribution and Population Size

6.3.1 Extent of occurrence

Caladenia gladiolata is endemic to South Australia. In 2006 the species was known from four sub-populations in two disjunct localities in the Flinders Ranges and Southern Lofty herbarium regions, which are separated by approximately five hundred kilometres (refer to Figure 4). The extent of occurrence of *C. gladiolata* was 317 km², and the area of occupancy was 2.4 hectares in 2006.

Figure 4: Current and historic distribution of *Caladenia gladiolata*.



There are historical records of *Caladenia gladiolata* from several other sub-populations in the Flinders Ranges and Southern Lofty regions (refer to Figure 4). Recent attempts to relocate these sub-populations have failed to locate the species (DEH 2006[a]).

The known historical extent of occurrence of *Caladenia gladiolata* based on historical records is 1008 km². Therefore, the extent of occurrence of *C. gladiolata* has declined by at least 69 percent over the last 50 to 100 years. This decline is attributed to broad-scale vegetation clearance and resulting habitat loss, fragmentation, and degradation.

6.3.2 Population size

The population size of *Caladenia gladiolata* was estimated to be approximately 780 mature plants in 2006, based on the average number of flowering plants in each sub-population (refer to Table 17). However, it is difficult to accurately determine the population size because of high levels of dormancy and annual fluctuations in the number of flowering plants in all sub-populations. All sub-populations have declined significantly since 1999, which is thought to be related to successive drought years, especially in the Mount Remarkable NP sub-populations.

Mount Remarkable NP contains the two largest extant sub-populations (comprising 99 percent of the total population size in 2006), while Scott Creek CP contains one small sub-population.

It is assumed that *Caladenia gladiolata* has declined in population size significantly over the last 50 to 100 years due to the extinction of historical sub-populations.

6.3.3 Important sub-populations

All extant sub-populations of *Caladenia gladiolata* are considered important for conservation due to the low number of sub-populations, and the continuing declining trend of the species.

Sub-population 2 is important due to its relatively large size, and likelihood of being self-sustaining and containing high genetic diversity. Sub-population 4 is also important because of its outlying distribution and because it may contain genetic diversity not found in Sub-populations 1, 2 and 3.

6.4 Habitat

Caladenia gladiolata grows in *Eucalyptus leucoxylon, E. cladocalyx* Woodland in Mount Remarkable NP, and *E. leucoxylon*, *E. fasciculosa* Woodland in Scott Creek CP. The understorey vegetation in Mount Remarkable NP includes *Acacia pycnantha, A. gracilifolia, Cassinia laevis,* and *Pultenaea graveolens*. The understorey vegetation in Scott Creek CP includes *Acacia pycnantha*, *Spyridium parvifolium, Astroloma humifusum* and *Gonocarpus tetragynus.*

Historically *Caladenia gladiolata* was known to grow in *Eucalyptus leucoxylon, E. odorata* Woodland, and *Eucalyptus camaldulensis, Callitris glaucophylla* Woodland (DEH 2006[b]).

All extant sub-populations of *Caladenia gladiolata* grow on moderate to steep slopes in sandy loam soils with scattered shale and quartzite.

Table 17: Sub-population numbers, trends and threats for *Caladenia gladiolata*

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1992-2006)	Sub-population Trend	Key Threats
1	Mt Remarkable NP	DEH (reserved)	185 (04)	450 (99)	114	Decline	Weed invasion, herbivory
2	Mt Remarkable NP	DEH (reserved)	295 (05)	1500 (00)	641	Decline	Weed invasion, herbivory
3	Mt Remarkable NP	DEH (reserved)	16 (05)	16 (05)	16	Unknown	Herbivory
4	Scott Creek CP	DEH (reserved)	0 (06)	20 (01)	9	Decline	Lack of pollination, herbivory
		TOTAL	**496**	**1986**	**780**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix C, which is available from DEH, Threatened Species Unit.

6.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within 500 metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix C contains maps of habitat critical to the survival of *Caladenia gladiolata*, and is available for legitimate purposes from DEH, Threatened Species Unit.

6.5 Reservation Status and Management Responsibility

All extant sub-populations of *Caladenia gladiolata* occur within NP&W Act reserves that are owned and managed by DEH (refer to Table 17).

6.6 Ecology

6.6.1 Biology

Caladenia gladiolata usually produces a leaf in May or June. However, it has been found that plants do not always produce a leaf or flowers every year, and can remain dormant for several years consecutively, especially in periods of drought (DEH 2006[a]). From July to September buds are produced, followed by flowering from September to October. By mid October the leaf shrivels and the pollinated flowers develop into seed capsules. In November the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. gladiolata* is not known, but is assumed to be more than fifteen years.

6.6.2 Pollination

Caladenia gladiolata is pollinated by a male thynnid wasp (*Zaspilothynnus* sp.) which is attracted to the flowers by pseudo-pheromones produced by the trichomes on the tips of the perianth segments (Bates 1994). *C. gladiolata* is known to hybridize with *Caladenia saxatilis*, *C. flindersica,* C*. tensa*, and *C. woolcockiorum*, particularly following disturbance.

6.6.3 Mycorrhiza

Caladenia gladiolata grows in association with mycorrhizal fungi. Mycorrhizal fungi have been isolated from each sub-population of *C. gladiolata*, but are yet to be identified. It is currently unknown whether a specific mycorrhizal fungus, or multiple fungi are associated with the species. Mycorrhizal fungi are thought to play a vital role in seed germination and nutrient absorption.

6.6.4 Response to fire and disturbance

Caladenia gladiolata does not require fire to flower, and it is not known to increase flowering after fire. Flowering of *C. gladiolata* is thought to have declined significantly since the wildfires in Mount Remarkable NP in 1982 and 1988 due to the dense regeneration of vegetation post-fire.

Caladenia gladiolata has been known to flower profusely after soil disturbance and vegetation clearance. Sub-population 1 was cleared with a bulldozer during road construction in the 1960s, and mass flowering occurred in the following years (Bates 1996). Increased recruitment of *C. gladiolata* was also observed after the bulldozing.

A disturbance trial was established in Mount Remarkable NP from 2001-2007 to investigate the response of *Caladenia gladiolata* to fire, soil disturbance, and vegetation clearance. No evidence of increased flowering or emergence was found in response to any of these disturbance treatments. Trends in the data suggest the species may have been influenced by environmental factors, including low winter rainfall.

6.6.5 Research opportunities

There has been some research into the fire and disturbance ecology of *Caladenia gladiolata* (Quarmby *et al* 2008), as detailed in Section 6.6.4.

The following areas have been identified as important for further research:

- Pollination biology – including identifying the pollinator;
- Population genetics – determining intra-population genetic diversity;
- Germination – determining *in situ* germination requirements.

6.7 Threats to Recovery

6.7.1 Weed invasion – HIGH

Weed invasion is a threat to all sub-populations of *Caladenia gladiolata*. Threatening weeds in Sub-populations 1, 2 and 3 include Salvation Jane, Thread Iris, Capeweed and Scarlet Pimpernel. These weeds are currently localised and in low abundance at the two sites, but appear to be spreading from turnout drains and other areas of disturbed soil on road and track verges.

Threatening weeds in the vicinity of Sub-population 4 include Tree Heath, Olive, and Boneseed. Weeds are currently in low abundance in this area due to ongoing weed control by the Friends of Scott Creek CP, but could colonise the area if control ceased.

6.7.2 Herbivory – HIGH

Herbivory is a threat to all sub-populations of *Caladenia gladiolata*; however monitoring of Sub-populations 1 and 4 has shown that herbivory has decreased significantly since 1999 at both localities. In 1999, twenty-six percent of plants were grazed in Sub-population 1, but this reduced to less than three percent from 2000 to 2003 (DEH 2006[a]). It is unclear exactly why herbivory has decreased, but it is suspected that it may be associated with a decrease in rabbit numbers in the park. In Sub-population 4, forty-six percent of plants were grazed in 2000, however from 2001 to 2004 less than four percent of plants were grazed (DEH 2006[a]). This reduction in herbivory can be directly attributed to the caging of all plants in 2001.

Kangaroos, rabbits and hares are present at all three sites, and are considered to be responsible for most of the herbivory. Snail and/or insect damage is suspected to be the cause of ongoing herbivory at Scott Creek CP since the cages were installed in 2001.

6.7.3 Lack of pollination – Moderate

Annual monitoring has shown that levels of pollination in Sub-population 4 have not exceeded eight percent per year (DEH 2006[a]). All sub-populations in Mount Remarkable NP have higher rates of pollination than the Scott Creek CP sub-population, but still average less than twenty percent per year.

6.7.4 Road and track management activities – Moderate

Sub-populations 1, 2 and 3 occur near vehicle tracks, including the public entrance road to Alligator Gorge. Many road and track management activities have the potential to impact on these sub-populations, including grading, constructing turnout drains, and pruning vegetation. Not only can these activities have a direct impact on sub-populations, they can also induce weed incursion.

6.7.5 Fire management activities – Moderate

All sub-populations of *Caladenia gladiolata* occur on public land that may be burnt or slashed as part of fire management activities. It is currently thought that burning during the active growth season of *C. gladiolata* (April – Nov) could destroy or damage plants. Burning during winter or spring is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations). Sub-populations in Mount Remarkable NP occur near fire access tracks and water filling points and are particularly susceptible.

6.7.6 Inbreeding and loss of genetic diversity – Moderate

Inbreeding is a threat to Sub-population 4 due to its small size and geographic isolation. Plants in Sub-population 4 are also morphologically different from Sub-populations 1 and 2, and may contain unique genetics. Further decline or extinction of Sub-population 4 could result in loss of genetic diversity.

6.7.7 *Phytophthora* – Moderate

It is currently unknown whether *Caladenia gladiolata* is susceptible to *Phytophthora*; however according to Velzeboer *et al* (2005) the species is regarded as potentially under high threat from *Phytophthora,* with eighteen percent of sub-populations occurring within a Moderate Risk Zone for *Phytophthora*, and seventy-eight percent occurring within a Low Risk Zone. Many of the plants that grow in association with *C. gladiolata* are known to be susceptible to *Phytophthora*.

6.7.8 Illegal collection – Low

Illegal collection is a potential threat to *Caladenia gladiolata*. Sub-population 4 is particularly at risk due to its small size, and close proximity to Adelaide.

6.8 Previous Recovery Actions

The following recovery actions were implemented for *Caladenia gladiolata* prior to 2007.

- Members of NOSSA artificially pollinated flowers in Sub-population 4 from 1988 to 1994.
- R. Davies established a permanent quadrat in Sub-population 1 in 1992, which has been monitored in subsequent years (Davies 1992).
- From 1993 to1996 TPAG received funding under from the Endangered Species Program to write and implement a recovery plan for *C. gladiolata*. The plan was completed in 1995 (Bates 1995[a]) and the following recovery actions were implemented.

  - Collection of seed from Sub-population 4 and re-dispersal around parent plants from 1993 to1996.

  - Hand pollination of a proportion of flowers in Sub-population 1 from 1993-1995.

  - *In vitro* cultivation of *C. gladiolata* seedlings with seed from Scott Creek CP, which were translocated into Onkaparinga NP in 1994 (none of which have survived).

  - A search for the species in Mount Brown CP in 1994.

  - Discovery of Sub-population 2 in 1995 as part of annual searches for the species.
- *C. gladiolata* was included in the LBTORP in 1998.
- Biannual recovery team meetings (NLBTORT and SLBTORT) have been held since 2000.
- Searches of five historic locations were undertaken between 2000 and 2002.
- Annual population monitoring and surveys of all sub-populations have been undertaken since 2000.
- A proportion of flowers in Sub-population 4 have been hand-pollinated each year since 2000.
- Genetic analysis of plants from Mount Remarkable NP and Scott Creek CP using allozyme electrophoresis was undertaken in 2000 to determine whether sub-populations are taxonomically similar. The results were positive (Bickerton & Adams 2001).
- A fact sheet was prepared for the species in 2001 (DEH 2001[c]), and has been publicly disseminated.
- Rabbit-proof cages were erected around all known plants in Sub-population 4 in 2001. All of these cages have been repaired or replaced since 2001.

- A trial was established in 2001 to investigate the response of *C. gladiolata* to various types of disturbance, including soil disturbance, fire, and vegetation clearance *in situ* (Sub-population 2). This has since been monitored on an annual basis.
- A translocation proposal was written for *C. gladiolata* (Bickerton 2002[d]) and an attempt has been made to re-introduce seedlings cultivated symbiotically *in vitro* into Sub-population 4. Approximately 20 seedlings were successfully raised symbiotically, but were never transferred to the site.
- A draft recovery plan was prepared for the species in 2002 (Bickerton 2002[a]), but was not endorsed under the EPBC Act.

The previous recovery actions implemented for this species have been successful in increasing knowledge of the species, especially in relation to its current distribution and population size. Discovery of the largest known sub-population in 1995 was particularly significant. Caging of plants at Scott Creek CP has significantly reduced herbivory at the site. However, efforts to increase the population size by hand pollination, seed redispersal and translocation have had limited success. Also, the disturbance trial in Mount Remarkable NP did not stimulate flowering and recruitment as was expected. All populations appear to have declined over the last 20 years through a reduction in flowering plants, which is thought to be largely due to prevailing drought conditions. This has also made it difficult to assess the effectiveness of recovery actions.

6.9 Recovery Objectives, Performance Criteria and Recovery Actions

6.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia gladiolata* is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Caladenia gladiolata* are listed in Table 18.

6.9.2 Specific recovery actions

The specific recovery actions for *Caladenia gladiolata* are listed in Table 19 in order of priority. Sub-populations and delivery groups for recovery action are listed where relevant. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 18: Specific recovery objectives and performance criteria for *Caladenia gladiolata*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species increased by at least 20 percent within five years.	EN B1 EN B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 5 extant sub-populations after five years.	EN B1a EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 10 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 3 sub-populations contain >50 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species is increased by at least 10 percent within five years.	EN B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 3 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 public land management authorities are involved in implementing recovery actions for the species during the term of this recovery plan.	
	8.2 At least 4 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Table 19: Specific recovery actions for *Caladenia gladiolata*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
1	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	4	DEH, BGA, WOL, FSC
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, NOSSA, FSC
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	1, 2, 3	DEH, NOSSA, FSC
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	4	DEH
2	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA
2	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	All	DEH, NOSSA
2	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	All	DEH
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, NOSSA
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	2	DEH, NOSSA
3	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
4	D.5 Develop protocols for track management activities on public land.	Year 1	1, 2, 3	DEH
4	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	All	DEH
4	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	-	DEH, NOSSA, FSC
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	All	DEH, AU
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

7. *Caladenia intuta* (Ghost Spider-orchid)

7.1 Description

Caladenia intuta has a single, narrow, lanceolate leaf, which is hairy with purple blotches at the base. It has a wiry, hairy scape 10-35 cm long. It produces 1 or 2 flowers, 4.5-6.5 cm across, white, sometimes with faint reddish medial lines. The labellum is white to cream, ovate-lanceolate, 13-16 mm long and 7-11 mm wide, with a recurved tip. Labellum margins are lined with short, blunt, white or purplish teeth. Calli in four rows, white or purplish, hockey stick shaped, and predominantly stalked. The sepals are 32-40 mm long, 2.5-3 mm wide, lanceolate, tapering to short, blackish, glandular caudae, sometimes with obscure osmophores. The petals are 27-35 mm long, 2-3 mm wide, lanceolate, tapering to short, blackish, glandular caudae. The dorsal sepal is erect, the lateral sepals are widely divergent and stiffly spreading, and the petals are also stiffly spreading (Jones 2005).

Types: South Australia, YP, 'near Hardwicke', early Sept, 2001, D.L. Jones.

Caladenia intuta, Brentwood, J Quarmby

7.2 Conservation Status

Caladenia intuta was listed as Critically Endangered nationally under the EPBC Act in 2008, and is also listed as Endangered in South Australia under the NP&W Act.

7.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia intuta* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Critically Endangered (CR B1ab(i, iii, iv, v)).

Table 20: IUCN Red List Criteria for *Caladenia intuta*.

IUCN Criteria	Justification
CR B1	It has an extent of occurrence of less than 100 km².
CR B1a	Sub-populations are severely fragmented.
CR B1b(i)	There is a projected continuing decline in the extent of occurrence.
CR B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
CR B1b(iv)	There is a projected continuing decline in the number of sub-populations.
CR B1b(v)	There is a projected continuing decline in the number of mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

7.3 Distribution and Population Size

7.3.1 Extent of occurrence

Caladenia intuta is endemic to South Australia. In 2006 the species was known from two sub-populations in the Yorke Peninsula herbarium region (refer to Figure 5). The extent of occurrence at that time was 2.7 km², and the area of occupancy was 0.6 hectares.

While there are no historical records of *Caladenia intuta* it is assumed that this species has declined in extent of occurrence due to broad-scale vegetation clearance over the last 50 to 100 years.

Areas of suitable habitat within the known range are severely limited and fragmented, and are generally small and degraded.

Figure 5: Current and historical distribution of *Caladenia intuta*.

7.3.2 Population size

The population size of *Caladenia intuta* was estimated to be approximately 400 mature individuals in 2006, based on survey data from 2005 and 2006 (refer to Table 21). However, the number of flowering plants in each sub-population fluctuates significantly from year to year, which makes it difficult to accurately determine the current population size.

It is assumed that the population size of *Caladenia intuta* has reduced over the last 50 to 100 years due to habitat loss, fragmentation and other threats.

7.3.3 Important sub-populations

Both known sub-populations are important for conservation of the species. Sub-population 1 is the largest; however it occurs within a smaller, more degraded site than Sub-population 2. Sub-population 2 also has more potential for expansion into adjacent areas of suitable habitat.

Table 21: Sub-population numbers, trends and threats for *Caladenia intuta*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Brentwood	DCYP/Private (unreserved)	380 (05)	380 (05)	186	Fluctuating	Weed invasion, trampling, vegetation clearance, grazing
2	Stansbury	Private (unreserved)	18 (06)	73 (05)	24	Fluctuating	Herbivory, weed invasion
		TOTAL	**398**	**453**	**210**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix D, which is available from DEH, Threatened Species Unit.

7.4 Habitat

Caladenia intuta grows in *Eucalyptus porosa*, *Allocasuarina verticillata* woodland, with an understorey of *Pittosporum phylliraeoides*, *Melaleuca lanceolata*, *Bursaria spinosa*, *Lasiopetalum behrii*, *Gahnia lanigera*, *Lepidosperma* sp., *Acrotriche patula*, and *Dianella revoluta.* It grows in red sandy loam soils, on calcrete rises.

7.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. Confidential Appendix D contains maps of habitat critical to the survival of *Caladenia intuta*, and is available for legitimate purposes from DEH, Threatened Species Unit.

7.5 Reservation Status and Management Responsibility

Caladenia intuta occurs on both private and public land, none of which is reserved for conservation purposes under legislation (refer to Table 21). Sub-population 1 occurs partially within a cemetery managed by the District Council of Yorke Peninsula, and partially within adjacent private land. Sub-population 2 occurs within a large area of remnant vegetation on private land that has recently been fenced to exclude stock.

7.6 Ecology

7.6.1 Biology

Caladenia intuta produces a leaf in July or August. It is likely that plants can remain dormant or sterile over several years as for other *Caladenia* species. During early to late August buds are produced, followed by flowering in late August to mid September. By early October the leaf shrivels and the pollinated flowers develop into seed capsules. In October the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. intuta* is not known, but is assumed to be more than fifteen years.

7.6.2 Pollination

Native bees are thought to be the pollinator of *Caladenia intuta*. Native bees were observed pollinating *C. intuta* by the author in August 2005. One specimen was collected and has been sent to the SA Museum for identification. Forty-seven percent of flowers in Sub-population 2 had formed capsules in September 2005 and a similar level of pollination was observed at Sub-population 1 (DEH 2006[a]). Jones (2005) also noted that pollination was evident at Sub-population 1 in 1999.

7.6.3 Mycorrhiza

Caladenia intuta grows in association with mycorrhizal fungi. Mycorrhizal fungi were isolated from *C. intuta* plants in 2005, but are yet to be identified. It is currently unknown whether a specific fungus, or multiple fungi are associated with the species. However, mycorrhizal fungi are thought to play a vital role in seed germination and nutrient absorption in most *Caladenia* species.

7.6.4 Response to fire

Caladenia intuta does not require fire to flower, and it is currently unknown how the species responds to fire because no sub-populations have been burnt in recent years.

7.6.5 Research opportunities

No specific research has been undertaken for *Caladenia intuta*. There is a need for research into the aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – including identifying the pollinator;
- Population genetics – determining genetic diversity and population viability;
- Seed ecology – determining germination requirements;

7.7 Threats to Recovery

7.7.1 Weed invasion – HIGH

Weed invasion is a significant threat to Sub-population 1. Freesia, Bridal Creeper, Soursob, Box Thorn, and annual grasses are the primary threatening weeds. Freesia and Bridal Creeper are very abundant and are expected to displace the orchids if not controlled. Freesia has spread from historic plantings within the cemetery, and therefore liaison will need to take place with local interests prior to control.

It is vital that any weed control in Sub-population 1 does not cause off-target damage on *Caladenia intuta*. Herbicide spraying is a definite risk within the sub-population, unless extreme care is used,

preferably when the orchids are dormant. Care should be taken when removing or brush-matting Box Thorn not to damage or cover the orchids.

7.7.2 Grazing - HIGH

Sheep grazing is currently a threat to the portion of Sub-population 1 within private land. Sheep grazing is also a potential threat to Sub-population 2, although the property within which it occurs is currently fenced to exclude stock.

7.7.3 Vegetation clearance – HIGH

Incremental vegetation clearance is a potential threat to Sub-population 1. Any attempt to remove native vegetation from around gravesites within the cemetery could have an adverse impact on the sub-population if not carefully undertaken.

7.7.4 Trampling – Moderate

Trampling is a threat to Sub-population 1. Local groups, orchid enthusiasts, and tourists visiting the cemetery during spring are known to accidentally damage the orchids when walking through the site. Defined foot paths have been established to visit the grave sites, but others are forming through the sub-population. It also appears as though a vehicle may have also driven through the sub-population in recent years.

7.7.5 Herbivory - Moderate

The level of herbivory of flowering plants in Sub-population 1 was four percent in September 2005, and one percent in Sub-population 2. While this is relatively low, it is likely to have increased by the end of the flowering season. Kangaroos and rabbits occur at both sites and are thought to be responsible for most of the herbivory.

7.7.6 Illegal collection – Moderate

Illegal collection is a potential threat to *Caladenia intuta*, especially to Sub-population 1. While there is no evidence that collection has occurred recently, it is highly possible. Visitors to the cemetery may also pick the flowers.

7.8 Previous Recovery Actions

The following recovery actions were implemented for *Caladenia intuta* prior to 2007.

- Yorke Peninsula Animal and Plant Control Board released Bridal Creeper Rust at Sub-population 1 in 2004.
- DCYP erected a sign at Sub-population 1 in 2004 to notify the public of the presence of threatened species.
- *C. intuta* was included in the LBTORP in 2005.
- Comprehensive baseline surveys of Sub-population 1 and 2 were undertaken in 2005.
- A plant list was compiled for Sub-population 1 in 2005.
- Seed was collected from both sub-populations in 2005 and is stored at BGA.
- Mycorrhizal fungi have been isolated from mature plants in both sub-populations in 2005 by BGA.
- Biannual recovery team meetings (NLBTORT) for the species have been held since 2005.
- The Friends of Brentwood Cemetery were formed in 2006 and a working bee was held to control Box Thorn and other weeds in the cemetery and on adjoining private land. A vegetation management plan is currently being prepared for the cemetery.

The previous recovery actions implemented for this species have been successful in increasing knowledge of the species, especially in relation to its current population size and threats. Weed control at Brentwood has abated the direct threat from weeds and has improved habitat condition, but requires ongoing follow-up. Community engagement has also been successful in increasing awareness and involvement in onground recovery actions. Recovery actions were initiated in 2004 and there is not enough data yet to adequately evaluate population trends or the success of other recovery actions.

7.9 Recovery Objectives, Performance Criteria and Recovery Actions

7.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia intuta* is to improve the conservation status from Critically Endangered to Endangered within 20 years. Specific recovery objectives and performance criteria for *Caladenia intuta* are listed in Table 22.

Table 22: Specific recovery objectives and performance criteria for *Caladenia intuta*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 20 percent within five years.	CR B1 CR B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 4 extant sub-populations after five years.	CR B1a CR B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 20 percent within five years.	CR B1b(iv) CR B1b(v)
	3.2 At least 2 sub-populations contain >80 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species increased by at least 10 percent within five years.	CR B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 2 sub-populations are actively managed to improve habitat condition.	CR B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 private landholders and 2 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 3 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

7.9.2 Specific recovery actions

The specific recovery actions for *Caladenia intuta* are listed in Table 23. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 23: Specific recovery actions for *Caladenia intuta*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, FBC
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	1	DEH, DCYP, FBC, NOSSA, TPAG
1	C.2 Prepare site action plans for selected sub-populations.	Year 1	1	DEH, NY NRM
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
1	C.5 Erect fences and remove stock from sub-populations.	Year 1	1	DEH, NY NRM
1	C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.	Year 1	1	DEH, FBC, DCYP
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
2	D.1 Encourage private landholders to enter into Heritage Agreements.	Year 1	All	DEH
2	D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	Year 1	1	DEH
3	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
3	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
3	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
4	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	1, 2	DEH, NOSSA, FBC
4	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	1, 2	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
4	C.8 Implement hygiene measures to prevent the introduction or spread of Phytophthora into habitat.	Years 1 to 7	All	DEH, NOSSA, TPAG, FBC
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
5	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	2	DEH, NOSSA
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

8. *Caladenia macroclavia* (Large-club Spider-orchid)

8.1 Description

Caladenia macroclavia has a single, hairy, ovate-lanceolate shaped leaf (8 –14 cm long). It has a slender, hairy scape (15 – 30 cm long). It produces one, or rarely two flowers. The perianth segments are linear lanceolate, green to yellowish green with a prominent dark red central stripe. The dorsal sepal is erect and incurved to 60 mm long, terminated by thick, laterally flat, brown, bayonet shaped osmophores (15 mm x 2 mm). The lateral sepals are spreading, falcate, to 50 mm, with similar osmophores to the dorsal sepal. The petals are decurved to 35 mm long, with no osmophores. The labellum is elongated-cordate when flattened, and is green to yellowish green with a dark maroon recurved apex. Labellum margins are fringed with linear, paired, obtuse, forward-facing teeth, 5 mm long. The calli are in four congested rows, extending two-thirds of the way to the apex, the basal ones are longest (Jones 1991).

Caladenia macroclavia, Pt Vincent, J Quarmby

Type: South Australia, 15 km east of Minlaton, Yorke Peninsula, Sept. 10 1988, R. Bates 15432.

Notes: There are at least four other species belonging the *C. dilatata* 'complex' in South Australia that are similar to *C. macroclavia.* These are differentiated mainly by size (particularly of the clubs), and by colour of the osmophores. Further genetic analysis using molecular techniques is required to differentiate each species.

8.2 Conservation Status

Caladenia macroclavia is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

8.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia macroclavia* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Critically Endangered CR C2a(ii); D

Table 24: IUCN Red List Criteria for *Caladenia macroclavia*.

IUCN Criteria	Justification
CR C	It has a population size of less than 250 mature individuals.
CR C2	There is a projected continuing decline in the number of mature individuals.
CR C2a(ii)	At least 90% of mature individuals occur within one sub-population.
CR D	It has a population size of less than 50 mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

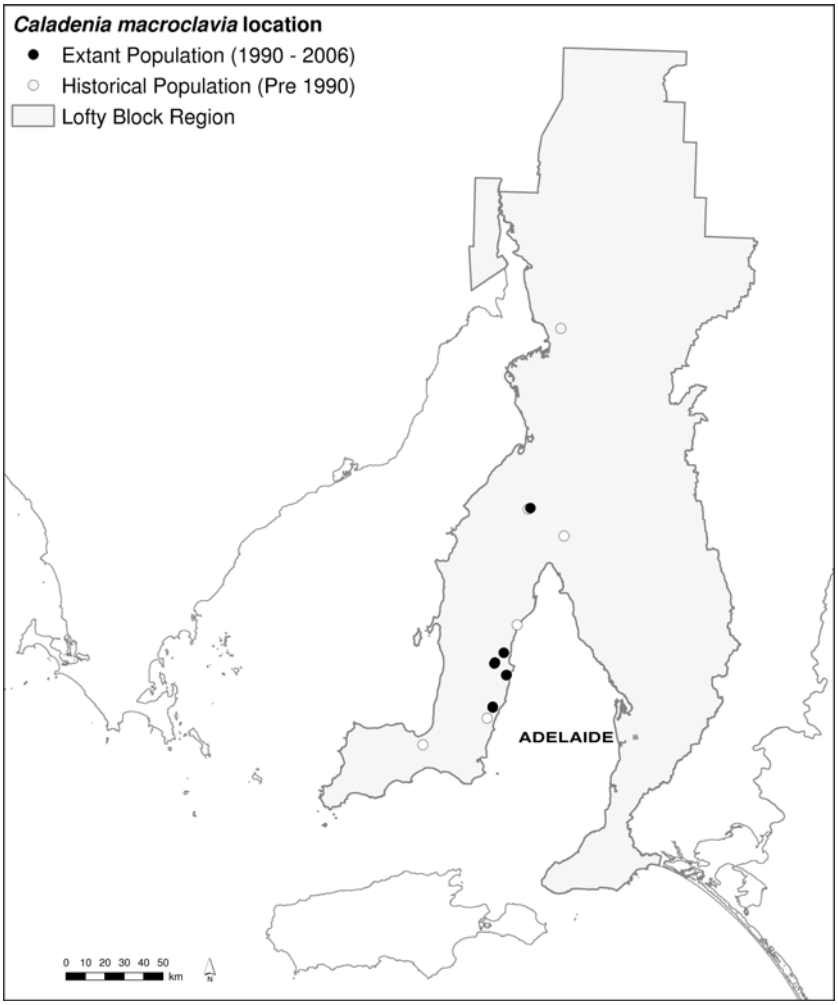
8.3 Distribution and Population Size

8.3.1 Extent of occurrence

Caladenia macroclavia is endemic to South Australia. In 2006 the species was known from five sub-populations in the Yorke Peninsula herbarium region (refer to Figure 6); the extent of occurrence was calculated to be 382 km² and the area of occupancy was 1.3 hectares. There is a high risk that the extent of occurrence will decline significantly within the next five to ten years due to the extremely small sizes of most sub-populations.

Caladenia macroclavia has also been recorded from Agery Reserve on the Yorke Peninsula (DEH 2006[b]), but the validity of these records has been questioned for taxonomic reasons, and consequently these records have not been included in this plan.

Figure 6: Current and historical distribution of *Caladenia macroclavia*.



There are historical records of *Caladenia macroclavia* from four other sub-populations on Yorke Peninsula, and one from Telowie Gorge CP in the Southern Flinders Ranges. Searches of these historical locations in recent years have failed to locate the species.

The historical extent of occurrence of *Caladenia macroclavia* is 5100 km², and therefore the extent of occurrence has reduced by at least ninety-three percent over the last fifty to one-hundred years.

8.3.2 Population size

The population size of *Caladenia macroclavia* was estimated to be between 35 and 80 mature individuals in 2006 (refer to Table 25). However, it is difficult to determine the actual current population size due to high levels of dormancy and annual fluctuations in the number of flowering plants in all sub-populations.

It is estimated that over ninety percent of the total population is contained with Sub-population 5. All other sub-populations consist of less than five individuals, and are at extreme risk of extinction. No flowers have been seen at Sub-population 2 since 1999 despite annual searches, and it is possible that this sub-population is already extinct.

It is assumed that the population size of *Caladenia macroclavia* has reduced over the last fifty to one-hundred years, due to the extinction of historical sub-populations, habitat loss, fragmentation, and other threats.

8.3.3 Important sub-populations

All *Caladenia macroclavia* sub-populations are important for conservation due to the low overall population size of the species. Sub-population 5 is considered to be the most important because it comprises over ninety percent of the total population size, and it is the only sub-population that is likely to be self-sustaining. It also contains the highest genetic diversity (Ottewell *et al* 2009).

Sub-populations 1, 2 and 4 are considered important for their outlying distribution and likelihood of containing genetic diversity not found in Sub-population 5. Extinction of any of these sub-populations would result in further decline in the extent of occurrence. Sub-population 3 is important because it is the second largest sub-population.

8.4 Habitat

Caladenia macroclavia grows in *Eucalyptus gracilis*, *E. socialis, or E. incrassata* mallee over *Melaleuca uncinata*, *Alyxia buxifolia*, *Acrotriche patula, Lepidosperma congestum*, *Gahnia deusta* and *Lomandra effusa*. *C. macroclavia* typically grows in sandy loam soils over limestone, usually in lower lying areas.

This habitat type has been severely reduced in area and is highly fragmented through land clearance pre-1970. Most of the known occurrences of this habitat type are small and degraded,

with the exception of Curramulka Scrub, which is thought to contain the largest area of suitable habitat for the species.

Table 25: Sub-population numbers, trends and threats for *Caladenia macroclavia*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Curramulka	Private (reserved)	0 (06)	7 (02)	4	Decline	Grazing, lack of recruitment
2	Mona	DTEI (unreserved)	0 (06)	4 (99)	1	Decline	Weed invasion, herbivory, lack of recruitment
3	Muloowurtie	DCYP (reserved)	2 (06)	7 (04)	4	Fluctuating	Herbivory, lack of pollination, weed invasion
4	Pt Julia	Private (unreserved)	1 (06)	1 (06)	1	Steady	Herbivory, lack of pollination
5	Pt Vincent	Private (unreserved)	35 (06)	65 (05)	28	Fluctuating	Herbivory, weed invasion
		TOTAL	**38**	**84**	**38**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix E, which is available from DEH, Threatened Species Unit.

8.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix E contains maps of habitat critical to the survival of *Caladenia macroclavia*, and is available for legitimate purposes from DEH, Threatened Species Unit.

8.5 Reservation Status and Management Responsibility

Caladenia macroclavia occurs across a variety of land tenures including reserved and unreserved, private and public land (refer to Table 25). Sub-population 3 occurs within crown land managed by DCYP that is reserved for conservation purposes under the *Crown Lands Act 1929*. Sub-population 1 occurs within private land that is reserved under Heritage Agreement.

Sub-population 2 is located within a railway reserve managed by DTEI, and sub-populations 4 and 5 occur within private land that is currently unreserved. However, the owner of Sub-population 4 is currently applying for a Heritage Agreement.

All landholders are aware of the presence of *Caladenia macroclavia* on their land and are supportive of recovery activities.

8.6 Ecology

8.6.1 Biology

Caladenia macroclavia usually produces a leaf in July or August. However, it has been found that plants do not always produce a leaf or flowers every year, and can remain dormant for one or more years (DEH 2006[a]). During early to late August buds are produced, followed by flowering in late August to mid September. By early October the leaf shrivels and the pollinated flowers develop into seed capsules. In October the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. macroclavia* is not known, but is assumed to be more than fifteen years.

8.6.2 Pollination

The pollinator of *Caladenia macroclavia* is yet to be identified; however, it is assumed to be a male thynnid wasp. *C. macroclavia* exhibits the characteristics of a sexually deceptive species that attracts male thynnid wasps by emitting kairomones from the osmophores on its sepals.

8.6.3 Mycorrhiza

Caladenia macroclavia is thought to grow in association with mycorrhizal fungi. Fungal isolation is yet to be attempted for *C. macroclavia*. However, it is thought that mycorrhizal fungi play an important role in seedling germination and growth in most *Caladenia* species.

8.6.4 Response to fire

Caladenia macroclavia does not require fire to flower, and it is currently unknown how *C. macroclavia* responds to fire because none of the known sub-populations have been burnt in recent years.

8.6.5 Research opportunities

A preliminary study of the population genetics of *Caladenia macroclavia* (Ottewell *et al* 2009) has found adequate diversity in Sub-population 5, and adequate relatedness between sub-populations. There is significant need for research into other aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – including identifying the pollinator;
- Seed ecology – determining germination requirements.
- Response to disturbance – determining the response to soil disturbance and vegetation clearance.

8.7 Threats to Recovery

8.7.1 Herbivory – HIGH

Herbivory of flowers by kangaroos and rabbits is a threat to all sub-populations of *Caladenia macroclavia*. Kangaroos are particularly prevalent at Sub-populations 5, while rabbits are prevalent at Sub-populations 2, 4 and 5. Cages have been placed around all known mature individuals, but there is nothing to prevent seedlings or previously undetected plants from being eaten.

8.7.2 Grazing – HIGH

Sheep grazing is a threat to a portion of Sub-populations 5 in an area that is currently unfenced. Sub-population 1 was grazed by stock in 2005 resulting in severe habitat degradation. Sub-populations 4 and 5 were fenced in 2005, but have been grazed by stock for decades.

8.7.3 Weed invasion – HIGH

Weed invasion is a threat to all sub-populations of *Caladenia macroclavia*. Threatening weeds include Bridal Creeper, Soursob, African Box Thorn, Wild Oats, and other introduced grass species.

8.7.4 Lack of pollination – HIGH

Lack of pollination is a threat to all sub-populations of *Caladenia macroclavia.* While effective natural pollination has been observed in low levels at Sub-populations 3 and 5, none has been observed at the small sub-populations (1, 2 and 4). Single flowers are often all that is found at these small sub-populations, thus making cross-pollination highly improbable. It is also possible that the pollinator of *C. macroclavia* has suffered population declines due to habitat loss, population fragmentation and pesticide drift.

8.7.5 Lack of recruitment – HIGH

Sub-populations 1, 2, 3 and 4 are all at risk of lack of recruitment. While this is partly caused by the low rates of natural pollination, there may be other factors contributing (*e.g.* disturbance requirements, seed viability etc).

8.7.6 Inbreeding and loss of genetic diversity – HIGH

Inbreeding and loss of genetic diversity is a threat to *Caladenia macroclavia*. All sub-populations except for Sub-population 5 consist of less than ten individuals, and have limited or no chance of out-crossing due to habitat fragmentation.

8.8 Previous Recovery Actions

Prior to 2007 the following recovery actions were implemented for *Caladenia macroclavia.*

- TPAG and Australian Plant Society (APS) have implemented a habitat restoration project at Muloowurtie Conservation Reserve since 1996, involving fencing, weed control and revegetation (Reynolds 1996; Reynolds 2000[a]; Reynolds 2000[b]). *C. macroclavia* was later discovered in the reserve in 1999.
- *C. macroclavia* was included in the LBTORP in 1998.
- Wire cages were placed around all known *C. macroclavia* plants from 2000 to 2003.
- A fact sheet was prepared for the species in 2001 (DEH 2001[b]), and has been publicly disseminated.
- Annual population monitoring was undertaken for all sub-populations from 2001 to 2003.
- A national Recovery plan was prepared for the species in 2003 (Bickerton 2003[a]), and the following recovery actions have been implemented.
  - 1. - Seed was collected from Sub-populations 3, 4 and 5 in 2005 and is stored at BGA.
  - 3.1.1 - All plants in Sub-populations 2, 3, 4 and 5 have been protected with wire cages since 2003.
  - 3.1.2 - Rabbit control was undertaken at Sub-population 3 in 2005.
  - 3.1.3 - Fences were erected around Sub-population 4 and part of Sub-population 5 in 2005.
  - 3.2 - Weed control was undertaken at Sub-populations 2, 3 and 5 in 2004 and 2005.
  - 3.3 - Plants were artificially pollinated in Sub-populations 3, 4 and 5 in 2005.
  - 4.1 - Searches of historical, known and potential habitat were undertaken in 2004 and 2005. Search areas included Curramulka, Minlaton, Port Julia, and Port Vincent.
  - 4.2.2 - A Heritage Agreement is currently being arranged for Sub-population 4.
  - 5. - Biannual recovery team meetings (NLBTORT) have been held since 2000.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

8.9 Recovery Objectives, Performance Criteria and Recovery Actions

8.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia macroclavia* is to improve the conservation status according to IUCN criteria from Critically Endangered to Endangered within 20 years. Specific recovery objectives and performance criteria for *Caladenia macroclavia* are listed in Table 26.

8.9.2 Specific recovery actions

The specific recovery actions for Caladenia macroclavia are listed in Table 27. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 26: Specific recovery objectives and performance criteria for *Caladenia macroclavia*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To maintain the extent of occurrence of the species.	1.1 The extent of occurrence of the species is maintained over five years.	CR B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 6 extant sub-populations after five years.	CR C CR C2
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 50 percent within five years.	CR C CR C2 CR D CR C2a(ii)
	3.2 At least 3 sub-populations contain >20 mature individuals after five years.	
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species is maintained over five years.	CR B2b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 5 sub-populations are actively managed to improve habitat condition.	CR B2b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 private landholders and 2 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 4 community groups and 15 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Table 27: Specific recovery actions for *Caladenia macroclavia*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, APS, PJPS, TPAG, NOSSA
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	All	DEH, NOSSA
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH, TPAG
1	C.5 Erect fences and remove stock from sub-populations.	Year 1	5	DEH
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	All	DEH
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	5	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
2	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
2	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
2	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA
2	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
2	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	All	DEH, NOSSA, USA
2	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	All	DEH
2	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	All	DEH, AU
3	C.2 Prepare site action plans for selected sub-populations.	Years 1 to 2	3, 4, 5	DEH, TPAG
3	D.1 Encourage private landholders to enter into Heritage Agreements.	Years 1 to 7	5	DEH
3	D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	Years 1 to 7	2	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
5	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	4	DEH, NOSSA

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

9. *Caladenia rigida* (White Spider-orchid)

9.1 Description

Caladenia rigida has a single, hairy, narrow-lanceolate shaped leaf, 3–20 cm long. It has a slender, hairy scape to 25 cm long. It produces one or two white flowers. The perianth segments are 2-5 cm long, linear-lanceolate, and white with a red central stripe beneath. The dorsal sepal is erect and incurved over the column, terminated by a dark red, glandular club. The lateral sepals are rigidly spreading, with similar clubs to the dorsal sepal. The petals are rigidly spreading, with no clubs. The labellum is ovate, c. 1 cm long, creamy white, with a recurved apex. Labellum margins are fringed with red-brown subulate teeth, which are white-tipped. The calli are in four rows, red with white tips, and basally club-shaped but becoming linear and sessile toward the apex (Bates and Weber 1990).

Type: South Australia, Golden Grove, Sept 12 1908, R.S. Rogers sn.

Caladenia rigida, South Para Reservoir, J Quarmby

9.2 Conservation Status

Caladenia rigida is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

9.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia rigida* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Endangered (EN B1ab(i, iv)c(iv).

Table 28: IUCN Red List Criteria for *Caladenia rigida*.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km².
EN B1a	Sub-populations are severely fragmented.
EN B1b(i)	There is a projected continuing decline in the extent of occurrence.
EN B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
EN B1b(iv)	There is a projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

9.3 Distribution and Population Size

9.3.1 Extent of occurrence

Caladenia rigida is endemic to South Australia. In 2006 the species was known from three disjunct areas in the Southern Lofty herbarium region, comprising of 24 sub-populations (refer to Figure 7); with an extent of occurrence of 458 km², and an area of occupancy of 7.8 hectares.

Historically *Caladenia rigida* was known to occur over 1153 km². At least 18 sub-populations of *C. rigida* have become extinct within the last fifty to one-hundred years, and the extent of occurrence has reduced by at least sixty percent. The main cause of this decline is assumed to be habitat loss and fragmentation.

9.3.2 Population size

The population size of *Caladenia rigida* was estimated to be approximately 5500 mature individuals in 2006 (refer to Table 29). However, these figures are based on limited survey data, and it is likely that the actual population size is much greater than suggested by these data (10000+).

Figure 7: Current and historic distribution of *Caladenia rigida*

Further surveys are required to determine the current size of Sub-populations 6, 7, 8 and 18 which are likely to contain much larger numbers than current figures indicate. Furthermore, Sub-populations 2, 21, 23 and 24 have not been visited in recent years and require surveys to determine their current size.

It is also highly likely that additional sub-populations exist in locations that have not yet been surveyed, especially in the Kersbrook and Mount Gawler area.

It is likely that the population size of *Caladenia rigida* has reduced substantially over the last fifty to one-hundred years, due to the extinction of historical sub-populations.

9.3.3 Important sub-populations

While all sub-populations of *Caladenia rigida* are important, Sub-populations 12, 22, 7 and 6 are considered to be the most important for conservation because of their relatively large size, and likelihood of being self-sustaining and containing high genetic diversity. Sub-populations 6, 7, 9, 10, 11, 14, 15 and 16 are also considered important due to their relatively large sizes.

Sub-populations 3, 4 and 9 are important because of their outlying distribution and relatively large size.

Table 29: Sub-population numbers, trends and threats for *Caladenia rigida*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Belair NP	DEH (reserved)	2 (06)	2 (06)	2	Unknown	Lack of recruitment, herbivory, weed invasion
2	Hale CP	DEH (reserved)	1 (95)	1 (95)	0	Possibly extinct	Lack of recruitment
3	Ironbank	Private (unreserved)	87 (05)	87 (05)	87	Unknown	Weed invasion, herbivory
4	Ironbank	Private (unreserved)	45 (05)	45 (05)	45	Unknown	Weed invasion, herbivory
5	Kersbrook	Private (unreserved)	18 (04)	18 (04)	18	Stable	Herbivory, weed invasion

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1999-2005)	Sub-population Trend	Key Threats
6	Kersbrook NFR	FSA (reserved)	555 (04)	555 (04)	555	Unknown	Herbivory, track management
7	Kersbrook NFR	FSA (reserved)	700 (04)	700 (04)	700	Unknown	Herbivory, track management
8	Kersbrook NFR	FSA (reserved)	100 (04)	100 (04)	100	Unknown	Herbivory, track management
9	Kuitpo Forest	FSA (mostly reserved, partly unreserved)	341 (06)	341 (06)	341	Unknown	Track management, recreation, weed invasion
10	Millbrook Reservoir	Private (reserved)/SAW (unreserved)	351 (06)	351 (06)	276	Unknown	Weed invasion, track management
11	Millbrook Reservoir	SAW (unreserved)	100 (06)	150 (05)	125	Unknown	Herbivory, weed invasion
12	Mt Gawler NFR	FSA (reserved)	1600 (05)	1600 (05)	1600	Unknown	Herbivory, recreation, track management
13	Mt Gawler NFR	FSA (reserved)	55 (04)	55 (04)	55	Unknown	Herbivory, track management, recreation
14	Mt Gawler NFR	FSA (reserved)	208 (04)	208 (04)	208	Unknown	Herbivory, track management, recreation
15	Mt Gawler NFR	FSA (reserved)	239 (05)	239 (05)	170	Unknown	Herbivory, recreation
16	Mt Gawler NFR	FSA (reserved)	208 (04)	208 (04)	208	Unknown	Herbivory, recreation, track management
17	Para Wirra RP	DEH (reserved)	3 (06)	3 (06)	3	Unknown	Lack of recruitment
18	Roachdale	NTSA (reserved)	1 (04)	1 (04)	1	Unknown	Herbivory, lack of recruitment
19	Scott Creek CP	DEH (reserved)	0 (06)	5 (04)	2	Fluctuating	Lack of recruitment
20	Scott Creek CP	DEH (reserved)	0 (06)	2 (03)	1	Decline	Lack of recruitment
21	Scott Creek CP	DEH (reserved)	1 (92)	1 (92)	0	Unknown	Lack of recruitment
22	South Para Reservoir	SAW (unreserved)	976 (06)	976 (06)	976	Unknown	Herbivory, weed invasion
23	Warren CP	DEH (reserved)	10 (93)	10 (93)	0	Possible decline	Herbivory, lack of recruitment
24	Warren CP	DEH (reserved)	1 (04)	10 (93)	6	Decline	Herbivory, lack of recruitment
		TOTAL	**5602**	**5668**	**5476**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix F, which is available from DEH, Threatened Species Unit.

9.4 Habitat

Caladenia rigida grows in *Eucalyptus obliqua, E. fasciculosa*, *E. leucoxylon, E. goniocalyx*, *E. microcarpa* open forests with a relatively open shrub layer dominated by *Xanthorrhoea semiplana*, *Acacia pycnantha*, *Hibbertia exutiacies, Pultenaea largiflorens, P. daphnoides*, *Spyridium parvifolium*, *Hakea rostrata* and *H. carinata*. *C. rigida* usually grows on the ridges and upper slopes of hills. Soils are generally sandy loams.

This habitat type has been significantly cleared, fragmented and degraded in the Southern Mount Lofty Ranges since European settlement, but relatively large intact tracts still exist in native forest reserves, water reserves, and NP&W Act reserves in the Kersbrook area.

9.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix F contains maps of habitat critical to the survival of *Caladenia rigida*, and is available for legitimate purposes from DEH, Threatened Species Unit.

9.5 Reservation Status and Management Responsibility

Caladenia rigida occurs across a variety of land tenures including reserved and unreserved public and private land (refer to Table 29). Thirteen sub-populations of *C. rigida* occur within land that is formally reserved for biodiversity conservation purposes. Eight sub-populations occur wholly or partly within Native Forest Reserves (Mount Gawler NFR and Kersbrook NFR), and eight sub-populations occur within NP&W Act reserves (Warren CP, Scott Creek CP, and Hale CP). Sub-population 9 occurs within ForestrySA land that is mostly zoned for conservation, and sub-population 10 occurs partially within private land under Heritage Agreement.

Seven sub-populations of *Caladenia rigida* occur wholly or partially within land that is not reserved for biodiversity conservation purposes. Three sub-populations occur wholly or partially within water reserves (Millbrook Reservoir and South Para Reservoir) and three sub-populations occur within unreserved private land.

9.6 Ecology

9.6.1 Biology

Caladenia rigida usually produces a leaf in June or July. However, tubers may not produce a leaf or flowers every year, and may remain dormant for several years. During early to late August buds are produced, followed by flowering in late August to October. In October the pollinated flowers develop into seed capsules. In late October the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. rigida* is not known, but is assumed to be more than fifteen years.

9.6.2 Pollination

Caladenia rigida is thought to be pollinated by native bees (*Exoneura* sp. and *Homalictus* sp.) and thynnid wasps (*Phymatothynnus* sp.) (Bates 1984, Bickerton 1997). It is therefore suggested that *C. rigida* uses both food mimicry and sexual deception as pollination mechanisms (Bates 1984, Bickerton 1997).

9.6.3 Mycorrhiza

Caladenia rigida is thought to grow in association with mycorrhizal fungi. Fungal isolation is yet to be undertaken for *C. rigida.* However, it is thought that mycorrhizal fungi play an important role in seedling germination and growth in most *Caladenia* species.

9.6.4 Response to fire

Caladenia rigida does not require fire to flower, however many sub-populations have been known to flower profusely in the years immediately following fire (Bates 1995[c], DEH 2006[a]). Furthermore, the number of *C. rigida* in Scott Creek CP has declined significantly with time since wildfire in 1990 (T. Hands *pers comm.* 2005). This decline is thought to be mainly caused by the dense regeneration of vegetation after fire. Bates (1995[c]) suggests that fire or vegetation slashing could be used as a management tool to maintain open habitat for *C. rigida*, however it would be important to determine the optimum timing, intensity and frequency for prescribed burning.

9.6.5 Research opportunities

Caladenia rigida has been the subject of a few research projects, mainly investigating pollination biology. Related papers include:

- Bates (1984) - ecology and biology of *Caladenia rigida*

- Bickerton (1997) – A study of pollination and herbivory of *Caladenia rigida*
- Faast (unpublished) - A research project by University of Adelaide investigating the effects of fragmentation on orchid pollination in the Mount Lofty Ranges.

Other areas that require research include:

- Seed ecology – determining germination requirements;
- Response to fire – determining the optimal timing, intensity, and frequency of fire;
- Response to disturbance – determining the response to vegetation slashing or soil disturbance.

9.7 Threats to Recovery

9.7.1 Herbivory – HIGH

Herbivory is regarded as a threat to most sub-populations of *Caladenia rigida*. Kangaroos, hares, rabbits, deer, snails, caterpillars and other invertebrates are all considered likely to be causing herbivory of *C. rigida*. High kangaroo numbers are thought to be responsible for most of the herbivory in sub-populations in the Kersbrook area.

Rabbits and hares are known to occur at most of the locations, but their numbers fluctuate between years, especially since the release of the Rabbit Calici Virus. Feral deer are also known to occur widely in the South Para/Mt Crawford area, and are regarded as a potential threat. Snails, caterpillars and other invertebrates are thought to be responsible for low levels of herbivory, and are most threatening to sub-populations in the Scott Creek area.

9.7.2 Weed invasion – HIGH

Weed invasion is a threat to many sub-populations of *Caladenia rigida*. Weeds of highest threat include Gorse, Boneseed, Radiata Pine, South African Daisy, and Tree Heath. All sub-populations in the Scott Creek area (1, 3, 4, 19, 20 and 21) are particularly at risk from weed invasion. Sub-populations 5, 10, 11 and 22 in the Kersbrook area, and Sub-population 9 in Kuitpo Forest are also known to be particularly at risk from weed invasion.

9.7.3 Lack of recruitment – Moderate

Lack of recruitment is a threat to the small sub-populations of *Caladenia rigida*, especially Sub-populations 1, 2, 8, 17, 18, 19, 20 and 21. While this is most likely related to low rates of natural pollination other factors may also be contributing (e.g. disturbance requirements, biomass levels etc).

9.7.4 Track management activities – Moderate

Sub-populations 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 occur near vehicle tracks and are at risk from track management activities (*e.g.* grading, constructing turnout drains, slashing and pruning vegetation, and weed control).

9.7.5 Recreational activities – Moderate

Recreation activities including motorbike, mountain bike and horse riding are a direct threat to Sub-populations 9, 12, 15 and 22. Some of these activities are permitted on designated trails, while other activities are occurring illegally. Of particular concern are the numerous illegal mountain bike trails through *Caladenia rigida* sub-populations in Mount Gawler NFR.

9.7.6 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to *Caladenia rigida*. Sub-populations 1, 5, 17, 18, 19, 20, 21, 23 and 24 have population sizes of less than 30 mature plants, and are relatively isolated. The likelihood of these sub-populations out-crossing is very limited.

9.7.7 Fire management activities – Moderate

Many sub-populations of *Caladenia rigida* occur on public land that may be burnt or slashed as part of fire management activities. It is currently thought that burning during the active growth season of *C. rigida* (April – Oct) could destroy or damage plants. Burning during winter or spring is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations).

9.7.8 *Phytophthora* – Low

It is currently unknown whether *Caladenia rigida* is susceptible to *Phytophthora*, however it is regarded as a potential threat to the species. According to Velzeboer *et al* (2005) *C. rigida* is

regarded as potentially under high threat from *Phytophthora* with fifty-six percent of sub-populations occurring within a Moderate Risk Zone for *Phytophthora*, and forty-four percent occurring within a Low Risk Zone. Many of the plants that commonly grow in association with *C. rigida* are highly susceptible to *Phytophthora*.

9.8 Previous Recovery Actions

The following recovery actions had been implemented for *Caladenia rigida* prior to 2007.

- From 1993 to1996 TPAG received funding under from the Endangered Species Program to write and implement a recovery plan for *C. rigida*. The plan was completed in 1995 (Bates 1995[c]) and the following recovery actions were achieved.
  - Collection of seed from Sub-population 4 and re-dispersal around parent plants from 1993-1996.
  - Hand pollination of a proportion of flowers in Sub-population 2 from 1993-1995.
  - Hand pollination was undertaken at Subpopulations 10, 12, 19, 20 and 21 in 1994.
  - Seed was collected from Sub-populations 10, 12, 19, 20 and 21 in 1994. A proportion of the seed was germinated at Paget's Nursery and Les Nesbitt's Nursery in 1994.
  - Searches of historic habitat in the Kuitpo and Macclesfield areas were undertaken in 1995. No sub-populations were located.
- *C. rigida* was included in the LBTORP in 2004.
- Biannual recovery team meetings (SLBTORT) have been held since 2004.
- Surveys of all known sub-populations except for Sub-populations 2, 8, 21, 23 and 24 were undertaken from 2004-2006.
- Plants in Sub-populations 3 and 19 were monitored in 2005.
- Seed was collected from Sub-populations 3, 10, 12, 19 and 22 in 2005. Mycorrhizal fungi were also collected from Sub-populations 19 in 2005, and are stored in BGA.
- Research into pollination ecology and population genetics by Adelaide University initiated in 2005.
- Surveys of Sub-populations 1, 9, 10, 11, 17 and 22 were undertaken in 2006.

The previous recovery actions implemented for this species have been successful in increasing knowledge of the species, especially in relation to its current distribution and population size. Research undertaken by Adelaide University has also improved knowledge of the biology and ecology of the species. However, efforts to increase the population size by hand pollination, seed redispersal and translocation appear to have been unsuccessful. Some populations have apparently declined over the last 20 years through a reduction in flowering plants, which is thought to be largely due to prevailing drought conditions and lack of fire. There are insufficent data to accurately assess the effectiveness of the other recovery actions.

9.9 Recovery Objectives, Performance Criteria and Recovery Actions

9.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia rigida* is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Caladenia rigida* are listed in Table 30.

9.9.2 Specific recovery actions

The recovery actions for *Caladenia rigida* are listed in Table 31. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 30: Specific recovery objectives and performance criteria for *Caladenia rigida*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 20 percent within five years.	EN B1 EN B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 30 extant sub-populations after five years.	EN B1a EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 30 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 13 sub-populations contain >20 mature individuals after five years.	
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species is increased by at least 20 percent within five years.	EN B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 10 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 3 private landholders and 4 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 4 community groups and 15 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Table 31: Specific recovery actions for *Caladenia rigida*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	1, 3, 4, 5, 9, 10, 11, 19, 20, 21, 22	DEH, SAW, SPBP
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	1, 18, 19, 20, 21	DEH
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	1, 2, 5, 17, 18, 19, 20, 21	DEH
1	C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.	Years 1 & 2	9, 12, 15, 22	FSA, DEH
1	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	11, 12	DEH, FSA
1	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24	DEH
1	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	All	DEH, FSA, SAW, NOSSA, TPAG, FSC, SPBP
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	9, 12	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	D.5 Develop protocols for track management activities on public land.	Year 1	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 22	DEH, FSA, SAW
3	D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.	Year 1	TBD	DEH
3	D.1 Encourage private landholders to enter into Heritage Agreements.	Year 1	3, 4, 5	DEH
3	D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	Year 1	9, 10, 11, 22	DEH
3	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
3	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	1, 3, 4, 5, 7, 12, 18, 19, 22	DEH, UA

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
3	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	1, 3, 4, 5, 7, 12, 18, 19, 22	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH, AU
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

10. *Caladenia woolcockiorum* (Woolcock's Spider-orchid)

10.1 Description

Caladenia woolcockiorum has a hairy, lanceolate leaf 15-24 cm long. It has a slender, hairy stem 20-30 cm tall. It produces one or two cream to greenish yellow flowers with a red labellum, and strong musky fragrance, c. 35 mm across. The dorsal sepal is linear-lanceolate, channelled, erect and incurved (35 mm x 4 mm), with thickened blackish, glandular osmophores (10 mm x 1 mm). The lateral sepals are linear-lanceolate, channelled, drooping and falcate (35 mm x 3.5 mm), with similar osmophores to dorsal sepal. The petals are linear-lanceolate and drooping (30 mm x 2.5 mm), with osmophores 5 mm x 0.7 mm. The labellum is linear cordate (18 mm x 9.5 mm), with a strongly recurved apex; distal margins with seven or eight linear, erect, sub-acute to obtuse calli. The lamina calli are dark red, stalked (1.2 mm), and in four rows (Jones 1991).

Type: South Australia, Devils Ledge, upper Mambray Creek Gorge, Flinders Ranges, Sept 3 1988, R. Bates 15319.

Caladenia woolcockiorum, Mt Remarkable NP, J Quarmby

10.2 Conservation Status

Caladenia woolcockiorum is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

10.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia woolcockiorum* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Critically Endangered (CR B1ab(i, ii, iv)).

Table 32: IUCN Red List Criteria for *Caladenia woolcockiorum*.

IUCN Criteria	Justification
CR B1	It has an extent of occurrence of less than 100 km².
CR B1a	All known sub-populations occur within Mt Remarkable NP.
CR B1b(i)	There has been an observed continuing decline in the extent of occurrence.
CR B1b(iii)	There has been an observed continuing decline in the area and quality of habitat.
CR B1b(iv)	There has been an observed continuing decline in the number of sub-populations.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

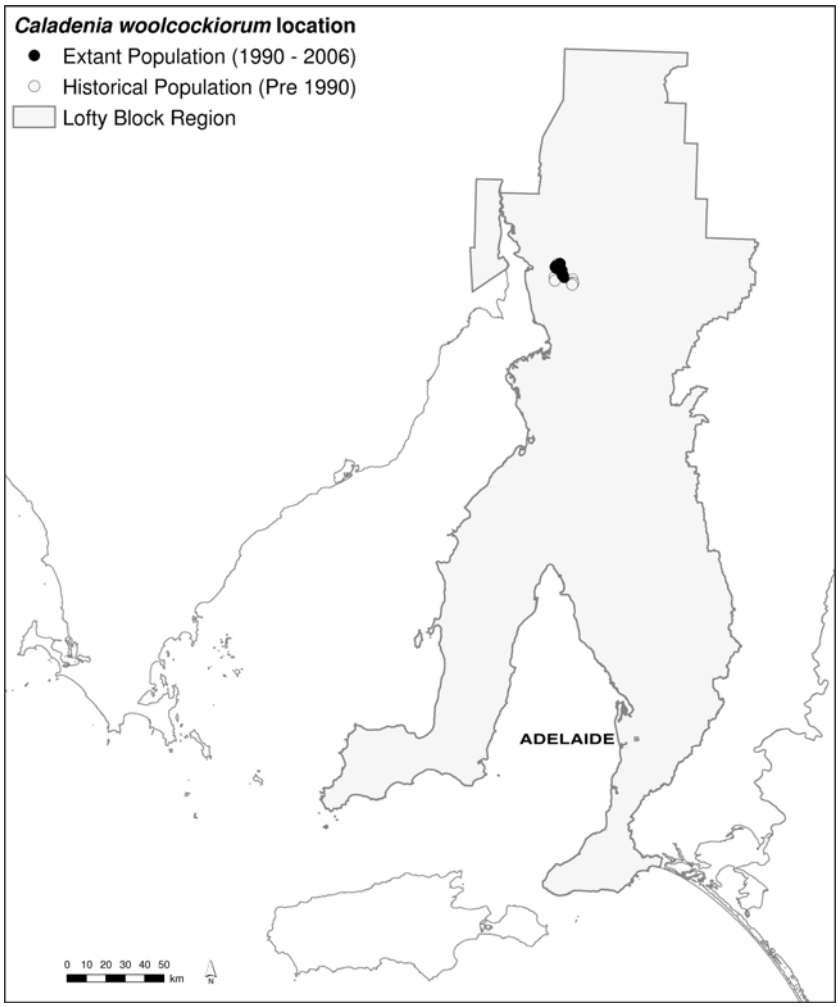
10.3 Distribution and Population Size

10.3.1 Extent of occurrence

Caladenia woolcockiorum is endemic to South Australia. In 2006 the species was known from nine sub-populations within Mount Remarkable NP in the Flinders Ranges herbarium region (refer to Figure 8). The extent of occurrence was 13 km² and the area of occupancy was 4.6 hectares.

There are historic records of *Caladenia woolcockiorum* from at least another four sub-populations within Mount Remarkable NP. Surveys indicate that these sub-populations have become extinct within the last fifty years (DEH 2006[b]). The historic extent of occurrence of *C. woolcockiorum* is 65 km², and therefore there has been a decline of at least eighty-one percent over the last fifty to one-hundred years.

Figure 8: Current and historic distribution of *Caladenia woolcockiorum*



10.3.2 Population size

The population size of *Caladenia woolcockiorum* was estimated to be approximately 5400 mature individuals in 2006 (refer to Table 33), based on survey data from 2005 and 2006. However, it is possible that the actual population size is higher than 2006 data indicate. Most of the survey effort to date has been focussed along vehicle tracks, and it is likely that some sub-populations extent into surrounding areas that have not yet been surveyed. In particular, there are large areas of suitable habitat surrounding Sub-populations 1 – 6 that require further surveys.

In 2006 ninety-eight percent of the known population was contained within three sub-populations (3, 4 and 5).

10.3.3 Important sub-populations

All sub-populations of *Caladenia woolcockiorum* are important for conservation of the species. Sub-populations 4 and 5 are considered to be most important for the conservation of the species due to their relatively large size, and likelihood of being self-sustaining and containing the highest genetic diversity.

Table 33: Sub-population numbers, trends and threats for *Caladenia woolcockiorum.*

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Mt Remarkable NP	DEH (reserved)	53 (04)	76 (02)	65	Fluctuating	Herbivory, weed invasion, track management
2	Mt Remarkable NP	DEH (reserved)	3 (04)	7 (99)	4	Declining	Herbivory, weed invasion, track management
3	Mt Remarkable NP	DEH (reserved)	767 (04)	767 (04)	452	Increasing	Herbivory, weed invasion, track management
4	Mt Remarkable NP	DEH (reserved)	3400 (05)	3400 (05)	1171	Increasing	Weed invasion, herbivory, track management
5	Mt Remarkable NP	DEH (reserved)	1112 (05)	1112 (05)	586	Increasing	Weed invasion, herbivory, track management

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
6	Mt Remarkable NP	DEH (reserved)	13 (06)	13 (06)	13	Unknown	Herbivory, weed invasion
7	Mt Remarkable NP	DEH (reserved)	65 (05)	65 (05)	24	Increasing	Herbivory, track management
8	Mt Remarkable NP	DEH (reserved)	1 (06)	1 (06)	1	Unknown	Track management, lack of recruitment
9	Mt Remarkable NP	DEH (reserved)	0 (05)	1 (00)	0	Possibly extinct	Track management, lack of recruitment
		TOTAL	**5414**	**5442**	**2316**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix G, which is available from DEH, Threatened Species Unit.

10.4 Habitat

Caladenia woolcockiorum typically grows in *Eucalyptus cladocalyx, E. goniocalyx*, *E. leucoxylon* subsp. *pruinosa* open forest or woodland with an understorey of *Acacia pycnantha*, *Cassinia laevis*, *Hibbertia exutiacies*, *Lomandra densiflora*, *Bulbine bulbosa*, *Caesia vittata*, and *Plantago* spp. *C. woolcockiorum* grows on the mid to lower slopes of steep gullies, in relatively open, herbaceous understorey vegetation with loam soils.

Caladenia woolcockiorum also grows in *Eucalyptus leucoxylon* subsp. *pruinosa, Allocasuarina verticillata* woodland over *Acacia pycnantha*, *A. gracilifolia, Pultenaea graveolens* and *Cassinia laevis* at Sub-population 6 and 7. In this habitat type *C. woolcockiorum* grows on gentle south facing slopes and flats with clay loam soils.

Historically *Caladenia woolcockiorum* also grew in *Eucalyptus microcarpa* woodland over *Acacia pycnantha*, *Bursaria spinosa*, and *Cassinia laevis* on mossy rock ledges and rocky slopes with shallow dark loam soil in Mambray Creek (DEH 2006[b], Jones 1991).

10.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix G contains maps of habitat critical to the survival of *Caladenia woolcockiorum*, and is available for legitimate purposes from DEH, Threatened Species Unit.

10.5 Reservation Status and Management Responsibility

All sub-populations of *Caladenia woolcockiorum* occur within Mt Remarkable NP, which is owned and managed by DEH (refer to Table 33).

10.6 Ecology

10.6.1 Biology

Caladenia woolcockiorum usually produces a leaf in July or August, however, like most *Caladenia* spp. It can sometimes remain dormant throughout the growing season, and therefore does not always produce a leaf or spike every year. During August buds are produced, followed by flowering in late August to mid September. By early October the leaf shrivels and the pollinated flowers develop into seed capsules. In October the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. woolcockiorum* is not known, but is assumed to be more than fifteen years.

10.6.2 Pollination

The pollinators of *Caladenia woolcockiorum* have not yet been identified, however male thynnid wasps and/or native bees are likely pollinators. *C. woolcockiorum* has osmophores on its sepals and petals, which are thought to emit a kairomone to attract a specific species of male thynnid wasp. *C. woolcockiorum* is also brightly coloured and strongly perfumed which indicates that it may also use food deception to attract native bees. *C. woolcockiorum* is known to form hybrids with *C. stellata, C. gladiolata* and *C. tensa*.

10.6.3 Mycorrhiza

Caladenia woolcockiorum grows in association with mycorrhizal fungi. Fungal isolation was undertaken for *C. woolcockiorum* in 2005, however the fungi are yet to be identified. It is currently unknown whether a specific fungus, or multiple fungi are associated with the species. However, mycorrhizal fungi are thought to play a vital role in seed germination and nutrient absorption in most *Caladenia* species.

10.6.4 Response to fire

Caladenia woolcockiorum does not require fire to flower, and it is currently unknown how *C. woolcockiorum* responds to fire.

10.6.5 Research opportunities

No specific research has been undertaken for *Caladenia woolcockiorum*. There is significant need for research into aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – identifying the pollinator, and the pollination mechanisms;
- Population genetics – determining genetic diversity and population viability;
- Seed ecology – determining germination requirements;

10.7 Threats to Recovery

10.7.1 Weed invasion – HIGH

Weed invasion is a threat to *Caladenia woolcockiorum*. The current abundance of weeds in most sub-populations is low, however there is significant potential for introduced grasses and herbs to rapidly increase in abundance. Sub-populations 1, 2, 3, 4, 5 and 6 occur in close proximity to large degraded areas and pastoral land, which provide a continual source of invasion by weeds such as Wild Oat, Quaking Grass, Salvation Jane and Plantain. Also the rate of weed invasion would be expected to increase if *C. woolcockiorum* habitat was burnt.

Weed invasion is thought to have contributed to the extinction of *Caladenia woolcockiorum* from Upper Mambray Creek. Weeds such as *Briza maxima* and *Sonchus* spp. increased in abundance after fires in 1982 and 1988, and *C. woolcockiorum* has since disappeared.

10.7.2 Herbivory – Moderate

The level of herbivory in *Caladenia woolcockiorum* sub-populations has not yet been assessed, however anecdotal evidence suggests that herbivory is a threat to all sub-populations. Herbivory of *C. woolcockiorum* has been observed in all sub-populations except for Sub-population 9. Kangaroos and euros have been seen in high numbers near Sub-populations 1, 2, 3, 4, 5 and 6, presumably because of the close proximity to large open grassy areas and paddocks, and are thought to be the primary cause of herbivory. Sheep that escape from adjoining pastoral land have also been seen near Sub-populations 4 and 5. Rabbits and hares are also known to occur within Mount Remarkable NP and are likely to contribute to some of the herbivory.

10.7.3 Track management activities – Moderate

All known sub-populations of *Caladenia Woolcockiorum*, except for Sub-population 6, occur near vehicle tracks and there is potential for track maintenance activities to impact on *C. woolcockiorum.* Plants grow on and near the edges of tracks in numerous locations and the grading of tracks could destroy *C. woolcockiorum* plants. The construction of turnout drains could also destroy plants, if poorly sited. Grading vehicles are also vectors for the spread of weeds.

The pruning of vegetation for track maintenance also has the potential to impact on *Caladenia woolcockiorum* sub-populations. Plants growing on or near tracks could be damaged by machinery or smothered by discarded prunings.

10.7.4 Fire management activities – Moderate

All sub-populations of *Caladenia woolcockiorum* occur on public land that may be burnt or slashed as part of fire management activities. It is currently thought that burning during the active growth season of *C. woolcockiorum* (April – Nov) could destroy or damage plants. Burning during winter or spring is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations).

10.7.5 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to *Caladenia woolcockiorum.* Sub-populations 2, 8 and 9 are very small and isolated, and have limited potential for out-crossing.

10.8 Previous Recovery Actions

The following recovery actions were implemented for *Caladenia woolcockiorum* prior to 2007.

- *C. woolcockiorum* was included in the LBTORP in 1998.
- Annual surveys of historical, known and potential habitat have been undertaken since 2000.
- Biannual recovery team meetings (NLBTORT) have been held since 2000.
- A fact sheet was prepared for the species in 2001 (DEH 2001[e]).
- A national recovery plan was prepared for the species in 2003 (Bickerton 2003[b]). The following recovery actions have been achieved.
  - 1.1.1 - Seed and mycorrhiza was collected from Sub-populations 4, 5 and 6 in 2005, and is stored at the BGA.
  - 4.1.1 - Searches of historical and potential habitat within Mount Remarkable NP have been undertaken in 2004 and 2005.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

10.9 Recovery Objectives, Performance Criteria and Recovery Actions

10.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia woolcockiorum* is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Caladenia woolcockiorum* are listed in Table 34.

10.9.2 Specific recovery actions

The specific recovery actions for *Caladenia woolcockiorum* are listed in Table 35. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 34: Specific recovery objectives and performance criteria for *Caladenia woolcockiorum*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species increased by at least 20 percent within five years.	CR B1 CR B1a CR B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 9 extant sub-populations after five years.	CR B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 20 percent within five years.	CR B1b(iv)
	3.2 At least 6 sub-populations contain >50 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species is maintained, or increased by at least 20 percent within five years.	CR B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 2 sub-populations are actively managed to improve habitat condition.	CR B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 1 public land management authority is involved in implementing recovery actions for the species during the term of this recovery plan.	
	8.2 At least 3 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Table 35: Specific recovery actions for *Caladenia woolcockiorum*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/S
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
2	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	4, 5, 6	DEH
2	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
2	D.5 Develop protocols for track management activities on public land.	Year 1	1, 2, 3, 4, 5, 7, 8, 9	DEH
2	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	All	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH
3	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	4, 5	DEH, BGA
3	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	4, 7	DEH, NOSSA
3	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	4, 7	DEH
4	C.8 Implement hygiene measures to prevent the introduction or spread of Phytophthora into habitat.	Years 1 to 7	All	DEH, NOSSA
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
5	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	2	DEH, NOSSA
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

11. *Caladenia xantholeuca* (Flinders Ranges Spider-orchid)

11.1 Description

Caladenia xantholeuca has a single, narrow, hairy leaf 15–24 cm long. It has a slender, hairy stem 15–25 cm tall. It produces one to four white flowers, c. 25 mm across. The dorsal sepal is erect, incurved with an obtuse tip (12-16 mm x 3-4 mm). The lateral sepals face forward, and are lanceolate with obtuse tips (17-21 mm x 5-6 mm). The petals are widely spreading, lanceolate with acute tips (16-18 mm x 3.5-4 mm). The labellum is ovate with a recurved apex (6.5-7.5 mm x 6-7 mm), with margins of apex fringed with three or four pairs of blunt, yellow teeth. Calli are yellow, in two rows, on slender stalks, inclined forward (Jones 1991).

Types: South Australia, Telowie Gorge, Sept. 16 1986, R. Bates 7181.

Notes: There is question as to whether collections from Mount Remarkable NP are the same species as collections from Telowie Gorge (R. Bates *pers comm.* 2005). Specimens from both locations were observed when describing the species (Jones 1991), however R. Bates recognises morphological differences between specimens collected from the two locations.

Caladenia xantholeuca, Telowie Gorge CP, R Bates

11.2 Conservation Status

Caladenia xantholeuca is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

11.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Caladenia xantholeuca* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Critically Endangered (CR A2(a); E).

Table 36: IUCN Red List Criteria for *Caladenia xantholeuca*.

IUCN Criteria	Justification
CR A2(a)	It has a suspected population size reduction of >80% over the last 25 years, where the causes of the reduction may not have ceased, and are not understood, and may not be reversible, based on direct observation.
CR E	It has a population size of less than 50 mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

11.3 Distribution and Population Size

11.3.1 Extent of occurrence

Caladenia xantholeuca is endemic to South Australia. It is known to have occurred in two sub-populations in Mt Remarkable NP in 1978, and one sub-population within Telowie Gorge CP in 1982 in the Flinders Ranges herbarium region (refer to Figure 9). The extent of occurrence of *C. xantholeuca* based on historical collections is 18 km², and the area of occupancy is 0.5 hectares.

11.3.2 Population size

Caladenia xantholeuca has not been seen since 1982 despite targeted searching, however much of the habitat is very difficult to access. It is unknown how many mature plants existed in the 1980s, but Bates (2006) refers to *C. xantholeuca* as being common in Mambray Creek in the wet years of 1974 and 1980 (refer to Table 37). Flowers were only seen in the Telowie Gorge Sub-population in the three years following the 1984 bushfire (Bates 2008). Therefore, it is thought that *C. xantholeuca* requires above average rainfall during the growing season to flower, and may also be stimulated by fire. It is

likely that *C. xantholeuca* populations still persist, but plants may have only produced leaves (which are difficult to detect) in recent years due to below average rainfall and lack of fire.

Figure 9: Current and historic distribution of *Caladenia xantholeuca*

11.3.3 Important sub-populations

All sub-populations of *Caladenia xantholeuca* are considered to be important for conservation, due to the high possibility of extinction.

11.4 Habitat

Caladenia xantholeuca occurs in *Callitris glaucophylla* woodland. It grows on the south facing slopes of steep gorges, in heavily shaded areas. It often grows on mossy rock ledges, or rocky slopes in red-brown loam soils.

11.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of historical sub-populations is considered to be habitat critical to the survival of the species. Confidential Appendix H contains maps of habitat critical to the survival of *Caladenia xantholeuca*, and is available for legitimate purposes from DEH, Threatened Species Unit.

Table 37: Sub-population numbers, trends and threats for *Caladenia xantholeuca*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Sub-population Trend	Key Threats
1	Mt Remarkable NP	DEH (reserved)	0 (00)	? (74)	Unknown	Lack of recruitment, weed invasion
2	Mt Remarkable NP	DEH (reserved)	0 (00)	? (78)	Unknown	Lack of recruitment, weed invasion
3	Telowie Gorge CP	DEH (reserved)	0 (02)	? (82)	Unknown	Lack of recruitment, weed invasion
		TOTAL	**0**	**?**	Source: DEH (2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix H, which is from DEH, Threatened Species Unit.

11.5 Reservation Status and Management Responsibility

All historical locations of *Caladenia xantholeuca* occur within NP&W Act reserves (refer to Table 37), which are owned and managed by DEH.

11.6 Ecology

11.6.1 Biology

Caladenia xantholeuca produces a leaf in July or August. During early to late August buds are produced, followed by flowering in late August to mid September. However, it is thought *C. xantholeuca* requires high autumn and winter rainfall and possibly fire to flower. By early October the leaf shrivels and the pollinated flowers develop into seed capsules. In October the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *C. xantholeuca* is not known, but is assumed to be more than fifteen years.

11.6.2 Response to fire

Caladenia xantholeuca was only seen in Telowie Gorge CP a few years after fire, and has not been seen since (R. Bates *pers comm.* 2006). While it is thought that rainfall is the main factor that limits flowering of *C. xantholeuca*, it is possible that fire might also stimulate flowering.

11.6.3 Research opportunities

No specific research has been undertaken for *Caladenia xantholeuca*. There is significant need for research into aspects of the biology and ecology of the species. Areas of particular importance include:

- Taxonomy – clarifying the taxonomy of collections from Mount Remarkable NP;
- Response to disturbance – determining the response to fire and soil disturbance;
- Demographics – determining rainfall requirements;
- Seed ecology – determining germination requirements.

11.7 Threats to Recovery

11.7.1 Lack of recruitment – HIGH

Lack of recruitment is thought to be a serious threat to *Caladenia xantholeuca* because it is not known to have flowered since the mid 1980s. It is thought that high rainfall and fire may stimulate flowering in the species, and it is possible that these factors are also important for recruitment.

11.7.2 Weed invasion – HIGH

Weed invasion is a threat to *Caladenia xantholeuca*. Introduced grasses and thistles have invaded all known locations of *C. xantholeuca* sub-populations.

11.8 Previous Recovery Actions

The following recovery actions were implemented for *Caladenia xantholeuca* prior to 2007.

- *C. xantholeuca* was included in the LBTORP in 1998.
- Surveys to locate the species were undertaken in Mount Remarkable in 2000 and in Telowie Gorge in 2002. Both attempts failed to find the species.

Recent surveys undertaken for this species have been unsuccessful in relocating any extant populations. No flowering plants were detected in historical locations, however sterile or dormant plants may still persist. It is thought that above-average rainfall and possibly fire may be required to stimulate flowering; however drought conditions have prevailed since 2002. Therefore, further surveys and recovery actions have been postponed until conditions are favourable.

11.9 Recovery Objectives, Performance Criteria and Recovery Actions

11.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Caladenia xantholeuca* is to improve the conservation status according to IUCN criteria from Critically Endangered to Endangered within 20 years. Specific recovery objectives and performance criteria for *Caladenia xantholeuca* are listed in Table 38.

Table 38: Specific recovery objectives and performance criteria for *Caladenia xantholeuca*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 10 percent within five years.	CR B1
2. To increase the number of extant sub-populations.	2.1 There is at least 1 extant sub-population after five years.	CR A2(a) CR E
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 20 percent within five years.	CR A2(a) CR E
	3.2 At least 1 sub-population contains >20 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species is increased by at least 10 percent within five years.	CR B2b(ii)
*5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 1 sub-population is actively managed to improve habitat condition.	CR B2b(iii)
*6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
*7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 1 public land management authorities is involved in implementing recovery actions for the species during the term of this recovery plan.	
	8.2 At least 2 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

Objectives 5, 6 & 7 and related performance criteria are only relevant if populations are relocated.

11.9.2 Specific recovery actions

The recovery actions for Caladenia xantholeuca are listed in Table 39. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 39: Specific recovery actions for *Caladenia xantholeuca*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	All	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	All	DEH
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

Potential Recovery Actions (if populations are relocated)	Suggested Delivery Group/s
C.1 Control threatening weeds in selected sub-populations.	DEH, NOSSA, TPAG
C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	DEH, NOSSA
C.4 Identify and control threatening herbivores.	DEH
C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	DEH, NOSSA
A.1 Survey the number of flowering plants in each sub-population.	DEH, NOSSA
A.2 Monitor the demographics of selected sub-populations.	DEH, NOSSA
A.3 Update database, and analyse demographic data for relevant sub-populations.	DEH
E.1 Collect seed from each sub-population, and preserve *in vitro*.	DEH, BGA, NOSSA
E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	DEH, BGA
E.3 Undertake *in vitro* seed germination and plant cultivation.	BGA, WOL
G.3 Undertake genetic analysis of selected sub-populations.	DEH, AU
F.1 Prepare a translocation feasibility assessment for the species.	DEH
F.2 Prepare and implement translocation proposals for selected sub-populations.	DEH, BGA, WOL
G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	DEH, USA, AU. FU
G.2 Establish and monitor disturbance trials for selected sub-populations.	DEH, NOSSA

12. *Pterostylis bryophila* (Hindmarsh Valley Greenhood)

12.1 Description

Pterostylis bryophila has 3 to 5 basal leaves (10-22 mm x 5-15 mm) forming a rosette, when not flowering. The flower scape is moderately tall (10-18 cm), very slender and smooth with 4 or 5 cauline leaves (10-30 mm x 3-5 mm). It has a solitary flower, which is translucent white, striped and suffused with bright green. The dorsal sepal is 29–37 mm x 10-12 mm, inflated at the base, constricted in the middle, and tapers suddenly to a long acuminate point (2-6 mm long). The lateral sepals are erect, tightly embracing the galea with tapering free points (16-21 mm long) held high above the galea. It has a prominent, gibbous sinus, which is deeply folded interiorly. The petals are 24-28 mm x 5-7 mm with anterior margins strongly flared and held horizontally. The labellum is dark brownish (10 mm x 3 mm) with a retuse apex, and protrudes from the sinus (Jones 1997).

Type: South Australia, Hindmarsh Valley.

Pterostylis bryophila, Mt Billy CP, J Quarmby

12.2 Conservation Status

Pterostylis bryophila has recently been listed as Critically Endangered under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

12.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Pterostylis bryophila* was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process and met the criteria for Critically Endangered (CR B1ab(i, iii, iv)c(iv)).

Table 40: IUCN Red List Criteria for *Pterostylis bryophila*.

IUCN Criteria	Justification
CR B1	It has an extent of occurrence of less than 100 km².
CR B1a	All known sub-populations are severely fragmented.
CR B1b(i)	There is a projected continuing decline in the extent of occurrence.
CR B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
CR B1b(iv)	There is a projected continuing decline in the number of sub-populations.
CR B1c(iv)	There are extreme fluctuations in the number of mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

12.3 Distribution and Population Size

12.3.1 Extent of occurrence

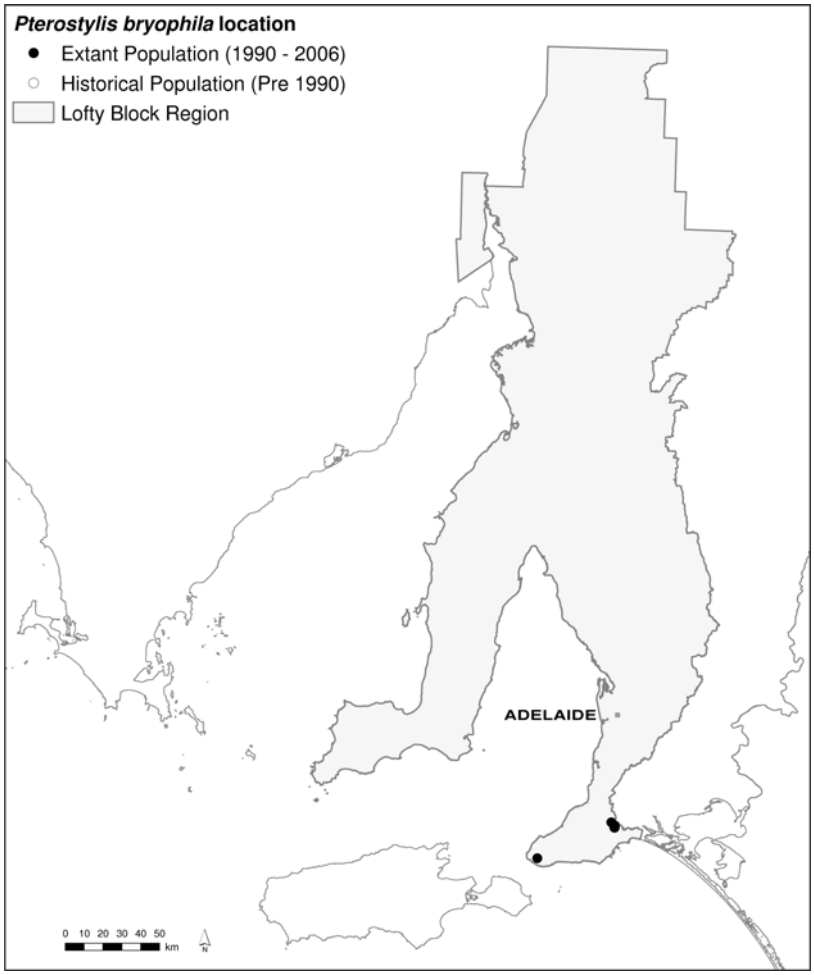
Pterostylis bryophila is endemic to the South Australia. It was known from two disjunct localities in the Southern Lofty herbarium region in 2006 (refer to Figure 10). There were two known sub-populations in the Hindmarsh Valley area and one sub-population in Talisker CP (refer to Table 41). The extent of occurrence of *P. bryophila* was 72 km² and the area of occupancy was 1.6 hectares.

There is one unconfirmed report of *Pterostylis bryophila* from near Inman Valley, but this sub-population has apparently become extinct (R. Bates pers comm. 2005).

12.3.2 Population size

The population size of *Pterostylis bryophila* was estimated to be approximately 1140 mature individuals in 2006 (refer to Table 41), based on the average number of flowering plants in each sub-population. However, it is very difficult to determine the actual population size due to extreme annual fluctuations in the number of flowering plants in all sub-populations.

Figure 10: Current and historic distribution of *Pterostylis bryophila*



In 2003, 3446 plants flowered in Sub-population 2, which was attributed to high autumn rainfall. However, in subsequent years with below average autumn rainfall less than 1000 plants flowered. A large proportion of mature plants remain dormant or only produce a rosette each year, especially in dry years.

Further surveys are needed to more accurately determine the size and extent of Sub-population 3. It was only discovered in 2004, and surveys in 2006 failed to find the species.

12.3.3 Important sub-populations

All sub-populations of *Pterostylis bryophila* are important to the conservation of the species due to the very limited number of sub-populations and restricted extent of occurrence.

Sub-population 2 is considered to be most important for conservation due to its relatively large size, and likelihood of being self-sustaining and containing the highest levels of genetic diversity. Sub-population 3 is also very important because of its disjunct location, and potential for containing genetic variation not found in the Hindmarsh Valley sub-populations.

Table 41: Sub-population numbers, trends and threats for *Pterostylis bryophila*

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Hindmarsh Falls	CVH (unreserved)	7 (06)	20 (99)	4	Decline	Weed invasion, lack of recruitment
2	Mt Billy CP/ Hindmarsh Reservoir	DEH (reserved)/ SAW (unreserved)	880 (06)	3446 (03)	1126	Fluctuating	Weed invasion, herbivory, trampling
3	Talisker CP	DEH (reserved)	0 (06)	20 (04)	10	Unknown	Weed invasion
		TOTAL	**887**	**3486**	**1140**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix I, which is available from DEH, Threatened Species Unit.

12.4 Habitat

Pterostylis bryophila grows in *Eucalyptus leucoxylon, E. fasciculosa* Open Forest or Woodland. The understorey is typically comprised of *Acacia pycnantha*, *A. paradoxa*, *Dodonaea viscosa*, *Bursaria spinosa*, *Exocarpus cupressiformis* and *Xanthorrhoea semiplana*. Groundcovers include a diversity of mosses, grasses, ferns, lilies, orchids and other annual herbs.

It grows in moist, shady, mossy areas (*e.g.* lower slopes of gullies, along creek lines) usually with a southerly aspect. The soils are typically well-structured fertile loams. This habitat type has been selectively cleared for agriculture in the Southern Mount Lofty Ranges, and remnants are often small, fragmented and/or heavily invaded by weeds.

12.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix I contains maps of habitat critical to the survival of *Pterostylis bryophila*, and is available for legitimate purposes from DEH, Threatened Species Unit.

12.5 Reservation Status and Management Responsibility

Pterostylis bryophila occurs predominantly within land reserved for biodiversity conservation purposes (refer to Table 41). The two largest sub-populations occur within NP&W Act reserves (Mount Billy CP and Talisker CP). Sub-population 1 occurs within a council conservation reserve (Hindmarsh Falls Reserve).

A portion of Sub-population 2 occurs within a water reserve (Hindmarsh Reservoir), which is not reserved for conservation purposes, but is being managed to protect biodiversity assets, including *Pterostylis bryophila* habitat. Table 41 specifies the landholder responsible for the management of land containing each sub-population.

12.6 Ecology

12.6.1 Biology

Pterostylis bryophila either produces a rosette of leaves or a single flower stem in autumn, so flowering and non-flowering plants are dissimilar. Non-flowering plants form a leafy rosette in March - April, and usually have smaller tubers than flowering plants. Flowering plants only have cauline leaves and produce buds in April – May, followed by flowering in May -July. Plants do not necessarily emerge each year, and tubers can remain dormant for several consecutive years (DEH 2006[a]). Flowering rates fluctuate significantly from year to year, which is thought to be related to summer-autumn rainfall. Seed capsules are formed in May – July and dry and dehisce by August. Tubers are replaced annually (during winter – spring), and extra daughter tubers may also be produced on the end of stolon-like roots, forming dense colonies. Tubers are dormant over the hot, dry summer months (December – March). The average longevity of *P. bryophila* is not known, but is assumed to be more than fifteen years.

12.6.2 Pollination

Pterostylis bryophila is most likely pollinated by nematoceran flies from the families *Culicidae* (mosquitoes) and *Mycetophilidae* (fungus gnats). However, Stephens *et al* (2001) identified a phorid fly (*Phoridae*) as a 'probable' pollinator. *P. bryophila* also reproduces vegetatively, often forming dense colonies.

12.6.3 Mycorrhiza

Pterostylis bryophila is presumed to grow in symbiosis with mycorrhizal fungi, like other *Pterostylis* species. Fungal isolation is yet to be attempted for *P. bryophila*, so little is known about the fungus. Mycorrhizal fungi are thought to play an important role in seedling germination and plant growth in most *Pterostylis* species.

12.6.4 Response to fire

Pterostylis bryophila is known to be fire-sensitive, presumably because the tubers occur close to the soil surface where they are susceptible to incineration. *Pterostylis bryophila* is known to have declined

substantially after a summer wildfire in Mount Billy CP in 1992 (R. Bates *pers. comm*. 2006), but has gradually recovered through re-colonisation.

12.6.5 Research opportunities

Pterostylis bryophila has been the subject of a study regarding the effect of Bridal Creeper on pollination (Stephens *et al* 2001).

A preliminary study of the population genetics of the species (Ottewell *et al* unpublished) determined that the genetic diversity of the Hindmarsh Reservoir site was significantly higher than at Hindmarsh Falls or the more populated Mt Billy sites. It is suggested that a high level of vegetative reproduction is responsible for the lower diversity at the latter sites. The study also found an adequate level of genetic relatedness between all sites measured.

There is a need for more research into other aspects of the biology and ecology of the species, including pollination ecology.

12.7 Threats to Recovery

12.7.1 Weed invasion – HIGH

Weed invasion is a significant threat to *Pterostylis bryophila*. Bridal Creeper is of particular concern, being very abundant in the area occupied by Sub-population 2. Bridal Creeper has an active growing season that begins before and finishes after that of *P. bryophila*, making it difficult to control with herbicide due to the risk of off-target damage. Bridal Creeper rust (*Puccinia myrsiphylli*) was released in Mount Billy CP in 2000 and was observed to be spreading and severely inhibiting the growth of Bridal Creeper in 2003 and 2004. Other weeds of concern to Sub-population 2 include Sweet Pittosporum, Bulbil Watsonia, Blackberry, Briar Rose, and Scabious.

Sub-population 1 is heavily invaded with weeds including introduced grasses, Plantain and Broom, Bulbil Watsonia and Bridal Creeper. This is thought to be a significant contributing factor to the decline and possible extinction of the sub-population.

Sub-population 3 is also threatened by weed invasion (R. Bates *pers comm.* 2005) but a comprehensive list of weed species is yet to be completed.

Weed invasion is also thought to be the main cause of extinction of the historic sub-population near Inman Valley (R. Bates *pers comm.* 2005).

12.7.2 Herbivory – Moderate

Herbivory of leaves, buds, and flowers by kangaroos, rabbits, hares and invertebrates is a threat to *Pterostylis bryophila*. While there is some seasonal variation in the level of herbivory within Sub-population 2, less than five percent of mature individuals are eaten per year (DEH 2006[a]). Macropods are evident at Sub-population 2 with 1-5 scats per square metre recorded in 2005. Rabbits were also evident in areas of Mount Billy CP in 2005.

Herbivory of *Pterostylis bryophila* at Hindmarsh Falls Reserve is unknown but kangaroos, rabbits and hares are known to exist within the reserve. Sub-population 3 is yet to be properly assessed for herbivory.

12.7.3 Wildfire – Moderate

Wildfire is known to cause decline in *Pterostylis bryophila* populations, presumably through the incineration of tubers. *P. bryophila* populations are known to gradually recover with time since fire, however overly frequent fires could severely impede recovery.

12.7.4 Trampling – Moderate

Trampling by humans and macropods is a threat to Sub-population 1 and 2. Sub-population 1 occurs near a walking trail and pedestrians have formed a path through the sub-population. A fence was erected along the trail in 2005 to prevent pedestrians from walking through the sub-population and this appears to have been effective.

Plants in Sub-population 2 have also been damaged by people undertaking on-ground recovery actions for *Pterostylis bryophila*, such as surveys, monitoring and weed control.

Kangaroos are known to damage *Pterostylis bryophila* plants in Sub-population 2. There is a myriad of kangaroo pads through the sub-population, especially in the Hindmarsh Reservoir section.

12.7.5 Lack of recruitment – Moderate

Lack of recruitment is a serious threat to Sub-population 1. No natural pollination has been observed, and there are very few mature plants.

12.7.6 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to Sub-populations 1 and 3. Both sub-populations are very small and isolated, and have limited potential for out-crossing.

12.7.7 Fire management activities – Moderate

All sub-populations of *Pterostylis bryophila* occur on public land that may be burnt or slashed as part of fire management activities. *P. bryophila* is known to be fire sensitive and it is highly likely that burning during the active growth season of *P. bryophila* (April – Nov) could destroy or damage plants. Burning during autumn and winter is likely to be most detrimental. There is also a risk of accidental damage to populations during the implementation of fire management activities (e.g. fire management vehicles driving through sub-populations).

12.7.8 *Phytophthora* – Moderate

Pterostylis bryophila occurs within Moderate and Low Risk Management Zones for *Phytophthora* (Velzeboer *et al* 2005). There is potential for *Phytophthora* to be introduced or spread into *P. bryophila* habitat. It is unknown whether *P. bryophila* is susceptible to *Phytophthora*, but many plant species within *P. bryophila* habitat are known to be susceptible to *Phytophthora.*

12.8 Previous Recovery Actions

Prior to 2007 the following recovery actions were implemented for *Pterostylis bryophila.*

- Friends of Mount Billy CP (FMB) conducted Bridal Creeper control trials and controlling weeds within and adjacent to Sub-population 2 from 1997.
- *P. bryophila* was included in the LBTORP in 1998.
- Surveys and monitoring of Sub-population 2 were undertaken from 1999 to 2001.
- Bridal Creeper rust (*Puccinia myrsiphylli*) was released in Sub-population 2 in 2000.
- Biannual recovery team meetings (SLBTORT) have been held since 2000.
- A Fact Sheet was prepared for the species in 2001 (DEH 2001[h]) and has been publicly disseminated.
- A draft recovery plan was prepared in 2001 (Bickerton 2001[a]), and the following recovery actions were implemented.
  - 1.1.1 - Seed was collected from Sub-population 2 in 2004 and is stored at BGA.
  - 2.1.1 - FMB has been controlling weeds in sub-population 2 since 2001.
    - TPAG and NOSSA have held annual weeding days at Hindmarsh Reservoir since 2001. They have also undertaken regular weed control at Sub-population 1.
    - TFL volunteers have been controlling weeds at Sub-population 1 since 2004 as part of the Bush for Life program.
    - TPAG obtained a grant to control Pittosporum, Bulbil Watsonia, Scabious and Dog Rose in Mount Billy CP. This was combined with funds from the Tiers Biodiversity Project to control Pittosporum and Bulbil Watsonia in Hindmarsh Reservoir.
  - 2.2.1 - Sub-population 2 has been monitored annually since 2001, including establishing permanent quadrats in 2004 and surveying plants.
  - 3.1.4 - A site action plan has been prepared for Sub-population 1 (Bickerton 2002[c]) to manage the complex management issues of the site.

The previous recovery actions implemented for this species have been successful in increasing knowledge of the species, especially in relation to its current distribution, population size and trends. Weed control programs at Mt Billy CP, Hindmarsh Reservor and Hindmarsh Falls have been very successful in reducing weed abundance; however ongoing follow-up is required. The Hindmarsh Falls sub-population was rediscovered in 2006 as a result of targeted surveys, despite being presumed extinct. Community participation in this recovery program has been very high. The largest sub-population in Mt Billy CP has fluctuated significantly since 1999, which is thought to be largely due to climatic patterns. This has made it difficult to assess the effectiveness of recovery actions.

12.9 Recovery Objectives, Performance Criteria and Recovery Actions

12.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Pterostylis bryophila* is to improve the conservation status from Critically Endangered to Endangered within 20 years. Specific recovery objectives and performance criteria for *Pterostylis bryophila* are listed in Table 42.

Table 42: Specific recovery objectives and performance criteria for *Pterostylis bryophila*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 20 percent within five years.	CR B1 CR B1(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 4 extant sub-populations after five years.	CR B1a CR B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 20 percent within five years.	CR B1b(iv) CR B1c(iv)
	3.2 At least 2 sub-populations contain >50 mature individuals after five years.	
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species increased by at least 10 percent within five years.	CR B2b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 2 sub-populations are actively managed to improve habitat condition.	CR B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 3 public land management authorities are involved in implementing recovery actions for the species during the term of this recovery plan.	
	8.2 At least 5 community groups and 15 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

12.9.2 Specific recovery actions

The specific recovery actions for *P. bryophila* are listed in Table 43. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 43: Specific recovery actions for *Pterostylis bryophila*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, FMB, TBP, TPAG, NOSSA, TFL
1	C.2 Prepare site action plans for selected sub-populations.	Year 1	2	DEH, TPAG
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	1, 3	DEH
1	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	All	DEH, SAW, FMB, NOSSA, TPAG
2	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	2, 3	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, FMB
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	2	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
2	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH, AU
3	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	2	DEH, FMB, NOSSA
3	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	2	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

13. *Pterostylis cucullata* (Leafy Greenhood)

13.1 Description

Pterostylis cucullata has 5 to 7 basal leaves (9 cm x 30 mm) crowded near the base forming a rosette, pointing upwards, and usually ascending the stem. It has an erect scape to 25 cm high, bearing one or two flowers, often partly enclosed by a leafy bract. The galea is 30 mm high with an inflated base, becoming erect then curving forward, with the apex pointing down. The dorsal sepal is translucent white striped with green veins, and is short with an acute tip that barely exceeds the petals. The petals are dark brown with velvet-like hairs, and prominent broad tips. The lateral sepals are dark brown and embrace the galea, with free tip less than 10 mm long. The lateral sepals have a flat sinus, weakly angled from the side and deeply v-shaped from the front. The labellum is dark brown, narrow and shortly recurved (16 mm x 5 mm), with an obtuse apex, not protruding from the sinus (Bates & Weber 1990).

Pterostylis cucullata subsp. *sylvicola*, Belair NP, J Quarmby

Notes: Pterostylis cucullata was recently split into two sub-species, namely *P. cucullata* subsp. *cucullata* and *P. cucullata* subsp. *sylvicola* (Jones 2006). While both sub-species have been recorded in South Australia, *P. cucullata* subsp. *cucullata* is presumed extinct in the Lofty Block region. All sub-populations referred to in this recovery plan belong to *Pterostylis cucullata* subsp. *sylvicola*.

13.2 Conservation Status

Pterostylis cucullata is listed as Vulnerable in Australia under the EPBC Act. It is also listed as Vulnerable in South Australia under the NP&W Act, as Vulnerable in Victoria under the F&FG Act, and as Endangered in Tasmania under the TSP Act.

13.2.1 IUCN Red List Criteria Version 3.1

South Australian sub-populations of *Pterostylis cucullata* subsp. *sylvicola* were assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Endangered (B1ab(i, iii, iv)c(iv)).

Table 44: IUCN Red List Criteria for *Pterostylis cucullata* in SA.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5000 km².
EN B1a	All known sub-populations are severely fragmented, and known from less than five locations.
EN B1b(i)	There is an observed continuing decline in the extent of occurrence.
EN B1b(ii)	There is an observed continuing decline in the area of occupancy.
EN B1b(iii)	There is an observed continuing decline in the area and quality of habitat.
EN B1b(iv)	There is an observed projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

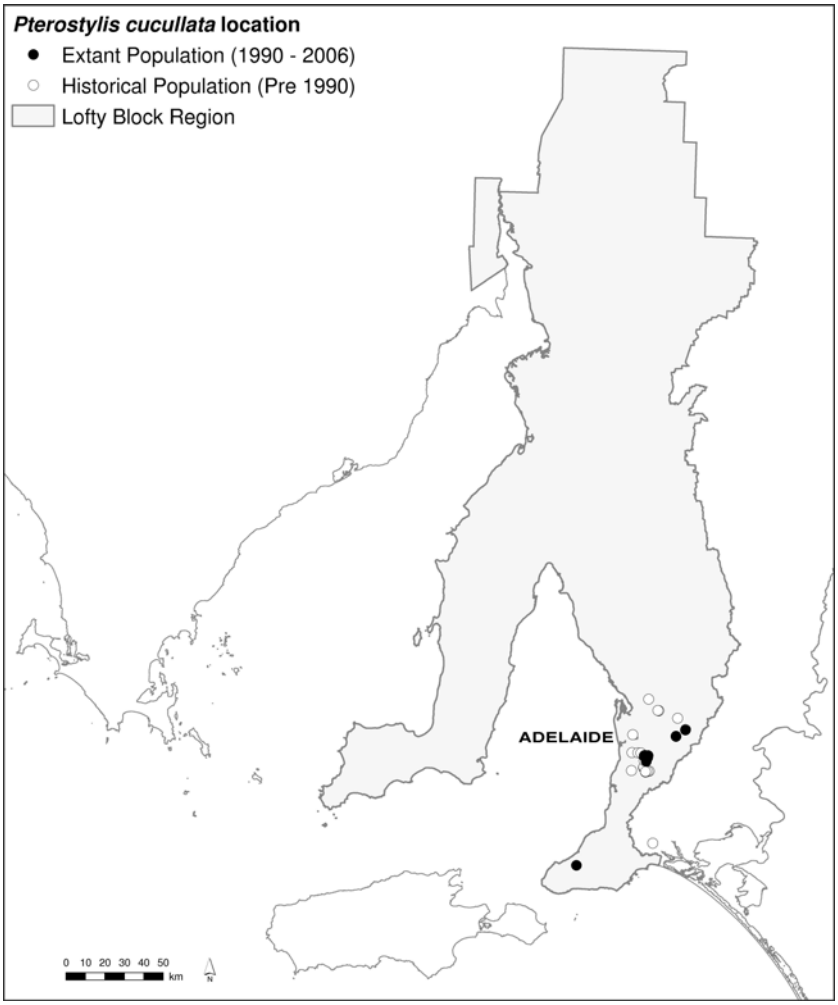
NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

13.3 Distribution and Population Size

13.3.1 Extent of occurrence

In 2006 *Pterostylis cucullata* subsp. *sylvicola* was known from five sub-populations in South Australia (refer to Figure 11). The extent of occurrence of *Pterostylis cucullata* subsp. *sylvicola* in South Australia was 366 km², and the area of occupancy was 4.4 hectares.

Figure 11: Current and historic distribution of *Pterostylis cucullata* in South Australia



Pterostylis cucullata also occurs in Victoria, however this recovery plan is only concerned with South Australian populations.

Historical records indicate that *Pterostylis cucullata* had an extent of occurrence of 2107 km² in the Lofty Block region, including locations near Teatree Gully, Fairview Park and Hindmarsh Valley. These records indicate that the extent of occurrence of *Pterostylis cucullata* has reduced by eighty-two percent in the last fifty to one-hundred years. However this estimate includes records of *Pterostylis cucullata* spp. *cucullata*.

There are also reports of historical sub-populations of *P. cucullata* from McLaren Vale, Robe, Lake Bonney, and Mount Gambier in South Australia (Bates & Weber 1990, Davies 2004). Again this includes *Pterostylis cucullata* subsp. *cucullata,* which now is only considered to occur along the south coast of Victoria and the central and north-west coast of Tasmania. Refer to Bramwells (1993), Davies (2004) TSS (2006) and Duncan (2007) for information regarding the Victorian and Tasmanian populations of *Pterostylis cucullata*.

13.3.2 Population size

The population size of *Pterostylis cucullata subsp. sylvicola* in South Australia was estimated to be approximately 6380 mature individuals in 2006 (refer to Table 45), based on the average number of flowering plants in each sub-population. However, it is difficult to accurately determine the population size due to extreme annual fluctuations in the number of flowering plants. It is presumed that large numbers of mature plants remain dormant or only produce leaves each year, and this number increases in drier years.

Further surveys of all sub-populations are needed, especially Sub-populations 2, 3 and 5. It is considered unlikely that other sub-populations of *Pterostylis cucullata* exist in the Lofty Block region, however it would be worth searching areas of potential habitat, especially on the Fleurieu Peninsula.

Ninety-nine percent of the total South Australian population was contained within Sub-population 1 in 2006. All other sub-populations of *Pterostylis cucullata* subsp. *sylvicola* in South Australia are extremely small and under high risk of extinction. It is possible that Sub-populations 3 and 5 are already extinct.

13.3.3 Important sub-populations

All sub-populations of *Pterostylis cucullata* subsp. *sylvicola* in South Australian are considered to be important for conservation of the species. Sub-population 1 is particularly important containing ninety-nine percent of the South Australian population of *Pterostylis cucullata* subsp. *sylvicola*. It is also likely to contain relatively high levels of genetic diversity.

Sub-population 4 and 5 are also considered to be important because of their outlying distribution, and may contain genetic diversity not found within Sub-population 1.

13.4 Habitat

All extant sub-populations of *Pterostylis cucullata* subsp. *sylvicola* in South Australia grow in *Eucalyptus leucoxylon* Open Forest, often with *E. viminalis, E. camaldulensis* or *E. obliqua*. The shrub layer is typically very sparse *Acacia pycnantha*, *A. melanoxylon*, *Bursaria spinosa* and *Acrotriche fasciculiflora*. The groundcover is dense and diverse with grasses, ferns, lilies, orchids and other annual herbs, often including *Microlaena stipoides*, *Adiantum aethiopicum*, *Cheilanthes austrotenuifolia*, and *Lomandra* spp. It grows on moist, south to south-east facing slopes in sandy loam soils.

Pterostylis cucullata subsp. *cucullata* was also known to occur in coastal sand dunes under dense heath near Robe and on the Adelaide plains near Fairview Park and McLaren Vale (Bates & Weber 1990). This sub-species is now presumed to be extinct in South Australia (Bates 2008).

Both of these habitat types have largely been cleared, fragmented and/or degraded in South Australia since European settlement. Remnant areas of *Eucalyptus leucoxylon* Open Forest are often small, isolated, infested with weeds and/or heavily grazed. Coastal sand dunes have been largely cleared for residential development.

Table 45: Sub-population numbers, trends and threats for *Pterostylis cucullata*.

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Belair NP	DEH (reserved)	4691 (05)	11158 (03)	6362	Fluctuating	Weed invasion, herbivory
2	Cherry Gardens	Private (unreserved)	1 (03)	1 (03)	1	Unknown	Weed invasion
3	Lenswood	AHC (reserved)	0 (05)	1 (90)	1	Possibly extinct	Weed invasion, herbivory
4	Lobethal	AHC (reserved)	6 (06)	37 (05)	21	Fluctuating	Weed invasion, herbivory
5	Second Valley	Private (reserved)	0 (06)	1 (92)	1	Possibly extinct	Herbivory, road management
		TOTAL	**4698**	**11198**	**6386**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix J, which is available from DEH, Threatened Species Unit.

13.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix J contains maps of habitat critical to the survival of *Pterostylis cucullata* subsp. *sylvicola*, and is available for legitimate purposes from DEH, Threatened Species Unit.

13.5 Reservation Status and Management Responsibility

Pterostylis cucullata subsp. *sylvicola* occurs across a variety of land tenures including reserved public and private land, and unreserved private land (refer to Table 45). Sub-populations 1 and 5 occur with NP&W Act reserves that are owned and managed by DEH. Sub-populations 3 and 4 are owned and managed by Adelaide Hills Council, and are protected under Heritage Agreements. Sub-population 5 occurs within private land that is protected under Heritage Agreement. Sub-population 2 occurs on unreserved private land.

13.6 Ecology

13.6.1 Biology

Pterostylis cucullata subsp. *sylvicola* usually produces a rosette of leaves in May - June. During August buds are produced, followed by flowering in September and October. However, flowering has been observed as early as July and as late as January (Davies 2004). By late October the leaves shrivel and the pollinated flowers develop into seed capsules. In November the capsules dry and dehisce. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). P*. cucullata* subsp. *sylvicola* is also capable of asexual reproduction by producing extra daughter tubers on the end of stolon-like roots. *Pterostylis cucullata* subsp*. sylvicola* is capable of remaining dormant longer than most other Greenhood orchid species (D. Jones *pers comm*., cited in Davies 2004). The average longevity of *Pterostylis cucullata* subsp. *sylvicola* is not known, but is assumed to be more than fifteen years.

13.6.2 Pollination

Pterostylis cucullata subsp. *sylvicola* is pollinated by fungus gnats belonging to the family *Mycetophilidae*. However, *P. cucullata subsp. sylvicola* typically has low levels of pollination, and reproduces predominantly by tubers (Jones 1988). *P. cucullata* subsp. *sylvicola* is known to hybridise with *P. curta* and *P. nutans*.

13.6.3 Mycorrhiza

Pterostylis cucullata subsp. *sylvicola* is presumed to grow in association with mycorrhizal fungi, like other *Pterostylis* species. Fungal isolation is yet to be attempted for *Pterostylis cucullata* subsp. *sylvicola.* Mycorrhizal fungi are known to play an important role in seedling germination and plant growth in other *Pterostylis* species.

13.6.4 Response to fire

Flowering of *Pterostylis cucullata* subsp. *sylvicola* is known to decline immediately after fire, and to gradually increase with time since fire (R. Bates *pers comm.* 2006, DEH 2006[a]).

13.6.5 Research opportunities

There has been limited research involving *Pterostylis cucullata* subsp. *sylvicola* in South Australia. There is a need for more research into the aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination ecology – including identifying the pollinator;
- Population genetics – determining genetic diversity and population viability.

13.7 Threats to Recovery

13.7.1 Weed Invasion – HIGH

Weed invasion is a serious threat to *Pterostylis cucullata* subsp*. sylvicola* in South Australia, and has contributed to the decline or extinction of at least six sub-populations in recent years (Davies 2004). Threatening weeds include Boneseed, Montpellier Broom, Sweet Pittosporum, Olive, Blackberry, Gorse, Tree Heath, Sparaxis, Three-cornered Garlic, Ivy, Plantain, Cleavers, and Soursob.

13.7.2 Herbivory – HIGH

Herbivory of leaves, buds and flowers by rabbits, hares, kangaroos, snails and invertebrates is a significant threat to *Pterostylis cucullata* subsp*. sylvicola.* Davies (1995) found that up to fifty-eight percent of plants were eaten or damaged at one site within Sub-population 1 (Belair NP). Rabbits are thought to be responsible for a large proportion of the herbivory of *P. cucullata* subsp*. sylvicola* within this sub-population. The high numbers of rabbits in the park are due in part to an ongoing fox-baiting program in the park, the availability of perennial grass on the ovals, and the abundance of weed thickets for shelter, protection and nesting. Kangaroos are also thought to be a significant threat to Sub-populations 1 and 4.

13.7.3 Wildfire – Moderate

Wildfire is known to cause decline in *Pterostylis cucullata* subsp*. sylvicola* populations, presumably through the incineration of tubers*. P. cucullata* subsp*. sylvicola* populations are known to gradually recover with time since fire, however overly frequent fires could severely impede recovery.

13.7.4 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to *Pterostylis cucullata* subsp. *sylvicola*. Sub-populations 2, 3, 4 and 5 are very small and isolated, and have limited potential for out-crossing.

13.7.5 Fire management activities – Moderate

Prescribed burning is a threat to *Pterostylis cucullata* subsp. *sylvicola*, and is known to have significant impacts on the species (as observed in Belair NP in 2004). Burning within *P. cucullata subsp. sylvicola* habitat at any time of year is likely to destroy and damage plants, especially in April – Nov when leaves and flowers are above ground. The potential for post-fire weed incursion is also a significant issue for *P. cucullata* subsp. *sylvicola*, especially in Subpopulations 1 and 4. Fuel reduction slashing along fire tracks in Belair NP and Bushland Park is also a threat when conducted in spring.

13.7.6 Road and track management activities – Moderate

Sub-populations 1 and 4 are threatened by road and track management activities (*e.g.* slashing, herbicide spraying, grading and surfacing). *Pterostylis cucullata* subsp. *sylvicola* grows on the verges of roads and tracks in Belair NP, and is known to have been damaged by management activities in the past. There have also been incidences where management vehicles have accidentally driven through *P. cucullata* subsp. *sylvicola* sites, usually when turning or parking.

13.7.7 Recreational activities – Moderate

Recreational activities including walking, horse riding, and mountain biking are a threat to Sub-populations 1 and 4. There are numerous tracks and trails through *P. cucullata* habitat in Belair NP, including multi-use trails that dissect populations. Impacts associated with recreational use include construction of illicit trails, trampling, and spread of weeds and pathogens e.g. *Phytophthora*.

13.7.8 *Phytophthora* – Moderate

It is currently unknown whether *Pterostylis cucullata* subsp. *sylvicola* is susceptible to *Phytophthora*; however it is regarded as a potential threat to the species. According to Velzeboer *et al* (2005) *P. cucullata* subsp. *sylvicola* is regarded as potentially under high threat from *Phytophthora* with ninety-five percent of sub-populations occurring within a Moderate Risk Zone for *Phytophthora*, and 0.5 percent occurring within a Low Risk Zone.

13.7.9 Illegal collection – Low

The collection of *Pterostylis cucullata* subsp. *sylvicola* plants from the wild for cultivation has occurred in the past, and is still considered a potential threat to the species in South Australia.

13.8 Previous Recovery Actions

Prior to 2007 the following recovery actions were implemented for *Pterostylis cucullata* subsp. *sylvicola.*

- R. Davies established a permanent quadrat to monitor *P. cucullata* subsp. *sylvicola* within Belair NP in 1992, and surveyed the extent of the species within the park. The quadrat was monitored in most years since 1992 (Davies 1995, Davies 2000).
- TPAG in association with FB, NOSSA and DEH have been restoring habitat at three sites within Belair NP (Court 37, Long Gully and Saddle Hill Track) since 1994 using minimal disturbance weed control techniques. Several weeding days were held each year since 1998.
- TPAG obtained numerous grants to employ weed control contractors to restore *P. cucullata* subsp. *sylvicola* habitat within Belair NP since 1998. Significant progress was made towards controlling threatening weeds within and adjacent to sites containing *P. cucullata* subsp. *sylvicola* including Sweet Pittosporum, Olive, Boneseed, Broom, Desert Ash, Dog Rose, Elm, Hawthorn, Blackberry and Sparaxis. This project is ongoing.
- TPAG obtained a grant in 2003 to prepare an Action Statement for *Pterostylis cucullata* (Davies 2004) and to employ a botanist to survey the extent of the Belair NP sub-population. The survey resulted in a significant increase in the known extent and abundance of the species within the park.
- TPAG obtained a grant in 2003 to employ a contractor to control threatening weeds within and adjacent to the Bushland Park (Lobethal) sub-population, and to undertake a survey of the reserve for *P. cucullata* subsp. *sylvicola*.
- *Pterostylis cucullata* was included in the LBTORP in 2004.

- Biannual recovery team meetings (SLBTORT) have been held since 2004.
- Sub-populations 1 and 4 were comprehensively surveyed in 2005. Plants in Sub-population 4 were also monitored throughout spring.
- Seed was collected from Sub-population 1 in 2005.

The previous recovery actions implemented for this species have been successful in increasing knowledge of the species, especially in relation to its current distribution, population size and trends. Weed control programs at Belair NP and Lobethal have been very successful in reducing weed abundance and improving habitat condition; however ongoing follow-up is required. The recovery program has been largely driven by community groups to date, especially TPAG, with high levels of volunteer participation. The largest sub-population in Belair NP has fluctuated significantly since 1992, which is thought to be largely due to climatic patterns. This has made it difficult to assess the effectiveness of recovery actions.

13.9 Recovery Objectives, Performance Criteria and Recovery Actions

13.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Pterostylis cucullata* subsp. *sylvicola* in South Australia is to improve the conservation status according to IUCN criteria from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Pterostylis cucullata* subsp. *sylvicola* in South Australia are listed in Table 46.

Table 46: Specific recovery objectives and performance criteria for *Pterostylis cucullata*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To maintain the extent of occurrence of the species.	1.1 The extent of occurrence of the species is maintained over five years.	EN B1 EN B1b(i)
2. To maintain the number of extant sub-populations.	2.1 There are at least 5 extant sub-populations after five years.	EN B1a EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 10 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 2 sub-populations contain >100 mature individuals after five years.	
4. To maintain or increase the area of occupancy of the species.	4.1 The area of occupancy of the species is maintained over five years.	EN B1b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 3 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 private landholders and 2 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 4 community groups and 20 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

13.9.2 Specific recovery actions

The specific recovery actions for *Pterostylis cucullata* subsp. *sylvicola* are listed in Table 47. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan

.

Table 47: Specific recovery actions for *Pterostylis cucullata* subsp. *sylvicola*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA, PL
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA, PL
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, PL
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, AHC, TPAG, FB, FBP, NOSSA
1	C.2 Prepare site action plans for selected sub-populations.	Years 1 & 2	1, 4	DEH, TPAG
1	C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Years 1 to 7	2, 3, 4, 5	DEH, FBP, NOSSA
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH, AHC, PL
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	2, 3, 4, 5	DEH
2	D.5 Develop protocols for track management activities on public land.	Year 1	1, 4	DEH, AHC
2	D.7 Liaise with fire management authorities regarding fire management activities.	Years 1 to 7	1, 3, 4, 5	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
2	C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Years 1 to 7	All	DEH, AHC, FB, FBP, TPAG, NOSSA, PL
2	D.1 Encourage private landholders to enter into Heritage Agreements.	Year 1	2	DEH
3	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
3	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	1, 4	DEH, BGA
3	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
4	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	1, 4	DEH, FB
4	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	1, 4	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

14. *Pterostylis despectans* (Lowly Greenhood)

14.1 Description

Pterostylis despectans has numerous leaves in a basal rosette, withered at the time of flowering. It has a short stem up to 5 cm tall, with scaly appressed bracts. It has 1 – 6 flowers, translucent white suffused and veined with dull green or brown, with very long horizontal, decurved pedicels (20 mm long). The galea is narrow, 16 mm long, including an apical filament 9 mm long. The lateral sepals are wider than the galea, upper margins are narrow, conjoined portion is flat with marginal cilia, tapering into long filiform tips to 16 mm long which often trail on the ground. The labellum is dark brown or green, obovate with a constriction near the base (4.5 mm x 2.5 mm), fine marginal setae (1 mm long), tip of basal lobe lacking setae, and two forward pointing setae (1.5 mm long) set in basal swellings (Bates and Weber 1990, Bishop 2000).

Type: Victoria, Maryborough, Nov. 1947, W.H. Nicholls s.n.

Pterostylis despectans, Peppermint Gully, J Quarmby

14.2 Conservation Status

Pterostylis despectans is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act, as Endangered in Victoria under the F&FG Act, and as Critically Endangered in New South Wales under the TSC Act.

14.2.1 IUCN Red List Criteria Version 3.1

South Australian sub-populations of *Pterostylis despectans* were assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process, and met the criteria for Critically Endangered (CR B1ab(iv)c(iv)).

Table 48: IUCN Red List Criteria for *Pterostylis despectans*.

IUCN Criteria	Justification
CR B1	It has an extent of occurrence of less than 100 km².
CR B1a	All known sub-populations are severely fragmented.
CR B1b(iii)	There is an observed continuing decline in the area and quality of habitat.
CR B1b(iv)	There is a projected continuing decline in the number of sub-populations.
CR B1c(iv)	There are extreme fluctuations in the number of mature individuals.

NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

14.3 Distribution and Population Size

14.3.1 Extent of occurrence

Pterostylis despectans has a disjunct distribution in South Australia and Victoria. In 2006 the species was known from four sub-populations in the Northern Lofty herbarium region of South Australia. The extent of occurrence of South Australian sub-populations was 79 km² (refer to Figure 12), and the area of occupancy was 4.1 hectares in 2006. In Victoria it is known from eleven locations in the Western Goldfields region (refer to Coates *et al* (2002) for details on the Victorian populations). This recovery plan only covers the South Australian sub-populations of *P. despectans*.

There is limited information on the historical distribution of *Pterostylis despectans* in South Australia. There is only one historical collection from 'Ulloolu Station', but this record has imprecise spatial information, and it is possible that it was collected from Sub-population 1. However, if this record is considered to represent a separate location then the historical extent of occurrence would be 257 km².

Figure 12: Current and historic distribution of *Pterostylis despectans* in South Australia.

14.3.2 Population size

The population size of *Pterostylis despectans* in South Australia was estimated to be approximately 600 mature individuals in 2006 (refer to Table 49). This is based on the estimated number of flowering plants in each sub-population from 2000 to 2006. It is very difficult to accurately determine the population size because of high levels of dormancy and annual fluctuations in the number of flowering plants. Furthermore flowering plants are very difficult to detect due to their size, habit and colour. Surveys of rosettes (which are easier to detect) conducted from 2000 - 2006 indicate the total number of plants could be as high as 3500, but only a small proportion of these plants actually flower in a year.

14.3.3 Important sub-populations

All known sub-populations of *Pterostylis despectans* in South Australia are considered to be important for conservation of the species. Sub-population 2 is most important because of its relatively large size, and likelihood of containing the highest genetic diversity. Sub-population 4 is also very important because of its outlying distribution.

14.4 Habitat

Pterostylis despectans grows in *Eucalyptus odorata*, *E. pruinosa*, *E. microcarpa* open woodland with a sparse understorey of *Austrostipa spp.*, *Austrodanthonia spp.*, *Vittadinia gracilis*, *Lomandra effusa*, *Plantago gaudichaudii* and *Wurmbea dioica*.

The soil is hard, clay loam covered with a microphytic crust. Rock outcrops are also frequent.

14.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. All native vegetation within five-hundred metres of historical sub-populations is also considered to be habitat critical to the survival of the species, unless it is considered no longer suitable for the species. Confidential Appendix K contains maps of habitat critical to the survival of *Pterostylis despectans*, and is available for legitimate purposes from DEH, Threatened Species Unit.

14.5 Reservation Status and Management Responsibility

All sub-populations of *Pterostylis despectans* in South Australia occur within private land (refer to Table 49). Only one of these properties is reserved under Heritage Agreement, and the others are currently unreserved.

Table 49: South Australian sub-population numbers, trends and threats for *Pterostylis despectans*

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Mt Bryan	Private (unreserved)	20 (06)	123 (01)	97	Fluctuating	Lack of pollination, herbivory
2	Peppermint Gully	Private (unreserved) /RCG (unreserved)	155 (06)	300 (05)	296	Fluctuating	Grazing, lack of pollination, weed invasion, herbivory
3	Ulloolu	Private (unreserved)	3 (00)	3 (00)	3	Unknown	Herbivory, grazing, lack of recruitment, lack of pollination
4	Yacka	Private (reserved)	50 (06)	350 (05)	207	Fluctuating	Weed invasion, herbivory, lack of pollination
		TOTAL	**288**	**776**	**603**	Source: DEH 2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix K, which is available from DEH, Threatened Species Unit.

14.6 Ecology

14.6.1 Biology

Pterostylis despectans usually produces a rosette of leaves in May - June. Flower spikes develop through spring, with peak flowering occurring from October to December. Flowering plants can produce one to ten flowers per spike, and flowering is staggered so that only one or two flowers are open at any one time. In dry years flowering may not occur because all available resources are put into replacing the parent tuber. The pollinated flowers develop into seed capsules from late October to late December. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (February – March). The average longevity of *P. despectans* is not known, but is assumed to be more than fifteen years.

14.6.2 Pollination

Pterostylis despectans is thought to be pollinated by flies or fungus gnats, like most other *Pterostylis* taxa. However, the pollinator has never been observed, let alone identified. The level of pollination in all known sub-populations is extremely low.

14.6.3 Mycorrhiza

Pterostylis despectans grows in association with mycorrhizal fungi. Mycorrhizal fungi associated with *P. despectans* have been isolated, but attempts to germinate seedlings *in vitro* in symbiosis with the mycorrhizal fungi have been unsuccessful. Mycorrhizal fungi are thought to play an important role in seedling germination and plant growth in most *Pterostylis* species.

14.6.4 Response to fire

Pterostylis despectans does not require fire to flower, and it is unknown how *P. despectans* responds to fire, because no sub-populations have been burnt in recent years.

14.6.5 Research opportunities

No specific research has been undertaken for *Pterostylis despectans*. There is significant need for research into the aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – including identifying the pollinator;

- Population genetics – determining genetic diversity and population viability;
- Seed ecology – determining germination requirements;
- Response to disturbance – determining the response to soil disturbance.

14.7 Threats to Recovery

14.7.1 Lack of pollination – HIGH

Lack of pollination is a significant threat to all sub-populations of *Pterostylis despectans*. Sub-population 2 has the lowest average rate of pollination with only 0.8 percent of flowering plants forming capsules per year. Sub-population 1 has the highest with approximately 2.6 percent of flowering plants forming capsules per year. The level of pollination at Sub-population 4 is 2.3 percent per year.

Levels of flowering and pollination were higher than average in 2005, presumably due to the high spring rainfall.

14.7.2 Grazing – HIGH

Sheep grazing is currently a threat to sub-populations 2 and 3. While stocking levels are relatively low, sheep cause high levels of herbivory and damage to *Pterostylis despectans*, and degrade the habitat. Sub-population 1 was fenced to exclude sheep in 2000, which has resulted in considerable regeneration of native vegetation, and a marked decrease in herbivory.

14.7.3 Weed invasion – HIGH

Weed invasion is a threat to all sub-populations of *Pterostylis despectans.* The main threats are Bearded Oats, Brome, Perennial Ryegrass, Salvation Jane, Horehound, Onion-grass, and Box Thorn.

14.7.4 Herbivory – Moderate

Macropods, rabbits and choughs are likely herbivores of *Pterostylis despectans*. Macropods are present at all *P. despectans* locations, and rabbits and choughs are particularly prevalent at Sub-population 2. Macropods are likely to eat the flowers, while rabbits may eat the whole plant including the tuber, and choughs dig up the tubers.

14.7.5 Road management activities – Low

Road management activities (e.g. grading, weed control, surfacing *etc*) are threats to sub-population 2. *Pterostylis despectans* grows close to the road in numerous locations and could be damaged by road management activities.

Weeds are also prolific along the road verges, and appear to be spreading. Weed incursion is markedly increased by road management activities. Any weed management within the road reserve needs to be mindful of the presence of *Pterostylis despectans*.

14.7.6 Utilities management – Low

Underground telephone cables occur along a roadside through Sub-population 2. *Pterostylis despectans* plants grow directly above where the cables are buried. Maintenance of these cables would need to be careful not to destroy *P. despectans* plants.

14.8 Previous Recovery Actions

Prior to 2007 the following recovery actions were implemented for *Pterostylis despectans.*

- Sub-population 1 was monitored in 1993, 1995, 1997 and 1999 by members of NOSSA. Plants were also artificially pollinated in 1993 and 1999.
- *P. despectans* was included in the LBTORP in 1998.
- A recovery plan was prepared for the species in South Australia in 2000 (Bickerton & Robertson 2000[b]). The following recovery actions were achieved prior to 2007.
  1. - Plants in Sub-populations 1, 2, and 4 have been artificially pollinated since 2000.
  2.1 - Sub-population 1 was fenced to exclude sheep in 2001.
  4. - Searches for the species resulted in the discovery of Sub-populations 2 and 4 in 2000.
  5. - Seed was collected from Sub-populations 1, 2 and 4 in 2004 and 2005, and is stored at the BGA.

7. - All sub-populations have been monitored since 2000, including the establishment of permanent monitoring quadrats. Surveys of the number of rosettes have occurred in August each year.
8. - Biannual recovery team meetings (NLBTORT) have been held since 2000.

- Box Thorn was controlled in Sub-populations 1 and 2 in 2004.
- A fact sheet was prepared for the species in 2001 (DEH 2001[g]), and has been publicly disseminated.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

14.9 Recovery Objectives, Performance Criteria and Recovery Actions

14.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Pterostylis despectans* is to improve the conservation status according to IUCN criteria from Critically Endangered to Endangered within 30 years. Specific recovery objectives and performance criteria for *Pterostylis despectans* are listed in Table 50.

Table 50: Specific recovery objectives and performance criteria for *Pterostylis despectans*.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species is increased by at least 20 percent within five years.	CR B1
2. To increase the number of extant sub-populations.	2.1 There are at least 6 extant sub-populations after five years.	CR B1a CR B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 10 percent within five years.	CR B1b(iv) CRB1c(iv)
	3.2 At least 2 sub-populations contain >50 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species is increased by at least 10 percent within five years.	CR B2b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 2 sub-populations are actively managed to improve habitat condition.	CR B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 private landholders and 2 public land management authorities are involved in implementing recovery actions for the species during the term of this plan.	
	8.2 At least 2 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

14.9.2 Specific recovery actions

The specific recovery actions for *Pterostylis despectans* are listed in Table 51. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 51: Specific recovery actions for *Pterostylis despectans*.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, PL
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, NOSSA, PL
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH, PL
1	C.5 Erect fences and remove stock from sub-populations.	Years 1 to 3	2, 3	DEH, PL
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	All	DEH
2	D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Year 1	2	RCG
2	D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.	Year 1	2	DEH, RCG
2	D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management.	Year 1	TBD	DEH
2	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
2	D.1 Encourage private landholders to enter into Heritage Agreements.	Years 1 to 7	1, 2, 3	DEH
3	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
3	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	2, 4	DEH, BGA
3	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	1, 2, 4	DEH, NOSSA, PL
3	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	1, 2, 4	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH
4	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
4	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

15. *Pterostylis* sp. Halbury (Halbury Greenhood)

15.1 Description

Pterostylis sp. Halbury has 5 to 10 ovate leaves in a small basal rosette, to 5 cm across, that lies flat to the ground, and is green at the time of flowering. The flower stem is usually about 10 cm tall, but can be up to 30 cm tall, and is slender, becoming wiry with age. It has 3 – 10 flowers, with only one or two open at a time, green suffused and veined with pale green, brown and translucent striations. The galea is up to 15 mm high, with a filiform up-turned apex to 1 cm long. The lateral sepals are deflexed, basally broad with marginal cilia, and the apices are filiform to 2 cm long, divergent and often up-turned. The labellum is small, to 4 mm long, oblong, thick and channelled, with few long silky marginal setae. There is considerable variation in flower morphology and colour (Bates 2008).

Pterostylis sp. Halbury, Halbury, J Quarmby

Type: South Australia, Halbury

Notes: Pterostylis sp. Halbury was described and named *Oligochaetochilus lepidus* by D.L. Jones in 2009, but this genus name is not currently accepted by the Council of Heads of Australasian Herbaria, and therefore the species is referred to by its phrase name in this plan. However, it is expected that a combination name (*Pterostylis lepidus*) will be published soon.

15.2 Conservation Status

Pterostylis sp. Halbury is listed as Endangered in Australia under the EPBC Act. It is also listed as Endangered in South Australia under the NP&W Act.

15.2.1 IUCN Red List Criteria Version 3.1

The conservation status of *Pterostylis* sp. Halbury was assessed in 2006 according to *IUCN Red List Criteria Version 3.1* (IUCN 2001) as part of this planning process and met the criteria for Endangered (B1ab(i,iii,iv)c(iv)).

Table 52: IUCN Red List Criteria for *Pterostylis* sp. Halbury.

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km².
EN B1a	All known sub-populations are severely fragmented, and are known from less than five locations.
EN B1b(i)	There is a projected continuing decline in the extent of occurrence.
EN B1b(iii)	There is a projected continuing decline in the quality of habitat.
EN B1b(iv)	There is a projected continuing decline in the number of sub-populations.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

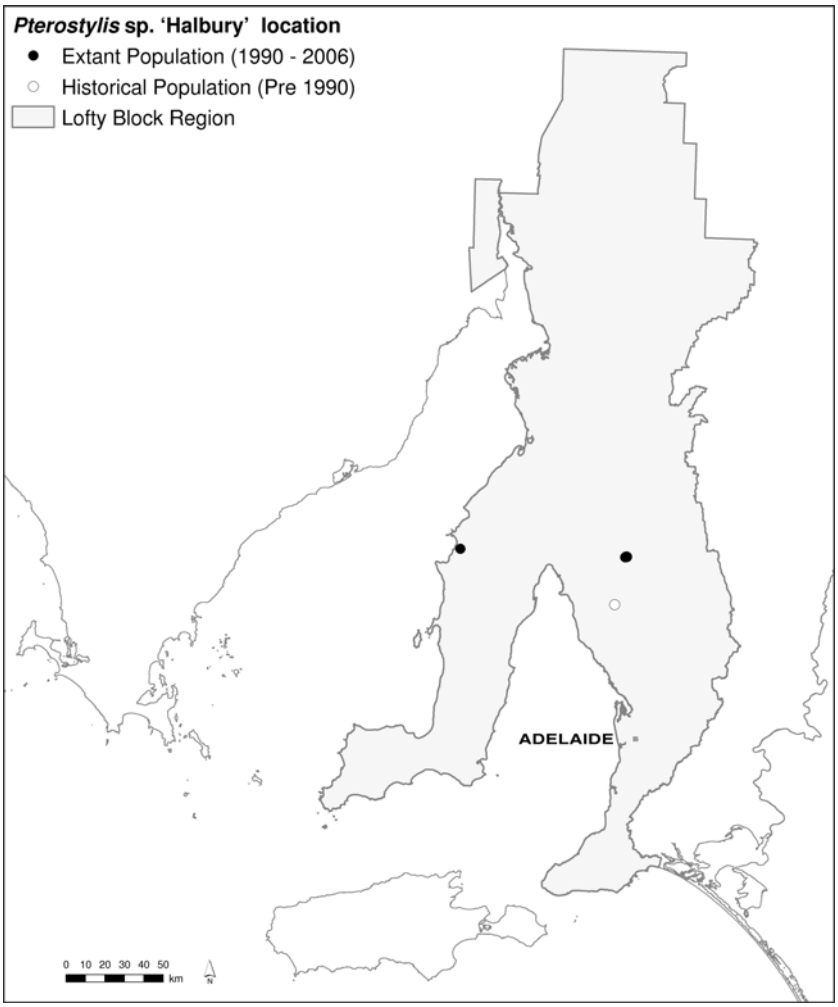
NOTE: IUCN Red List Criteria relating to area of occupancy were not considered appropriate for measuring the conservation status of any species in this plan, and were therefore disregarded in this assessment.

15.3 Distribution and Population Size

15.3.1 Extent of occurrence

Pterostylis sp. Halbury is endemic to South Australia. In 2006 the species was known from two sub-populations in the Northern Lofty and Yorke Peninsula herbarium regions (refer to Figure 13). The extent of occurrence of *P.* sp. Halbury was 17 km², and the area of occupancy was 0.8 hectares in 2006. There is also a recent unconfirmed sighting of *P.* sp. Halbury from a small remnant of native vegetation near Roseworthy (50 km SSE of Halbury), however subsequent visits to the site have failed to find the species.

Figure 13: Current and historic distribution of *Pterostylis* sp. Halbury



There is only one historical record of *Pterostylis* sp. Halbury from Pinery. Numerous visits to this site in recent years have failed to re-locate the species. The historical extent of occurrence is 995 km².

The plains north of Adelaide have been extensively cleared of native vegetation for agricultural purposes, and therefore it is likely that *Pterostylis* sp. Halbury was more widely distributed prior to European settlement.

15.3.2 Population size

The population size of *Pterostylis* sp. Halbury was estimated to be approximately 9000 mature plants in 2006 (refer to Table 53), based on surveys in 2006. However, it is difficult to accurately determine the population size with the available data. Furthermore, the number of flowering plants fluctuates from year to year depending on rainfall, with a large proportion of mature plants remaining dormant or sterile in dry years. Comprehensive surveys of both sub-populations are required to properly assess population size.

Sub-population 1 is the largest known sub-population, comprising ninety-nine percent of the total population size in 2006. Only two flowering plants were discovered near Moonta (Sub-population 2) in 2000, but subsequent visits have failed to relocate the species at this site.

Table 53: Sub-population numbers, trends and threats for *Pterostylis* sp. Halbury

Sub-population No.	Sub-population Locality	Land Holder and Reservation Status	No. Flowering Plants in Most Recent Census (Yr)	Highest No. Flowering Plants (Yr)	Mean No. Flowering Plants (1990-2006)	Sub-population Trend	Key Threats
1	Halbury	WRC (reserved /unreserved)	9000 (06)	11000 (03)	5163	Fluctuating	Weed invasion, recreational activities, trampling
2	Moonta	DCYP (unreserved)	0 (06)	2 (00)	1	Unknown	Weed invasion, herbivory, inbreeding
		TOTAL	**9000**	**11002**	**5164**	Source: DEH (2006[a], DEH 2006[b]	

All figures and information in this table are based on 2006 data.

The exact location of each sub-population is contained within Confidential Appendix L, which is available from DEH, Threatened Species Unit.

15.3.3 Important sub-populations

All sub-populations of *Pterostylis* sp. Halbury are important for conservation of the species. Sub-population 1 is the most important for the conservation of the species because it contains ninety-nine percent of the population size, and it has the highest potential for self-sustainability, and likelihood of containing the highest genetic diversity.

Sub-population 2 is also very important because of its outlying distribution and likelihood of containing genetic variability not found within Sub-population 1.

15.4 Habitat

Pterostylis sp. Halbury grows in *Callitris gracilis*, *Eucalyptus phenax* subsp. *phenax*, *E. odorata or E. socialis* low mallee woodland with a dense shrub layer dominated by *Alyxia buxifolia*. It occurs on plains with an elevation of less than 130 metres above sea level. The associated soil is red-orange clay loam, over heavy clay.

This habitat type was relatively widespread on the plains north of Adelaide prior to European settlement; however it is now confined to small isolated remnants, which are often linear and generally highly degraded.

15.4.1 Habitat critical to survival

All native vegetation within five-hundred metres of known sub-populations is considered to be habitat critical to the survival of the species. Confidential Appendix L contains maps of habitat critical to the survival of *Pterostylis* sp. Halbury, and is available for legitimate purposes from DEH, Threatened Species Unit.

15.5 Reservation Status and Management Responsibility

All known sub-populations of *Pterostylis* sp. Halbury occur within council land (refer to Table 53). The majority of the area occupied by Sub-population 1 is reserved for conservation purposes.

15.6 Ecology

15.6.1 Biology

Pterostylis sp. Halbury usually produces a rosette of leaves in May - June, however it has been found that plants do not always produce leaves or flowers every year, and can remain dormant for several years (DEH 2006[a]). From July to October a flower spike with multiple buds is produced, which flower from mid August to early November. The leaves usually wither by flowering time. Pollinated flowers develop into seed capsules any time between late August and early November. Tubers are replaced annually (during winter – spring) and are dormant over the hot, dry summer months (December – March). The average longevity of *P.* sp. Halbury is not known, but is assumed to be more than fifteen years.

15.6.2 Pollination

The pollinator of *Pterostylis* sp. Halbury is currently unknown, however it is likely that the species is pollinated by flies or fungus gnats, like other *Pterostylis* species.

15.6.3 Mycorrhiza

Pterostylis sp. Halbury grows in association with mycorrhizal fungi. Mycorrhizal fungi have been isolated from *P.* sp. Halbury, and seedlings have been symbiotically germinated *in vitro*. The fungi are yet to be identified. It is currently unknown whether a specific fungus, or multiple fungi are associated with the species. Mycorrhizal fungi are thought to play a vital role in seedling germination and nutrient absorption in most *Pterostylis* species.

15.6.4 Response to fire and disturbance

Pterostylis sp. Halbury does not require fire to flower, and it is unknown how *P.* sp. Halbury responds to fire because no sub-populations have been burnt in recent years.

However, for an undetermined number of years, Sub-population 1 was subject to illegal ploughing by a local resident. This activity ceased in 2002. In 2004 and 2005, high numbers of *Pterostylis* sp. Halbury were found flowering in areas previously ploughed but it is unknown how many *P.* sp. Halbury were flowering in these areas prior to the ploughing.

15.6.5 Research opportunities

No specific research has been undertaken for *Pterostylis* sp. Halbury. There is a significant need for research into the aspects of the biology and ecology of the species. Areas of particular importance include:

- Pollination biology – including identifying the pollinator;
- Population genetics – determining genetic diversity and population viability;
- Seed ecology – determining germination requirements.
- Response to disturbance – determining the response to soil disturbance.

15.7 Threats to Recovery

15.7.1 Weed invasion – HIGH

Weed invasion is a serious threat to all known sub-populations of *Pterostylis* sp. Halbury. Bridal Creeper and Soursob are of primary concern, being abundant throughout all known locations of *P.* sp. Halbury. Both of these species are annuals and have an active growth season similar to that of *P.* sp. Halbury. This also complicates the use of herbicides for control due to the risk of off-target damage.

Annual introduced grasses (*e.g.* Bearded Oat, Brome) are also a threat to all sub-populations. There are many other weeds present at the three sites, all of which degrade the condition of habitat for *Pterostylis* sp. Halbury.

15.7.2 Herbivory – High

Rabbits are present at all sites of *Pterostylis* sp. Halbury and are known to have caused high levels of herbivory in Sub-population 1 prior to the erection of rabbit proof fencing around a large proportion of the sub-population. Sub-population 2 is not protected from rabbits and is highly susceptible to herbivory. Kangaroos are also present at Sub-population 2.

15.7.3 Trampling – Moderate

There is a plethora of trails and foot paths throughout the sites containing Sub-populations 1 and 2. *Pterostylis* sp. Halbury grows directly on many of the paths in Halbury Parklands, and is consequently at risk from trampling.

15.7.4 Recreational activities – Moderate

Recreational activities such as walking, cycling, motorbike riding, horse riding, and exercising dogs are threats to *Pterostylis* sp. Halbury. These activities cause direct damage to plants in Sub-population 1, especially plants growing directly on trails and foot paths.

15.7.5 Inbreeding and loss of genetic diversity – Moderate

Inbreeding and loss of genetic diversity is a threat to Sub-population 2 given its small size and the lack of potential for out-crossing due to habitat isolation. It is unknown whether natural pollination is occurring in this sub-population.

15.8 Previous Recovery Actions

The following recovery actions were implemented for *Pterostylis* sp. Halbury prior to 2007.

- *P.* sp. Halbury was included in the LBTORP in 1998.
- The Friends of Halbury Parklands (FHP) was formed in 1999 to assist with the management of Halbury Parklands, including recovery actions for *P.* sp. Halbury.
- A national recovery plan was prepared for the species in 2000 (Bickerton & Robertson 2000[a]). The following recovery actions were achieved prior to 2007.
  2. - TFL controlled weeds in Bush for Life sites in Halbury Parklands since 2000.
     - FHP also controlled weeds throughout Halbury Parklands since 2000.
     - NOSSA controlled weeds in Halbury Parklands (section 706) since 2000.
     - TPAG established a Bridal Creeper control trial in Halbury Parklands (section 706) in 2005.
  4 - Rabbit-proof fences were erected around two areas within Halbury Parklands (sections 409 and 706) in 2002. This has assisted in ceasing the ploughing that previously occurred, and decreasing the level of inappropriate recreational use.
  6. - Rubbish was removed from Halbury Parklands in 2000 by FHP.
  7. - FHP undertook rabbit baiting in Halbury Parklands in 2005.

8. - Seed and mycorrhiza was collected from Sub-population 1 and is stored at the BGA.
9. - A vegetation management plan was prepared for Halbury Parklands in 2002 (Robertson & Bickerton 2002).
10. - Annual monitoring of *P.* sp. Halbury was undertaken in Sub-population 1 since 2000. Grids were established throughout Halbury Parklands (section 409 and 706) to survey P. sp. Halbury numbers and weed densities. Permanent quadrats were also established in 2004 to monitor *P.* sp. Halbury demographics.
11. - Biannual recovery team meetings (NLBTORT) have been held since 2000.

- A fact sheet was prepared for the species in 2001 (DEH 2001[a]), and has been publicly disseminated.

The previous recovery plan for this species was reviewed by DEH in 2007 (Waudby *et al* 2007), and the findings and recommendations are summarised at Appendix F. A draft of the current recovery plan was available to the reviewer and the review recommended proceeding with this plan.

15.9 Recovery Objectives, Performance Criteria and Recovery Actions

15.9.1 Recovery objectives and performance criteria

The overall recovery objective for *Pterostylis* sp. Halbury is to improve the conservation status from Endangered to Vulnerable within 30 years. Specific recovery objectives and performance criteria for *Pterostylis* sp. Halbury are listed in Table 54.

Table 54: Specific recovery objectives and performance criteria for *Pterostylis* sp. Halbury.

Recovery Objectives	Performance Criteria	IUCN Criteria Addressed
1. To increase the extent of occurrence of the species.	1.1 The extent of occurrence of the species increased by at least 20 percent within five years.	EN B1 EN B1b(i)
2. To increase the number of extant sub-populations.	2.1 There are at least 4 extant sub-populations after five years.	EN B1b(i) EN B1b(iv)
3. To increase the population size of the species.	3.1 The population size of the species is increased by at least 20 percent within five years.	EN B1b(iv) EN B1c(iv)
	3.2 At least 2 sub-populations contain >50 mature individuals after five years.	
4. To increase the area of occupancy of the species.	4.1 The area of occupancy of the species is increased by at least 10 percent within five years.	EN B2b(ii)
5. To maintain or improve the quality of habitat critical to survival.	5.1 At least 2 sub-populations are actively managed to improve habitat condition.	EN B1b(iii)
6. To safeguard against the risk of sub-population extinctions.	6.1 Seed from each sub-population and mycorrhizal fungi are preserved in long-term storage within five years.	
7. To increase the knowledge of the biology and ecology of the species.	7.1 There is an increased number of research projects undertaken related to the biology and ecology of the species within five years.	
8. To maintain or increase the level of community participation in the recovery process.	8.1 At least 2 public land management authorities are involved in implementing recovery actions for the species during the term of this recovery plan.	
	8.2 At least 3 community groups and 10 volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	

15.9.2 Specific recovery actions

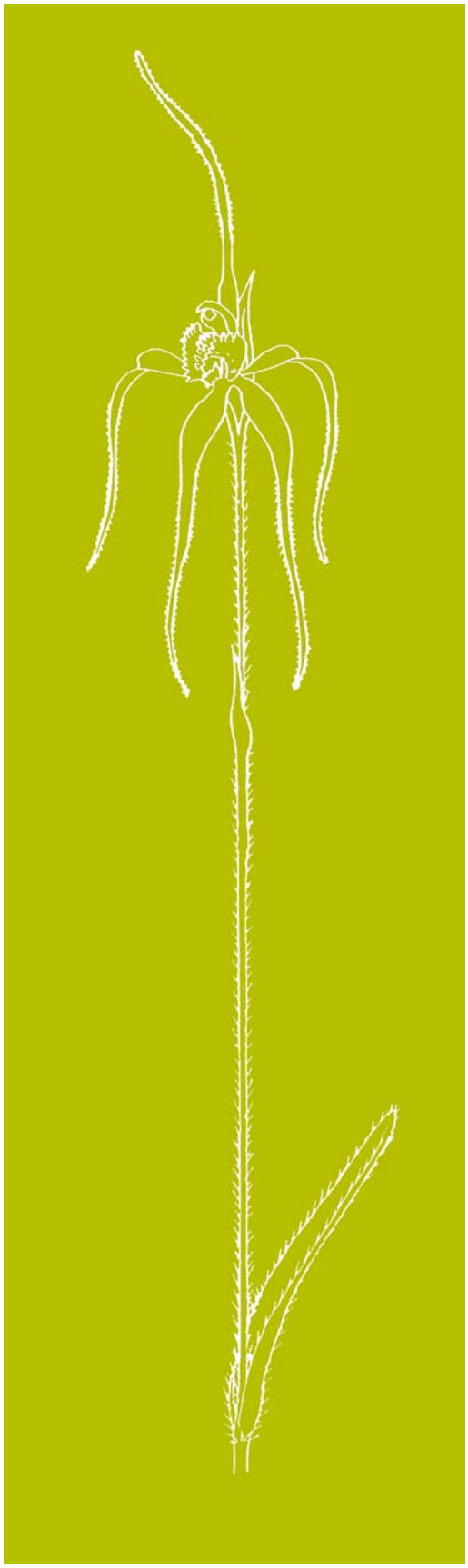
The specific recovery actions for *Pterostylis* sp. Halbury are listed in Table 55. Relevant sub-populations for each recovery action are listed where applicable. Suggested delivery groups for each recovery action are also listed. Detailed descriptions of each recovery action can be found in section 3.3 of this recovery plan.

Table 55: Specific recovery actions for *Pterostylis* sp. Halbury.

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
1	B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species.	Years 1 to 7	-	DEH, NOSSA
1	B.2 Search potential habitat for the species, and evaluate habitat suitability.	Years 1 to 7	-	DEH, NOSSA
1	B.3 Update herbarium and BDSA records for the species.	Years 1 to 7	All	DEH
1	C.1 Control threatening weeds in selected sub-populations.	Years 1 to 7	All	DEH, FHP, TFL, NOSSA, TPAG
1	C.4 Identify and control threatening herbivores.	Years 1 to 7	All	DEH, FHP
1	C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination.	Years 1 to 7	2	DEH
1	C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.	Years 1 & 2	All	DEH, FHP
2	A.1 Survey the number of flowering plants in each sub-population.	Years 1 to 7	All	DEH, NOSSA, FHP
2	A.2 Monitor the demographics of selected sub-populations.	Years 1 to 7	1	DEH, NOSSA, FHP
2	A.3 Update database, and analyse demographic data for relevant sub-populations.	Years 1 to 7	1	DEH
2	F.1 Prepare a translocation feasibility assessment for the species.	Year 1	All	DEH
2	F.2 Prepare and implement translocation proposals for selected sub-populations.	Years 1 to 7	TBD	DEH
2	E.1 Collect seed from each sub-population, and preserve *in vitro*.	Years 1 to 7	All	DEH, BGA
2	E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Years 1 to 7	1	DEH, BGA
2	E.3 Undertake *in vitro* seed germination and plant cultivation.	Years 1 to 7	-	BGA, WOL
3	D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation.	Year 1	2	DEH
3	H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.	Years 1 to 7	All	DEH
3	D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Year 1	2	RCG
3	D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases.	Year 1	2	DEH, RCG
4	H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project.	Years 1 to 7	-	DEH
4	G.1 Encourage, direct, and support universities and other researchers to study the biology and ecology of the species.	Years 1 to 7	-	DEH, SAM
4	G.2 Establish and monitor disturbance trials for selected sub-populations.	Years 1 to 7	2	DEH, NOSSA, FHP
4	G.3 Undertake genetic analysis of selected sub-populations.	Years 1 to 7	TBD	DEH

Priority	Recovery Actions	Timing (Yr)	Sub-populations	Delivery Group/s
5	H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Years 1 to 7	-	DEH
5	H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Year 1	-	DEH

Part C: Duration, Costs and Evaluation



16. Duration, Costs and Evaluation

16.1 Duration of the Project

This recovery plan is intended to guide action over seven years. However, the recovery of each of the species will be a long-term process. Based on the current rate of achievement it is anticipated that an improvement in the conservation status of most species will not be achieved until 2030 or later.

It is therefore envisaged that the LBTORP will require funding for some time to come, if the overall recovery objectives are to be achieved.

16.2 Seven-year Budget

The total cost of implementing this recovery plan over seven years is estimated to be $968800, with an average cost of $138400 per year. A break-down of costs is outlined in Table 56. The costs for implementing the plan in the AMLR and NY NRM regions are outlined in Tables 58 and 59.

Annual funding applications will be made to the AMLR and NY NRM Boards for the duration of the recovery plan. The funding support of these Boards and the ongoing contributions by DEH are crucial for the implementation of this plan.

Community groups and private landholders will be encouraged to apply for community grants (e.g. NRM On-ground Works Fund *etc*) in partnership with DEH to cover some of the costs of implementing recovery actions, where necessary.

16.3 Plan Evaluation

Annual progress of recovery actions for each species in this recovery plan will be evaluated and reported by the Lofty Block Threatened Orchid Recovery Teams. Progress towards meeting recovery objectives and performance criteria will also be assessed by the recovery teams.

Quarterly and annual reporting for the LBTORP will also be provided to the AMLR and NY NRM Boards as required by funding contracts.

A major review of the recovery process will occur after the plan has been in operation for five years. An independent body will be contracted to undertake this review. Outcomes of the review will be incorporated into future recovery plans for the species in this plan.

Table 56: Estimated costs of implementing the recovery plan.

Project Co-ordination	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
Salaries and on-costs (Full-time equivalent of 1 x PO1 + 20% on-costs)	64430	64430	64430	64430	64430	64430	64430	**451010**
Travel, accommodation, and meals	12500	12500	12500	12500	12500	12500	12500	**87500**
SUB-TOTAL	**76930**	**76930**	**76930**	**76930**	**76930**	**76930**	**76930**	**538510**

Recovery Actions	Likely Expenses	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
A.2 Monitor the demographics of selected sub-populations.	Equipment/ materials	20	20	20	20	20	20	20	**140**
C.1 Control threatening weeds in selected sub-populations.	Contract wages, equipment/ materials	30000	30000	30000	30000	30000	30000	30000	**210000**
C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Equipment, materials	200	200	200	200	200	200	200	**1400**
C.4 Identify and control threatening herbivores.	Contract wages, materials	5000	5000	5000	2000	2000	2000	2000	**23000**
C.5 Erect fences and remove stock from sub-populations.	Contract wages, materials	5000	5000	0	0	0	0	0	**10000**
C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.		3000	1000	1000	1000	0	0	0	**6000**
C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Equipment, materials	50	50	50	50	50	50	50	**350**
D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Materials	2000	1000	1000	0	0	0	0	**4000**
E.1 Collect seed from each sub-population, and preserve *in vitro*.	Contract wages, materials	3000	3000	3000	3000	3000	3000	3000	**21000**
E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Contract wages, equipment/ materials	5000	5000	2000	1000	1000	1000	1000	**16000**
E.3 Undertake *in vitro* seed germination and plant cultivation.	Contract wages, equipment/ materials	10000	10000	10000	5000	5000	5000	5000	**50000**
Recovery Actions	**Likely Expenses**	**Year 1 $**	**Year 2 $**	**Year 3 $**	**Year 4 $**	**Year 5 $**	**Year 6 $**	**Year 7 $**	**Total $**

F.2 Prepare and implement translocation proposals for selected sub-populations.	Equipment/materials	0	5000	5000	5000	5000	5000	5000	**30000**
G.2 Establish and monitor disturbance trials for selected sub-populations.	Equipment/materials	100	100	100	100	0	0	0	**400**
G.3 Undertake genetic analysis of selected sub-populations.	Contract wages, equipment/ materials	20000	10000	10000	10000	0	0	0	**50000**
H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Contract wages, printing/laminating	1500	0	0	0	0	0	1500	**3000**
H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Contract wages, printing	4000	0	0	500	0	0	500	**5000**
	SUB-TOTAL	**88870**	**75370**	**67370**	**57870**	**46270**	**46270**	**48270**	**430290**

Total Cost	**Year 1 $**	**Year 2 $**	**Year 3 $**	**Year 4 $**	**Year 5 $**	**Year 6 $**	**Year 7 $**	**Total $**
Salaries, on-costs, travel, accommodation & meals	76930	76930	76930	76930	76930	76930	76930	**538510**
Recovery actions	88870	75370	67370	57870	46270	46270	48270	**430290**
TOTAL	**165800**	**152300**	**144300**	**134800**	**123200**	**123200**	**125200**	**968800**

Table 57: Estimated costs of implementing the recovery plan in the AMLR NRM region

Project Co-ordination	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
Salaries and on-costs (0.5 PO1 + 20% on-costs)	32215	32215	32215	32215	32215	32215	32215	**225505**
Travel, accommodation, and meals	3500	3500	3500	3500	3500	3500	3500	**24500**
SUB-TOTAL	**35715**	**35715**	**35715**	**35715**	**35715**	**35715**	**35715**	**250005**

Recovery Actions	Likely Expenses	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
A.2 Monitor the demographics of selected sub-populations.	Equipment/ materials	10	10	10	10	10	10	10	**70**
C.1 Control threatening weeds in selected sub-populations.	Contract wages, equipment/ materials	15000	15000	15000	15000	15000	15000	15000	**105000**
C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Equipment, materials	100	100	100	100	100	100	100	**700**
C.4 Identify and control threatening herbivores.	Contract wages, materials	1000	1000	1000	1000	1000	1000	1000	**7000**
C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.		2000	500	500	500	0	0	0	**3500**
C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat.	Equipment, materials	50	50	50	50	50	50	50	**350**
D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Materials	1000	500	500	0	0	0	0	**2000**
E.1 Collect seed from each sub-population, and preserve *in vitro*.	Contract wages, materials	1500	1500	1500	1500	1500	1500	1500	**10500**
E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Contract wages, equipment/ materials	2500	2500	1000	500	500	500	500	**8000**
E.3 Undertake *in vitro* seed germination and plant cultivation.	Contract wages, equipment/ materials	5000	5000	5000	2500	2500	2500	2500	**25000**
Recovery Actions	**Likely Expenses**	**Year 1 $**	**Year 2 $**	**Year 3 $**	**Year 4 $**	**Year 5 $**	**Year 6 $**	**Year 7 $**	**Total $**

F.2 Prepare and implement translocation proposals for selected sub-populations.	Equipment/materials	0	2500	2500	2500	2500	2500	2500	**15000**
G.2 Establish and monitor disturbance trials for selected sub-populations.	Equipment/materials	50	50	50	50	0	0	0	**200**
G.3 Undertake genetic analysis of selected sub-populations.	Contract wages, equipment/ materials	10000	5000	5000	5000	0	0	0	**25000**
H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Contract wages, printing/laminating	750	0	0	0	0	0	750	**1500**
H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Contract wages, printing	2000	0	0	250	0	0	250	**2500**
	SUB-TOTAL	**40960**	**33710**	**32210**	**28960**	**23160**	**23160**	**24160**	**206320**

Total Cost	**Year 1 $**	**Year 2 $**	**Year 3 $**	**Year 4 $**	**Year 5 $**	**Year 6 $**	**Year 7 $**	**Total $**
Salaries, on-costs, travel, accom. & meals	35715	35715	35715	35715	35715	35715	35715	**250005**
Recovery actions	40960	33710	32210	28960	23160	23160	24160	**206320**
TOTAL	**76675**	**69425**	**67925**	**64675**	**58875**	**58875**	**59875**	**456325**

Table 58: Estimated costs of implementing the recovery plan in the N&Y NRM region

Project Co-ordination	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
Salaries and on-costs (0.5 PSO1 + 20% on-costs)	32215	32215	32215	32215	32215	32215	32215	**225505**
Travel, accommodation and meals	9000	9000	9000	9000	9000	9000	9000	**63000**
SUB-TOTAL	**41215**	**41215**	**41215**	**41215**	**41215**	**41215**	**41215**	**288505**

Recovery Actions	Likely Expenses	Year 1 $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Year 7 $	Total $
A.2 Monitor the demographics of selected sub-populations.	Equipment/ materials	10	10	10	10	10	10	10	**70**
C.1 Control threatening weeds in selected sub-populations.	Contract wages, equipment/ materials	15000	15000	15000	15000	15000	15000	15000	**105000**
C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory.	Equipment, materials	100	100	100	100	100	100	100	**700**
C.4 Identify and control threatening herbivores.	Contract wages, materials	4000	4000	4000	1000	1000	1000	1000	**16000**
C.5 Erect fences and remove stock from sub-populations.	Contract wages, materials	5000	5000	0	0	0	0	0	**10000**
C.7 Close or re-align inappropriate recreational trails that dissect sub-populations.		1000	500	500	500	0	0	0	**2500**
D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers.	Materials	1000	500	500	0	0	0	0	**2000**
E.1 Collect seed from each sub-population, and preserve *in vitro*.	Contract wages, materials	1500	1500	1500	1500	1500	1500	1500	**10500**
E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*.	Contract wages, equipment/ materials	2500	2500	1000	500	500	500	500	**8000**
E.3 Undertake *in vitro* seed germination and plant cultivation.	Contract wages, equipment/ materials	5000	5000	5000	2500	2500	2500	2500	**25000**
Recovery Actions	**Likely Expenses**	**Year 1 $**	**Year 2 $**	**Year 3 $**	**Year 4 $**	**Year 5 $**	**Year 6 $**	**Year 7 $**	**Total $**
F.2 Prepare and implement translocation proposals for selected sub-populations.	Equipment/materials	0	2500	2500	2500	2500	2500	2500	**15000**

G.2 Establish and monitor disturbance trials for selected sub-populations.	Equipment/materials	50	50	50	50	0	0	0	**200**
G.3 Undertake genetic analysis of selected sub-populations.	Contract wages, equipment/ materials	10000	5000	5000	5000	0	0	0	**25000**
H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations.	Contract wages, printing/laminating	750	0	0	0	0	0	750	**1500**
H.4 Prepare or update a fact sheet for the species, and disseminate to the public.	Contract wages, printing	2000	0	0	250	0	0	250	**2500**
	SUB-TOTAL	**47910**	**41660**	**35160**	**28910**	**23110**	**23110**	**24110**	**223970**

Total Cost	**Year 1** **$**	**Year 2** **$**	**Year 3** **$**	**Year 4** **$**	**Year 5** **$**	**Year 6** **$**	**Year 7** **$**	**Total** **$**
Salaries, on-costs, travel, accommodation & meals	41215	41215	41215	41215	41215	41215	41215	**288505**
Recovery actions	47910	41660	35160	28910	23110	23110	24110	**223970**
TOTAL	**89125**	**82875**	**76375**	**70125**	**64325**	**64325**	**65325**	**512475**

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Abbreviations

AHC	Adelaide Hills Council
ANH	Australian National Herbarium
AMLR	Adelaide and Mount Lofty Ranges
APS	Australian Plant Society
ARC	Australian Research Council
BDSA	Biological Databases of South Australia
BEST	Biodiversity and Endangered Species Team
BC	Barossa Council
BGA	Botanic Gardens of Adelaide
C&GVC	Clare and Gilbert Valleys Council
CBD	Convention on Biological Diversity
CFS	Country Fire Service
CITES	Convention on International Trade in Endangered Species
CL Act	*Crown Lands Act 1929*
CP	Conservation Park
CYP	City of Playford
CVH	City of Victor Harbor
DAC	Development Assessment Commission
DCYP	District Council of Yorke Peninsula
DEH	Department for Environment and Heritage, South Australia
DEWHA	Department of the Environment, Water, Heritage and the Arts (Australian Government)
DNA	Deoxyribonucleic acid
DSE	Department of Sustainability and Environment, Victoria
DTEI	Department for Energy, Transport and Infrastructure, South Australia
DWLBC	Department of Water, Land and Biodiversity Conservation
EMU	Environment Management Unit
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FB	Friends of Belair National Park
FBC	Friends of Brentwood Cemetery
FBP	Friends of Bushland Park
F&FG Act	*Flora and Fauna Guarantee Act 1988*
FKS	Friends of Kaiser Stuhl Conservation Park
FHP	Friends of Halbury Parklands
FMB	Friends of Mount Billy Conservation Park
FSC	Friends of Scott Creek Conservation Park
FSG	Friends of Spring Gully Conservation Park
FSA	ForestrySA
GIS	Geographic Information System
HA	Heritage Agreement
IUCN	International Union for Conservation of Nature and Natural Resources

LBTORP	Lofty Block Threatened Orchid Recovery Project
NFR	Native Forest Reserve
NLBTORT	North Lofty Block Threatened Orchid Recovery Team
NOSSA	Native Orchid Society of South Australia
NP	National Park
NP&W Act	*National Parks and Wildlife Act 1972*
NRM	Natural Resource Management
NRMB	Natural Resources Management Board
NT Act	*Native Title Act 1993*
NTSA	Natural Trust of South Australia
NV Act	*Native Vegetation Act 1991*
NVC	Native Vegetation Council
NY	Northern and Yorke
NYAD	Northern and Yorke Agricultural District
PJPS	Port Julia Progress Society
PL	Private landholders
PVA	Population Viability Analysis
RCG	Regional Council of Goyder
RMS	Roadside Marker Scheme
RP	Recreation Park
RSSD	Roadside Significant Sites Database
SAM	South Australian Museum
SAW	SA Water
SLBTORT	South Lofty Block Threatened Orchid Recovery Team
sp.	species
subsp.	sub-species
SPBP	South Para Biodiversity Project
TBD	To be determined
TBP	Tiers Biodiversity Project
TFL	Trees for Life
TPAG	Threatened Plant Action Group
TPPB	Threatened Plant Population Database
TSN	Threatened Species Network
UA	University of Adelaide
USA	University of South Australia
WRC	Wakefield Regional Council
WOL	Western Orchid Laboratories

Definitions

Area of occupancy

Area of occupancy is defined as the area within the 'extent of occurrence' which is occupied by a taxon (IUCN 2001). For the purposes of this recovery plan area of occupancy was calculated by applying a fifty metre buffer around the known locations for each sub-population using GIS.

Extent of occurrence

Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known 'sub-populations' of a taxon (IUCN 2001). For the purposes of this recovery plan extent of occurrence was calculated by drawing a minimum convex polygon containing all known sub-populations using GIS.

Habitat critical to survival

Regulation 7.09 of the EPBC Act sets out criteria that must be considered in identifying habitat critical to survival of a taxon. For the purposes of this recovery plan habitat critical to survival comprises all of the known locations of a taxon, including historical locations, and any native vegetation within 500 metres buffer.

Important sub-populations

Important sub-populations are defined as 'sub-populations' that are essential to the survival and long-term evolutionary development of a taxon. All sub-populations of species in this recovery plan are considered to be important. The largest sub-populations are generally considered to be most important because they are more likely to be viable and contain the highest genetic diversity. Outlying, isolated sub-populations are also likely to contain genetic diversity not found within other sub-populations. Genetic analysis is required to determine the genetic diversity of each sub-population.

Mature individuals

Mature individuals are defined as individuals that are capable of reproduction (IUCN 2001). The number of flowering plants has been used as the measure for mature individuals in this recovery plan.

Populations

Populations are defined as the total number of mature individuals of a taxon (IUCN 2001). This number can fluctuate significantly from year to year due to dormancy, and therefore a lower estimate of population size is used, which in most cases is less than the mean.

Potential habitat

Potential habitat is defined as habitat that may be suitable for a taxon, but is not currently occupied. This may include historical locations, suitable habitat that is yet to be searched, or areas where the species does not currently occur but may be suitable for re-introductions.

Sub-populations

Sub-populations are defined as geographically distinct groups within the population between which there is little demographic exchange, typically one successful migrant or gamete per year or less (IUCN 2001). Because there is little information on the genetics or demographics of the species in this recovery Plan, sub-populations were defined as geographically distinct groups, separated by more than five hundred metres.

Glossary of Botanical Terms

acuminate Tapering to a long drawn-out point.

apex The uppermost point.

appressed Pressed closely against another organ, as leaves against a stem.

anther Pollen producing male section of the column.

articulate On a movable hinge.

basal Arising from the base.

bract A leaf at the base of a scape, or on the scape as a sterile bract.

calli Non-secreting glands located on the labellum.

caudae Tail, or hair-like extensions.

caudate With a long tail.

cauline On the stem, as in cauline leaves.

chlorophyll The green, light absorbing pigments of plants.

cilia Fine soft hairs.

clavate Club shaped, as in the thickened tip of a sepal.

club A thickened glandular tip of a floral segment, containing osmophore cells.

column A central fleshy structure in orchid flowers composed of the stamen, style and stigma.

column wing Enlarged or expanded wing-like edges to the column.

cordate Heart-shaped.

cortical Related to, or consisting of, the region of tissue in a root or stem between the epidermal and vascular tissue.

decurved Curved downward.

deflexed Bent sharply downward.

dehisce Splitting, as in the opening of a seed capsule.

dentate Edged with teeth.

distal Away from the base, toward the apex.

divergent Spreading apart, as in divergent sepals.

dorsal On the upper side.

entire A smooth margin, free of any interruption or irregularity such as toothing.

epidermal The outermost protective layer of plant cells.

falcate Sickle-shaped.

filiform Fine and thread-like.

free point The extended part of a lateral sepal which is not attached to the galea of *Pterostylis*.

galea A hooded structure, as in the galea of *Pterostylis* where the dorsal sepal unites with the petals.

gibbous Partly swollen, or humped.

glabrous Lacking hairs or similar coverings.

gland Secretory organ.

hyphal Fungal threads.

incurved Curved inwards.

inflorescence Flowering structure of a plant.

in situ Situated in the original, natural, or existing place or position.

in vitro In an artificial environment.

kairomone Chemical substance produced by a flower that replicates the female sex hormone of an insect.

labellum A modified third petal, often referred to as the lip.

lamina A flattened, blade-like structure, such as a leaf.

lanceolate Lance-shaped; longer than wide and tapering gradually at each end.

lateral Arising from the side, as in lateral sepals.

linear A structure that is much longer than it is wide, and with parallel sides.

lip see labellum.

lobe Of a lamina, a rounded part produced by incomplete division from the margin to the centre.

marginal Attached to or near the edge.

medial The mid line of a segment.

meristem Undifferentiated plant tissue from which new cells are formed, as in the tip of a stem or root.

mycorrhiza A soil fungus that forms a beneficial relationship with the roots of a plant, resulting in nutrient exchange.

obovate Ovate with the broadest part above the middle.

obtuse Blunt or rounded at the apex**.**

osmophore Scent producing gland, as in the kairomone producing glands on the tips of *Caladenia* segments.

ovary Part of the flower which develops into the fruit after fertilisation.

ovate Egg-shaped in a plane.

pedicel Stem supporting an individual flower in an inflorescence.

perianth Collective term for the petals and sepals of a flower.

petal An inner segment of a whorl.

pollinia Aggregated coherent mass of pollen grains.

protocorm A structure that develops after orchid seed germination, from which a shoot develops after mycorrhizal infection.

pyriform Pear-shaped.

recurved Bent backwards.

reflexed Bent sharply backward or upward.

retuse With an obtuse apex the centre of which is notched.

rhizome An underground stem that has nodes and roots and can produce shoots.

rosette Cluster of basal leaves radiating from a central point.

scape The floral stem.

segment Any part of the perianth.

sepal An outer segment of a whorl.

sessile Attached directly on to, without a stalk.

seta A bristle.

sinus A cavity or recess, or the area between two lobes or segments.

spike An unbranched inflorescence usually with sessile flowers.

stamen Male part of a flower that produces pollen.

stigma Enlarged viscous part of the column receptive to pollen.

style Slender column or connection between the stigma and the ovary of a flower.

sub- A prefix meaning somewhat, almost, as in sub-acute.

subulate Awl-shaped.

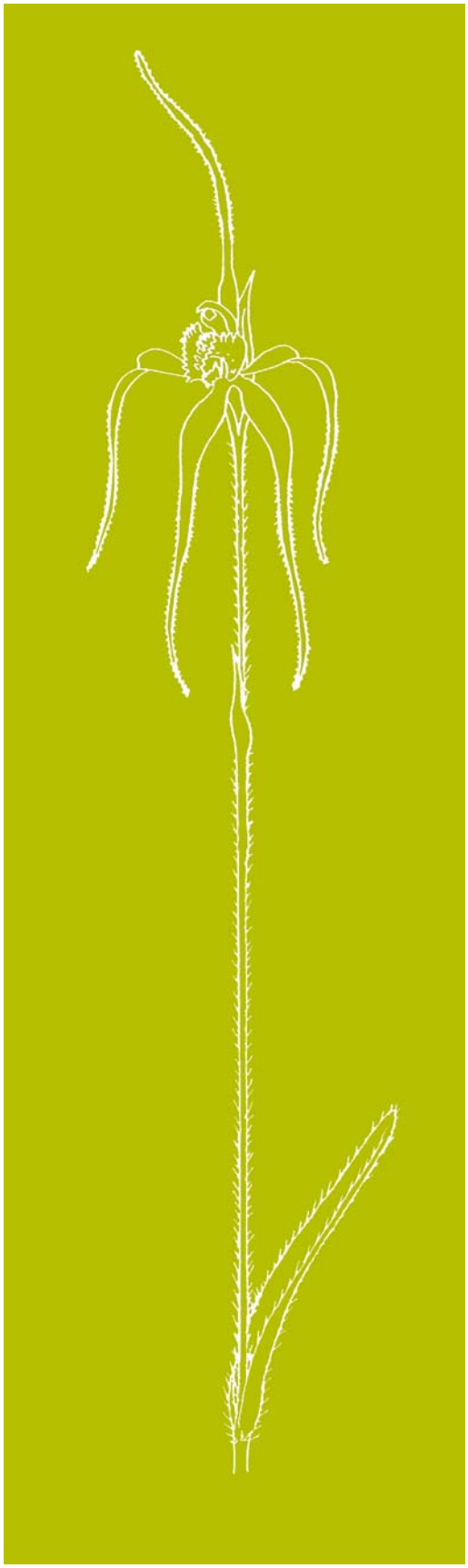
tepals A collective term for the petals and the petal-like sepals of an orchid flower.

tuber An underground storage organ or root.

vascular Of, or containing vessels that carry or circulate fluids through a plant.

whorl Three or more segments in a circle at a node.

Appendices



Appendix A: Current Membership of Recovery Teams

Organisations	South Recovery Team	North Recovery Team
Clare and Gilbert Valleys Council		x
ForestrySA	x	
Friends of Belair NP	x	
Friends of Halbury Parklands		x
Friends of Mount Billy CP	x	
Friends of Scott Creek CP	x	
Friends of Spring Gully CP		x
National Trust of South Australia	x	
Native Orchid Society of SA	x	x
Private land holder		x
DEH Adelaide Region	x	
DEH Fleurieu District	x	
DEH Mid North District		x
DEH Northern Lofty District	x	
DEH Southern Flinders District		x
DEH Southern Lofty District	x	
DEH Threatened Species Unit	x	x
DEH Yorke Mid North Region		x
SA Water	x	
Threatened Plant Action Group	x	x
Trees for Life	x	x
Wakefield Regional Council		x
Western Orchid Laboratories	x	x

Appendix B: Hand Pollination Protocol

(Extract from Bickerton (2001[b]), reproduced with author's permission.)

Introduction

This protocol was devised by the two recovery teams that manage the Lofty Block Threatened Orchid Recovery Project, as a guide for field workers participating in native orchid conservation in South Australia. The project receives Commonwealth funding from the Natural Heritage Trust, and is concerned with conservation in the wild of threatened orchid taxa in the Southern and Northern Lofty Ranges of South Australia.

Threat abatement is the action of highest priority for many of the populations covered by the project, however when a declining population is in danger of extinction it is sometimes deemed necessary to reverse the process and enhance recruitment by hand pollinating plants. The guidelines set out in this document are intended to assist people in deciding when it is necessary to hand pollinate, what proportion of flowers should be pollinated, what records should be kept and what hygiene procedures should be followed.

In July 1998 the *Caladenia behrii* Recovery Team devised a set of hand pollination guidelines for field workers. The guidelines were modified slightly over the subsequent two years. On 12th May 2000 an Orchid Recovery Forum was held at Black Hill, Adelaide and the 50 participants were invited to discuss the guidelines and suggest changes. Participants included National Parks and Wildlife (SA) staff, Plant Biodiversity Centre staff, experienced scientists and government representatives from Western Australia and Victoria, members of the Lofty Block Threatened Orchid Recovery Team, Native Orchid Society (SA) representatives, Threatened Plant Action Group members, university academics and members of various Friends groups. Subsequent to the Forum, discussions were held with scientists and orchidologists at the Fourth Australian Native Orchid conference in Melbourne in October 2000, and at the Native Orchid Ex-situ Conservation conference in Melbourne in November 2000. The protocol presented in this document is the final result of these discussions.

It should be emphasized that hand pollination should only be performed when a population has been observed to be in decline or in danger of extinction, and if pollinators are observed to be scarce. It should also be noted that although the guidelines were first devised for *Caladenia behrii*, they are suitable for other single flowering taxa and *Pterostylis rufa* group taxa that develop an inflorescence of 1 – 10 flowers per stem.

Recommended Guidelines

Monitoring requirements

- Mark the location of all hand-pollinated plants and all pollen donor plants with a stake and flagging tape or similar.
- Allocate a patch number and plant number, *e.g.* Patch B No. 6, to every hand-pollinated plant and pollen donor plant. Use an ID tag written in indelible ink, and place it as close as possible to the base of the plant.
- Record which plants were cross-pollinated, or self-pollinated, and the ID number of the pollen donor.
- Visit the site at least once in the following weeks and record the fate of all tagged plants.
- Monitor plants in subsequent years.
- For taxa covered by the Lofty Block Threatened Orchid Recovery Project, forward the data to the Project Officer.

How many should be pollinated?

This should be determined by the population size. For the purposes of this protocol a population is defined as a group or a number of groups of one taxon that are disjunct (i.e. separated geographically or by a large distance from other groups and therefore highly unlikely to have interaction with other groups). As a general rule of thumb, if there are no other groups or patches of a taxon within 1km, the group or groups are considered to be disjunct, and therefore a distinct population.

Populations with 1 flowering plant

- Pollinate from another population within a 10km radius if pollen is available and if it is feasible to do so.
- If i) is not possible, self-pollinate the flower. For taxa with an inflorescence, pollinate 50%.

Populations with 2 – 20 flowering plants

- Pollinate up to 50% of flowers.
- If little or no pollen is available within the population, pollinate from another population within a 10km radius if pollen is available and if it is feasible to do so.

Populations with 21 – 50 flowering plants

- Pollinate up to 10 flowers.
- Populations with more than 50 flowering plants:
- Pollinate up to 20% of flowers if necessary.

Important notes

- Before considering self-pollination, it is important to know whether the taxon is self-compatible.
- Before introducing pollen from a nearby population, it is important to know whether the species suffers from inbreeding or outbreeding depression.
- Never hand-pollinate the same plant two years in succession.

Hygiene

- Ensure that your hands are clean and free of grease before hand pollinating.
- Use a toothpick or similar implement (e.g. toothpick, twig, yacca frond tip) to remove the pollen from the donor flower. Once the pollen has been placed on the recipient stigma, discard the implement. Never use the same implement twice.
- When hand-pollinating avoid touching the flower as much as possible.

Appendix C: Code of Practice for Bush Care

(Extract from Threatened Plant Action Group (2003), reproduced with author's permission.)

Before Working on a Site

1. Notify the land manager before entering the property.
2. If possible work in sensitive areas when plants are dormant (e.g. orchids) or before seed is set.
3. Work out a "plan of attack" before you start each day's work.
4. Identify any sensitive "no-go" or restricted access areas (e.g. rare plants, orchids). Always look for any native plants at risk and mark or protect them before commencing a spray program.
5. Determine the maximum number of bush-carers that the site can handle.
6. For heavily weed-infested areas, work should be staged over several years to minimise the short-term impact. Staged removal will allow natural regeneration of native vegetation.
7. Choose the most appropriate methods and chemicals for weed control (refer to TPAG (2003), Robertson (2005)).
8. Take local conditions into account (slippery slopes, microphytic crust and weather)

When Working on a Site

1. Avoid trampling native vegetation and making tracks. Minimise the number of times that you cross an area. Wear soft, lightweight shoes and try to tread lightly.
2. Start work in higher value (or least degraded) areas and work towards lesser value (or more degraded) areas.
3. Within each of these areas commence work from the top of site and work systematically down through the bushland.
4. Hand-pull where possible, taking care not to disturb the soil structure. Hand-pull when the soil is damp and weeds can be pulled easily. Lightly tamp down any disturbed soil to prevent re-invasion by weeds.
5. Use "cut and swab[1]" method if hand-pulling is likely to cause too much soil disturbance.
6. When using the cut and swab method target woody weed species before seed is set. Remove any weeds with mature seedpods from the site.
7. Distribute small quantities of weed material evenly across the cleared area; large quantities may have to be removed off site to allow access for follow-up work.
8. Do not drag felled vegetation through the bush; always cut to manageable size and carry out.

Chemical Use

1. Do not spray chemicals if windy, or if raining (or expected to rain in the next 6 hours).
2. Do not use chemicals on very hot days as they will vaporise.
3. Use a marker dye with the herbicide (e.g. Envirodye®)
4. Mark any significant plants at risk, or cover to protect where necessary to avoid off-target spray damage.
5. Treat weeds with herbicide when actively growing for best results.
6. Ensure adequate safety equipment is being used (e.g. gloves, hat, sun-block, face mask and eye protection). Make sure there is a First Aid kit on hand.
7. Ensure Material Safety Data Sheets and product labels for chemicals being used are available at the work site.

[1] Notes on "cut & swab" method:

Apply chemical with shoe-polish applicator within 5 seconds of making the cut to ensure good translocation of the chemical through the plant. (It is best to work in pairs when cutting and swabbing, i.e. 1 "cutter" plus 1 "swabber").

To ensure best results make sure that the cut is close to the ground surface and that all foliage is removed. If necessary, make extra cuts ("frills") into the outer stump to provide more surface area for the chemical to penetrate.

Appendix D: List of Threatening Weeds

Common Name	Species
Bearded Oat	*Avena barbata*
Blackberry	*Rubus* spp.
Boneseed	*Chrysanthemoides monilifera* ssp. *monilifera*
Box Thorn	*Lycium ferocissimum*
Bridal Creeper	*Asparagus asparagoides*
Brome	*Bromus spp.*
Cape Tulip	*Moraea flaccida*
Cleavers	*Galium aparine*
Dog Rose	*Rosa canina*
English Broom	*Cytisus scoparius*
Fescue	*Vulpia* spp.
Freesia	*Freesia* hybrid
Gorse	*Ulex europaeus*
Horehound	*Marrubium vulgare*
Ivy	*Hedera helix*
Montpellier Broom	*Genista monspessulana*
Olive	*Olea europaeus*
Onion-grass	*Romulea sp.*
Perennial Ryegrass	*Lolium perenne*
Phalaris	*Phalaris aquatica*
Pine	*Pinus* spp.
Plantain	*Plantago lanceolata*
Quaking grass	*Briza maxima*
Salvation Jane	*Echium plantagineum*
Soursob	*Oxalis pes-caprae*
South African Daisy	*Senecio pterophorus*
Scarlet Pimpernel	*Anagallis arvensis*
Sparaxis	*Sparaxis bulbifera*
St John's Wort	*Hypericum perforatum*
Sweet Pittosporum	*Pittosporum undulatum*
Thread Iris	*Moraea setifolia*
Three-cornered Garlic	*Allium triquetrum*
Topped Lavender	*Lavendula stoechas*
Tree Heath	*Erica arborea*
Bulbil Watsonia	*Watsonia meriana* var. *bulbillifera*
Wild Oat	*Avena barbata*

Appendix E: Recovery Plan Project Design

Recovery Objectives	Performance Criteria	Recovery Actions
▪ To increase the known extent of occurrence of the species.	→ The extent of occurrence of the species is increased by at least X percent within five years.	→ B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species. → B.2 Search potential habitat for the species, and evaluate habitat suitability. → B.3 Update herbarium and BDSA records for the species. → F.1 Prepare a translocation feasibility assessment for the species. → F.2 Prepare and implement translocation proposals for selected sub-populations. → H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations. → H.4 Prepare or update a fact sheet for the species, and disseminate to the public.
▪ To increase the number of known sub-populations.	→ There are at least X known sub-populations after five years.	→ B.1 Search historical locations for extant sub-populations, and evaluate the suitability of the habitat for the species. → B.2 Search potential habitat for the species, and evaluate habitat suitability. → B.3 Update herbarium and BDSA records for the species. → F.1 Prepare a translocation feasibility assessment for the species. → F.2 Prepare and implement translocation proposals for selected sub-populations. → H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations. → H.4 Prepare or update a fact sheet for the species, and disseminate to the public.

Note: X represents a variable which is quantified for each species in Part B of this plan.

Recovery Objectives	Performance Criteria	Recovery Actions
▪ To maintain or increase the size of each sub-population.	→ All known sub-populations are extant after five years. → At least X percent of sub-populations are increased in size within five years. → At least X sub-populations contain >X mature individuals after five years. → The population size of the species is increased by at least X percent within five years.	→ A.1 Survey the number of flowering plants in each sub-population. → B.3 Update herbarium and BDSA records for the species. → C.1 Control threatening weeds in selected sub-populations. → C.2 Prepare site action plans for selected sub-populations. → C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory. → C.4 Identify and control threatening herbivores. → C.5 Erect fences and remove stock from sub-populations. → C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination. → C.7 Close or re-align inappropriate recreational trails that dissect sub-populations. → D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers. → D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases. → D.5 Develop protocols for track management activities on public land. → D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management. → D.7 Liaise with fire management authorities regarding fire management activities. → F.1 Prepare a translocation feasibility assessment for the species. → F.2 Prepare and implement translocation proposals for selected sub-populations. → G.2 Establish and monitor disturbance trials for selected sub-populations. → H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.

Note: X represents a variable which is quantified for each species in Part B of this plan.

Recovery Objectives	Performance Criteria	Recovery Actions
▪ To maintain or increase the area of occupancy of each sub-population.	→ The area of occupancy of each sub-population is maintained, or increased by at least X percent within five years.	→ A.1 Survey the number of flowering plants in each sub-population. → C.1 Control threatening weeds in selected sub-populations. → C.2 Prepare site action plans for selected sub-populations. → C.3 Cage all plants in small and/or declining sub-populations with high rates of herbivory. → C.4 Identify and control threatening herbivores. → C.5 Erect fences and remove stock from sub-populations. → C.6 Hand-pollinate flowers in sub-populations with low rates of natural pollination. → D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers. → D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases. → D.5 Develop protocols for track management activities on public land. → D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management. → D.7 Liaise with fire management authorities regarding fire management activities. → F.1 Prepare a translocation feasibility assessment for the species. → F.2 Prepare and implement translocation proposals for selected sub-populations. → G.2 Establish and monitor disturbance trials for selected sub-populations. → H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.

Note: X represents a variable which is quantified for each species in Part B of this plan.

Recovery Objectives	Performance Criteria	Recovery Actions
▪ To maintain or improve the quality of habitat critical to survival.	→ The condition of habitat critical to the survival of the species is maintained or improved within five years. → At least X percent of sub-populations are, or are in the process of being, formally protected within the reserve system within five years. →	→ C.1 Control threatening weeds in selected sub-populations. → C.2 Prepare site action plans for selected sub-populations. → C.4 Identify and control threatening herbivores. → C.5 Erect fences and remove stock from sub-populations. → C.7 Close or re-align inappropriate recreational trails that dissect sub-populations. → C.8 Implement hygiene measures to prevent the introduction or spread of *Phytophthora* into habitat. → D.1 Encourage private landholders to enter into Heritage Agreements. → D.2 Encourage public land authorities to dedicate land for conservation purposes under legislation. → D.3 Register all sub-populations that occur within road reserves in the Roadside Significant Sites Database and local government databases, and install Roadside Markers. → D.4 Develop protocols for road management activities, and include in the Roadside Significant Sites Database and local government databases. → D.5 Develop protocols for track management activities on public land. → D.6 Identify all sub-populations that occur within utility easements and develop protocols for utilities management. → D.7 Liaise with fire management authorities regarding fire management activities. → G.2 Establish and monitor disturbance trials for selected sub-populations. → H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations.
▪ To safeguard against the risk of sub-population extinctions.	→ Seed from each sub-population and mycorrhizal fungi associated with the species are preserved in long-term storage within five years.	→ E.1 Collect seed from each sub-population, and preserve *in vitro*. → E.2 Collect and isolate fungi from selected sub-populations, and preserve *in vitro*. → E.3 Undertake *in vitro* seed germination and plant cultivation.
▪ To increase the knowledge of the biology and ecology of the species.	→ There is an increased knowledge of the biology and ecology of the species within five years.	→

Recovery Objectives	Performance Criteria	Recovery Actions
▪ To maintain or increase the level of community participation in the recovery process.	→ At least X private landholders and X public land management authorities are involved in implementing recovery actions for the species during the term of this recovery plan. → At least X community groups and X volunteers are involved in implementing recovery actions for the species during the term of this recovery plan.	→ H.1 Advise all landholders and land management authorities of the location and management requirements of sub-populations. → H.2 Encourage and support landholders, land managers, community groups, and volunteers to participate in the recovery project. → H.3 Include information about the species and the recovery project in media articles, newsletters, journals, websites and presentations. → H.4 Prepare or update a fact sheet for the species, and disseminate to the public.

Note: X represents a variable which is quantified for each species in Part B of this plan.

Appendix F: Summary of Reviews of Previous Recovery Plans

Recovery plans were previously adopted under the EPBC Act for six of the twelve species addressed by this recovery plan. These were reviewed in 2007 as part of an independent review, commissioned by DEH in conjunction with DEWHA, of the efficacy and implementation of threatened species recovery plans in South Australia (Waudby *et al* 2007). The following table summarises the findings and recommendation of the reviews of the recovery plans for each of these six species.

Recovery Plan for *Caladenia argocalla* (White Beauty Spider Orchid) (2000) (adopted under the EPBC Act in 2001)	
Objectives Overall Recovery Objectives 1. Long term: to increase the probability of survival of *Caladenia argocalla* across its range. 2. Medium Term: to prevent decline in area of occupancy, quality of habitat and abundance of *C. argocalla* in the next five years. Specific Objectives 1. Maintain or increase the area of occupancy of the species. 2. Minimise the loss of genetic variability across the species range. 3. Maintain the extent of occurrence of the species. 4. Maintain or increase the abundance of the species. Performance Criteria 1. Extent of occurrence is maintained in the next five years. 2. Populations that currently have less than 5 mature plants are protected from extrinsic threats within one year and increased in size by at least 50 % within five years. 3. The number of mature plants at the main populations (more than 100 mature plants) is maintained or increased in the next five years. 4. Area of occupancy of the main populations is maintained or increased in the next five years. 5. Seed from all known populations greater than one plant is collected and stored within one year to minimise the loss of genetic variability. 6. Available area of quality habitat at the Windermere location increased by 20% within 5 years.	
Summary of Achievements to Date	• 8 new sub-populations discovered since 2000, including 2 relatively large sub-populations, increasing known population size from 490 in 2000 to 4590 in 2006. • Weed control programs implemented at 6 sub-populations since 2000. • Seed collected from 7 sub-populations in 2000 and stored at Botanic Gardens Adelaide. • Flowers hand-pollinated in 6 sub-populations since 2000. • Plant lists and habitat information compiled for all known sub-populations. • All sub-populations monitored annually since 2000. Permanent monitored quadrats established at 6 sub-populations. • Bi-annual recovery team meetings held since 2000. • Plants in 3 sub-populations caged or fenced.
What Was Successful	• Searching for new populations was very effective in improving conservation status (e.g. increasing extent of occurrence, area of occupancy, number of populations & mature plants). • Weed control improved habitat quality especially at Leighton Rd, Emu Flat, and Spring Gully CP. • Caging and fencing decreased herbivory and damage to plants. • Community participation was very successful.
What Was Not Successful	• Caging plants at Spring Gully CP attracted public attention and put the population at risk of trampling and collection. • Seed re-dispersal trials in 2003 did not appear to have resulted in seedling recruitment in 2004-2005. Seed may not have been viable or germination conditions may not have been suitable. • Weed control did not appear to have increased flowering or recruitment. However habitat condition had improved as a result of weeding. Lack of flowering and recruitment was probably a result of drought.
Recommendations for the Recovery Program	1. Search historical and potential habitat for additional sub-populations. 2. Survey and monitor plants in each sub-population. 3. Control threatening weeds and herbivores in selected sub-populations. 4. Prepare a translocation feasibility assessment for *C. argocalla*. 5. Hand-pollinate flowers in selected sub-populations. 6. Install roadside markers and develop guidelines for managing roadside populations. 7. Advise and assist landholders and community groups with the management of populations and habitat. 8. Collect seed and mycorrhizal fungi, and cultivate plants *ex situ*.
Recommendations for the Recovery Plan	Continue to implement the new draft Lofty Block Orchids Recovery Plan.

Pink-lipped Spider Orchid (*Caladenia behrii*) Recovery Plan (1999) (adopted under the EPBC Act in 2001)

Objectives

Overall Recovery Objectives

There is an immediate aim to continue risk management and minimize the likelihood of losing smaller populations, and an ongoing objective to stabilize or increase all populations. The overall objectives are:

1. Long Term: To increase the probability of survival of *C. behrii* across its range.
2. Medium Term: To improve the conservation status of *C. behrii* from Endangered to Vulnerable within five years.

Specific Objectives

The first two specific objectives are necessary for the species to survive, and the last two are directly related to improving the conservation status of *C. behrii*:

1. Maintain the extent of occurrence of the species.
2. Minimize the loss genetic variability across the species' range.
3. Increase the abundance of the species.
4. Increase the area of occupancy of the species.

Performance Criteria

1. The majority of populations that currently have less than 20 mature plants are protected from extrinsic threats within one year, and increased in size by at least 50% within five years.
2. Seed from all known populations is collected and stored within one year to minimize the loss of genetic variability.
3. The total number of mature plants has increased from 1,980 to at least 2,500 within five years, consisting of:
    1. At least five populations with more than 250 mature plants and
    2. At least seven other populations with more than 50 mature plants.
4. The total area of occupancy for the species is increased by at least 5%, from 148 ha to at least 155 ha within five years, with an appreciable increase in range for at least 6 populations.

Summary of Achievements to Date	• Wire cages placed around plants in eight sub-populations since 2000. • Weed control undertaken at three sub-populations since 1999. • Seed collected from 18 sub-populations since 1999. • Since 1998, orchids artificially pollinated in 15 sub-populations. • Seed collected and re-dispersed into 21 sub-populations since 1998. • Kangaroo exclosures erected around four sub-populations in 2001 and 2002. • Extensive searches of known and potential habitat undertaken in 2000, 2001, and 2005; regular monitoring undertaken for some sub-populations.
What Was Successful	Some protection measures have been implemented for the species. The appointment of a permanent and dedicated Threatened Orchid Project Officer has ensured the ongoing management of this species (and many other orchid species).
What Was Not Successful	In terms of the overall objective, it is difficult to ascertain whether the probability of survival has increased for the species at this stage; the apparent decline in the overall population suggests not. A criterion for the overall objective was to downgrade the species' conservation status in 5 years; this criterion has not been achieved and the time-frame was probably not realistic in the first place. The species appears to be experiencing a decline, the cause of which is not clear (though drought conditions are suspected). Monitoring hasn't been extensive enough to make real determinations about what factors may be causing this decline.
Other Comments	The overall objective needed to be more measurable (i.e. a criterion for what constituted increased survival probability was needed) and realistic (in terms of the time-frame for the conservation downgrading).
Recommendations for the Recovery Program	1. Investigate potential causes behind the current decline. 2. Fund the Project Officer's position on a permanent and ongoing basis. 3. Formally adopt the new draft Lofty Block Orchids Recovery Plan and implement the actions it details. 4. Include an assessment of the efficacy of weed control and herbivore exclosure on orchid recruitment.
Recommendations for the Recovery Plan	Adopt the objectives, criteria, and actions delineated by the current draft Lofty Block Orchids Recovery Plan and review the plan in five years.

Recovery Plan for *Arachnorchis macroclavia* (syn. *Caladenia macroclavia*) (Large-club Spider-orchid) (2003) (adopted under the EPBC Act in 2003)

Objectives

Overall Recovery Objective

To ensure that *C. macroclavia* is no longer critically endangered within 20 years (two generations).

Specific Recovery Objectives

1. Minimize the loss of genetic variability across the species range within five years.
2. Resolve taxonomic issues relating to outlying herbarium collections within two years.
3. Maintain or increase the abundance of all sub-populations over the next five years.
4. Halt or reverse the decline in number of locations over the next five years.

Performance Criteria

1. Seed from all known sub-populations greater than one plant is collected and placed in long-term storage by December 2007, to minimize the loss of genetic variability.
2. The taxonomic status of spider-orchids at sites on Eyre Peninsula, at Telowie Gorge and near Karoonda is clarified by December 2004.

3.1. All sub-populations are protected from herbivores by October 2003.
3.2. Weed cover has decreased by 30% at three sites by December 2007.
3.3. All sub-populations contain more mature individuals by September 2007, and at least one sub-population has more than 50 mature individuals within ten years.
4.1. All areas of critical habitat on Yorke Peninsula are searched by September 2007.
4.2. All five confirmed sub-populations remain extant by December 2007 and there are at least six extant sub-populations within 20 years.

Summary of Achievements to Date	• Seed collected from sub-populations at Muloowurtie, Pt Julia, and Pt Vincent in 2005 and stored at the Adelaide Botanic Gardens Seed Conservation Centre. • All plants at Mona, Muloowurtie, Pt Julia, and Pt Vincent protected with wire cages. • Rabbit control undertaken at Muloowurtie in 2005 and at Pt Julia in 2007. • Fences erected around sub-populations at Pt Julia and Pt Vincent in 2005. • Weed control undertaken at Mona, Muloowurtie, and Pt Vincent in 2004, 2005 and 2006. • Individual plants artificially pollinated at Muloowurtie, Pt Julia, and Pt Vincent in 2005. • Searches for *C. macroclavia* undertaken at historical, known, and potential habitat sites in 2004 and 2005. • As a result of liaison with land owners, Heritage Agreement arranged for the sub-population at Pt Julia. • Biannual Recovery Team meetings held since 2003.
What Was Successful	Liaison with landowners who have *C. macroclavia* on their properties has resulted in preparations for a Heritage Agreement for the Pt Julia sub-population; this arrangement has been assisted by the Project Officer's understanding of the needs and priorities of landowners, resulting in good working relations with landowners.
What Was Not Successful	The overall objective has not been met in this instance; the population may have actually decreased. Although numbers may increase in the next 20 years, the increase would probably not be enough to downgrade the species' conservation status since so few individuals are left. The downgrading may be achievable if translocations are undertaken. The fact that all populations are located on council and private lands is not ideal for the conservation of the species because the Recovery Team has less control over the management of orchids in those areas. There have also been difficulties in clarifying the taxonomic status of the species, which has sometimes made it unclear as to whether populations are actually *C. macroclavia*; consequently the population's status may be worse than it appears.
Other Comments	The overall objective was probably based on inadequate baseline data. Having unachievable objectives has hampered the overall success of other orchid recovery programs; future Recovery Plans need to carefully consider whether objectives fit within a 'SMART' framework.
Recommendations for the Recovery Program	1. Clarify the taxonomic status of *C. macroclavia* (future genetic analyses to be undertaken by universities may assist with clarification). 2. Continue to liaise with landowners in regards to the management of *C. macroclavia* populations occurring on their land. 3. Investigate causes behind declines in *C. macroclavia* populations (and threatened orchids in general).
Recommendations for the Recovery Plan	Implement actions designated in the current draft Lofty Block Orchids Recovery Plan and review the Recovery Program's progress in 2012. Continue to assess the priority of implementing certain actions as the Program progresses and as new information becomes available.

Recovery Plan for *Arachnorchis woolcockiorum* (syn. *Caladenia woolcockiorum*) (Woolcock's spider orchid) (2003) (adopted under the EPBC Act in 2003)

Objectives

Overall Recovery Objectives

To secure the status of *C. woolcockiorum* as Vulnerable in the next five years by increasing the total population size to 2500 mature individuals and / or by ensuring that the species remains stable in at least six separate locations.

Since the current distribution of *C. woolcockiorum* is considerably restricted, it is not deemed feasible to attempt to downgrade the conservation status from Vulnerable in the short term. However, the aim of this Recovery Plan is to ensure that known subpopulations are stabilized and increased in size and abundance if possible, and to make certain that an appropriate management regime is implemented at all locations.

Specific Recovery Objectives

1. Minimize the loss of genetic variability across the species range.
2. Maintain or increase the area of occupancy of the species over the next five years.
3. Maintain or increase the abundance of the species over the next five years.
4. Maintain or increase the extent of occurrence of the species over the next five years.

Performance Criteria

1. Seed from all known subpopulations greater than one plant is collected and stored within five years to minimize the loss of genetic variability.
2. The total area of occupancy of the species is not reduced by weed invasion or herbivory over the next five years.

3.1. Track maintenance policies and fire prevention protocols suitable for the species are developed and implemented within five years.

3.2. Subpopulations currently with fewer than five mature plants are protected from extrinsic threats and all sub-populations contain as many or more mature plants after five years.

4. Systematic searches have been conducted annually for five years, for new subpopulations of *A. woolcockiorum* in areas of critical and potential habitat.

Summary of Achievements to Date	• Seed and mycorrhiza collected from three sub-populations in 2005 and stored at the Seed Conservation Centre. • Searches of historical and potential habitat within Mount Remarkable National Park undertaken in 2004, 2005, and 2006. • Liaison with NPWSA staff regarding the location and management of populations near Park tracks effective and conditions to protect orchid populations now included in the contracts of road maintenance contractors. • Considerations for *C. woolcockiorum* included in SA DEH fire and park management plans.
What Worked	Three sub-populations contain more than 750 mature plants, indicating that they are probably stable; however, further monitoring is required to determine population trends. The appointment of an experienced and permanent Project Officer has assisted in the ongoing management of *C. woolcockiorum* and enabled actions to be re-prioritised as new data were obtained. Although some actions were not implemented for this species, in the larger scheme of orchid recovery in SA (the Project Officer is responsible for the management of 12 threatened orchid species in the Lofty Block Region), the *C. woolcockiorum* population is considered relatively stable, and resources, (mainly the Project Officer's time), have been allocated to species that have more pressing needs in terms of recovery actions (for example, *C. macroclavia*). In comparison to the minimal amount of funding provided for the onground recovery of Lofty Block threatened orchids, implementation of recovery actions has been considerable.
What Didn't Work	• The overall objective has not been entirely met. The species' conservation status (Vulnerable) cannot be considered secure. *C. woolcockiorum* population estimated at approximately 5,500 mature individuals in 2006, suggesting that the total population size has increased from the beginning of the 2003 plan; However, the orchid could be considered Critically Endangered based on more recent IUCN criteria (2001). • Monitoring and control of weeds and herbivory was not implemented, largely because these activities were not considered a priority of the Lofty Block Orchid project at the time of the Recovery Plan's implementation. However, as weeds and herbivory have been identified as key threats to the species in the recent draft Lofty Block Orchids Recovery Plan, monitoring at least should be implemented. • Creating more specific and measurable performance criteria would have helped with achieving both specific and overall objectives, as would have been the development of a more long-term overall objective. The time-frame given in the overall objective (population stability achieved in five years) is not suitable to determine the level of population stability. Long-term monitoring would be required before population stability can be inferred.
Other Comments	More efforts should be undertaken to inform the local and wider community of the *C. woolcockiorum* recovery program (i.e. through media articles and the SA DEH website). Such efforts may assist in developing community support and a sense of responsibility for *C. woolcockiorum* and for threatened orchid recovery programs in general.

Recovery Plan for *Arachnorchis woolcockiorum* (syn. *Caladenia woolcockiorum*) (Woolcock's spider orchid) (2003) (adopted under the EPBC Act in 2003)	
Recommendations for the Recovery Program	1. Continue monitoring sub-populations for the impacts of threatening processes (particularly weed invasion) and implement procedures to mitigate the effects of these processes where necessary. 2. Continue liaison with NPWSA and track management contractors in regard to considering orchid requirements when implementing track maintenance or fire management and assist with developing track management protocols for NPWSA staff. 3. Conduct further searches for *C. woolcockiorum* in critical habitat areas.
Recommendations for the Recovery Plan	Implement actions as designated by the draft Lofty Block Orchids Recovery Plan and review the recovery program's progress in 2012.

Recovery Plan for *Pterostylis despectans* "Mt Bryan" (Lowly Greenhood) (2000) (adopted under the EPBC Act in 2004)	
Objectives <u>Overall Recovery Objectives</u> To increase the probability of survival of *Pterostylis despectans* in South Australia. <u>Specific Objectives</u> 1. Increase the abundance of the species. 2. Maintain or increase the area of occupancy in South Australia. 3. Minimise the loss of genetic variability of the South Australian population. Preventing the extinction of *P. despectans* (Mt Bryan) will help to maintain the overall national extent of occurrence of *P. despectans*. Preventing the extinction of the species in Victoria will also contribute to this objective. <u>Performance Criteria</u> 1. The South Australian population of *P. despectans* (Mt Bryan) is increased to at least 250 mature plants within five years. 2. The area of occupancy of the species in South Australia is at least one hectare in five years. 3. Seed from the South Australian population is collected and stored within two years.	
Summary of Achievements to Date	• 3 new sub-populations discovered, including 2 large sub-populations, increasing population size from 130 mature plants in 2000 to 1320 in 2006. • Seed collected from all sub-populations. • Flowers hand-pollinated since 2000. • All sub-populations fenced-off to exclude sheep. • All sub-populations monitored annually since 2000. Surveys have also contributed to the increase in the number of known plants. • Bi-annual recovery team meetings held since 2000. • Weeds controlled in 2 sub-populations.
What Was Successful	• Searching for new populations has been very effective in improving the conservation status (e.g. increasing extent of occurrence, area of occupancy, number of mature plants). • Fencing off area to exclude sheep has improved habitat condition and reduced herbivory. • Surveys and monitoring has increased the number of known plants and the area of occupancy. • Landholder and community participation has been good.
What Was Not Successful	• Hand-pollination and seed collection has proven to be difficult. However, techniques have improved, allowing seed to be collected. No seed has been re-dispersed due to drought conditions.
Recommendations for the Recovery Program	1. Search historical and potential habitat for additional sub-populations. 2. Survey and monitor plants in each sub-population. 3. Control threatening weeds and herbivores in selected sub-populations. 4. Prepare a translocation feasibility assessment for *P. despectans*. 5. Hand-pollinate flowers in selected sub-populations. 6. Install roadside markers and develop guidelines for managing roadside populations. 7. Advise and assist landholders and community groups with the management of populations and habitat. 8. Collect seed and mycorrhizal fungi, and cultivate plants *ex situ*.
Recommendations for the Recovery Plan	Continue to implement the new draft Lofty Block Orchids Recovery Plan.

Halbury Greenhood (*Pterostylis* 'Halbury') Recovery Plan (2000) (adopted under the EPBC Act in 2001)

Objectives

Overall Recovery Objectives

1. Medium Term: To improve the conservation status of *Pterostylis* 'Halbury' from Critically Endangered to Vulnerable within ten years.
2. Long Term: To increase the probability of survival of *Pterostylis* 'Halbury'.

Specific Objectives

1. To maintain the area of occupancy of the species.
2. To improve the quality of habitat of the only known population of the species.
3. To maintain or increase the abundance of the species.
4. To minimise the loss of the species' genetic variability.

Performance Criteria

1. The known area of occupancy is at least its current level of 5 hectares in five years. The species still occurs in sections 409, 411, 706, 710 and 712 Hundred of Hall in ten years
2. At least 50% of the bridal creeper *(Asparagus asparagoides*) and / or soursobs (*Oxalis pes-caprae*) currently found in Sections 409 and 706 of Halbury parkland are removed within five years.
3. The damaging activities of ploughing, bike riding and dogs have been excluded from Sections 409, 706, 710 and 712 within five years.
4. All of the large items of rubbish found within Sections 409 and 706 are removed within one year without further damage to vegetation.
5. The total number of mature plants is at least its current level of 800 - 1000 in five years.
6. Seed from each of the land parcels on which the species occurs is collected and stored within one year.

Summary of Achievements to Date	• Weed control undertaken regularly at Halbury Parklands by various groups since 2000. • A number of community, non-government, and government groups have collaborated or assisted in implementing the recovery process. • Herbivory control implemented in the form of rabbit-proof fences erected around two sites in Halbury Parklands and in the form of rabbit baiting undertaken by the Friends of Halbury Parklands in 2005. • Seed and mycorrhiza collected from sub-population 1 and stored at the Adelaide Botanic Gardens. • Vegetation Management Plan for Halbury Parklands developed by Robertson and Bickerton in 2002. • Annual monitoring of *Pterostylis* 'Halbury' and weed densities undertaken since 2000; permanent quadrats established in 2004 to monitor the population dynamics of *Pterostylis* 'Halbury'.
What Was Successful	Most of the actions have been implemented. In particular, weeding and herbivore control efforts appear to have been successful, probably because they have been implemented in a strategic and regular manner. The formation of a Friends group for Halbury Parklands has probably helped considerably in garnering local support for the recovery process and has given assistance for management of the orchid in Halbury Parklands.
What Was Not Successful	Rabbit control programs have had limited success and probably need to be implemented over a larger area.
Recommendations for the Recovery Program	1. Implement actions as outlined in the new draft Lofty Block Orchids Recovery Plan. 2. Undertake monitoring of the efficacy of weed/herbivore control actions.
Recommendations for the Recovery Plan	Continue to implement the new draft Lofty Block Orchids Recovery Plan.

For further information please contact:

Department for Environment and Heritage
GPO Box 1047 Adelaide SA 5001
Telephone: (08) 8124 4900 Fax: (08) 8214 4920 Website:
www.environment.sa.gov.au

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