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Recovery Plans for three orchid species in South Australia and Victoria:

Caladenia richardsiorum (Little Dip Spider-orchid)
Caladenia calcicola (Limestone Spider-orchid)
Pterostylis tenuissima (Swamp Greenhood)

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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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Copies of this Recovery Plan are available for comment at:

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and from:

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Abbreviations

CCMA	Corangamite Catchment Management Authority
CP	Conservation Park
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVRFASC	Commonwealth and Victorian Regional Forest Agreement Steering Committee
DEH	Department for Environment and Heritage South Australia
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
DPIFM	Department of Primary Industries, Fisheries & Mines, Northern Territory
DSE	Department of Sustainability and Environment, Victoria
DWBLC	Department of Water, Biodiversity, and Land Conservation
EPBC Act	*Environment Protection and Biodiversity Conservation Act,* 1999.
EVC	Ecological Vegetation Class
FFG Act	Flora and Fauna Guarantee Act
GHCMA	Glenelg Hopkins Catchment Management Authority
GIS	Geographical Information System
IBRA	Interim Biogeographic Regionalisation of Australia
IUCN	International Union for Conservation of Nature
NHV	National Herbarium of Victoria
NOSSA	Native Orchid Society of South Australia
NPW Act	*National Parks and Wildlife Act* 1972
NPWSA	National Parks and Wildlife South Australia
PPWCMA	Port Phillip and Westernport Catchment Management Authority
PV	Parks Victoria
RBG	Royal Botanic Gardens, Melbourne, Australia
SENRCC	South East Resource Consultative Committee
SHSA	State Herbarium of South Australia
SPRAT	Species Profile and Threats
TPAG	Threatened Plant Action Group
VROTPop	Victorian Rare or Threatened Population Database

Definitions

The term "subpopulation" is used as defined in the IUCN categories (IUCN 2001). Sub-populations are defined as "*geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)*" pp. 10. The term "population" has not been used to describe geographically distinct populations, as under IUCN categories "population" is described as "*the total number of individuals in a taxon" (*IUCN 2001, pp.10).

The term "Heritage Agreement" is applicable only in South Australia. It refers to a legal agreement attached to the title for a piece of privately owned land. The agreement protects existing native vegetation from clearance or stock grazing.

Introduction

Outline

The nationally Endangered *Caladenia richardsiorum* (Little Dip Spider-orchid) and nationally Vulnerable *C. calcicola* (Limestone Spider-orchid) and *Pterostylis tenuissima* (Swamp Greenhood) are small terrestrial orchids, which have highly fragmented and isolated sub-populations. *Caladenia richardsiorum* is endemic to the coastal vegetation of South East, South Australia, with an approximate population of 8,000 individuals occurring across 40 sub-populations. *Caladenia calcicola* consists of only 277 recorded individuals across 8 sub-populations, which occur predominantly near Portland and Nelson, Victoria. In contrast, *P. tenuissima* has a relatively wide distribution, occurring in Silky Tea-tree (*Leptospermum lanigerum*) Scrub from near Robe in South East, South Australia, through to Wilson's Promontory National Park in eastern Victoria. There are approximately 17,700 individual *P. tenuissima* distributed across 57 sub-populations. Although there are a high number of sub-populations of both *C. richardsiorum* and *P. tenuissima*, only seven and nine sub-populations respectively, occur on land reserved for conservation.

Planning for threatened taxa listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is undertaken primarily through the compilation of national recovery plans. Information in these plans includes details regarding the taxonomy, ecology and distribution of the species. It also outlines the current and potential threatening processes acting on sub-populations, as well as the existing and intended management actions required to prevent the further decline of the species. Recovery plans should address specific criteria as outlined in the Act. These objects of the Act are listed below.

Objects of the *Environment Protection and Biodiversity Conservation Act 1999.*

In developing a plan consideration must be had to the objects of the Act, which are:

"*a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and*

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

c) to promote the conservation of biodiversity; and

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

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

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

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

[s3(1)]

International Obligations

The three orchid species covered in this plan are not subject to any international agreement. As such, Australia's responsibilities as they relate to environmental protection are not affected by this plan. The implementation of this Recovery Plan is consistent with the following international agreements:

1992 United Nations Convention on Biological Diversity

1992 Rio Declaration on Environment and Development (Agenda 21)

Affected Interests

Sub-populations for all three species occur on a variety of land tenure, including parks and reserves, unreserved public land (such as roadsides) and private land. A range of land managers are involved in managing these areas and include DEH, DSE, Parks Victoria, Catchment Management Authorities, District Councils, Shires and private landholders. Further details of land managers and associated sub-populations are outlined in Part A in each of the three Recovery Plans.

Land managers and other affected interests have been invited to comment on the plan prior to it being nationally endorsed. This plan has the support of government agencies, statutory authorities and community groups involved in orchid conservation in Victoria and South Australia.

Role and Interests of Indigenous People

Consultation with the relevant South Australian indigenous groups has been undertaken by Aboriginal Partnerships, DEH. Victorian indigenous communities involved in the region affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Social and Economic Impacts

Sub-populations for all three species occur on both private and crown land. Actions outlined in this plan are unlikely to significantly affect any party unfavourably, either socially or economically. Recovery actions outlined in this plan on public land will occur after negotiation with the relevant public land manager. It is not anticipated that any commercial or recreational activities will be adversely affected by implementing any recovery actions (e.g. track closures, fencing or signage). Most sub-populations covered by this multi-species recovery plan occur on private land. Where applicable, voluntary agreements will be sought with private landholders to secure protection for sub-populations.

Description of the Region

The region covered by these plans is predominantly described by two Interim Biogeographic Regionalisation for Australia (IBRA) bio-regions; 1) the Naracoorte Coastal Plain, stretching across from the Coorong in the South East of South Australia to Portland in South West Victoria, and 2) the South East Coastal Plain, which occurs in three distinct segments, two of which, the Warrnambool Plain and Otway Plain, occur in the context of this plan. The remainder of the region covered by the plans includes the eastern section of the Victorian Midlands, extending from the South Australian border to the Great Dividing Range's lower inland slopes, and the eastern section of Victorian Volcanic Plain, which in its entirety stretches from Portland to west Melbourne.

The Naracoorte Coastal Plain consists of a series of low coastal and inland dunes that run parallel to the present coastline (Environment Australia 2000). The calcarenite inland dunes were formed from marine sands and shell fragments that were subsequently consolidated into limestone. Low-lying flats which lie between the ancient dunes were once seasonally inundated, forming extensive wetlands that covered much of the region (Environment Australia 2000). These areas have been significantly altered through drainage and agricultural development.

The Warrnambool Plain is characterised by low calcareous dune formations overlayed with nutrient poor soils, which terminate in distinctive coastal cliffs along the coastline (Environment Australia 2000). Similar to the Naracoorte Coastal Plain, fertile peat swamplands exist between the calcareous dunes, which are seasonally inundated. To the east of Warrnambool the land is dominated by deeper volcanic soils over limestone (Environment Australia 2000). The Otway Plain consists of river valleys, coastal plains and foothills. Much of the native vegetation of these regions has also been cleared for agriculture.

The Victorian Midland is defined by isolated ranges and sloping foothills of the Great Dividing Range, which supports a variety of sclerophyll forests and woodlands. The Victorian Volcanic Plain supports extensive and fertile grassland over a gently undulating basaltic plain, occasionally interrupted by large shallow lakes, stony rises, and low volcanic peaks of extinct volcanoes (Environment Australia 2000). Similar to the other bioregions encompassed in this plan, the Volcanic Plains have been intensively used since European settlement for grazing and cropping purposes.

Relationship to other Management Documents for the States and Regions

This recovery plan relates to a range of other regional, State and Federal documents that provide specific recommendations or regional objectives regarding to the management of threatened species.

In South Australia this recovery plan helps meet the objectives of the *State Natural Resources Management Plan* 2006 (DWLBC 2006), which requires the adoption of relevant policies from *No Species Loss – A Biodiversity Strategy for South Australia* (DEH 2006). This plan contributes to the priority targets of the *No Species Loss Strategy* by eradicating or halting significant threats at priority threatened species sites; reassessing the conservation status for priority threatened species; and securing key populations of priority threatened species.

The *Biodiversity Plan for the South East of South Australia* (Croft *et al.* 1999) discusses the importance of conserving a range of threatened species in the region including *Caladenia richardsiorum* and *Pterostylis tenuissima*. The report recommends undertaking surveys to determine their extent as well as identifying threats to sub-populations and preparing recovery plans for these species.

Croft *et al.* (1999) also recognises biologically significant habitat in the region. This includes the highly threatened Silky Tea-tree (*Leptospermum lanigerum*) Scrub in which *P. tenuissima* occurs. Silky Tea-tree Scrub is listed as Endangered under the South Australian Provisional List of Threatened Ecosystems (DEH 2001). Management recommendations include fencing and de-stocking remnant vegetation, encouraging regeneration and reinstating natural hydrological regimes to these communities. The Biodiversity Plan also recognises coastal systems and prioritises specific coastal areas including *C. richardsiorum* habitat at Little Dip and Beachport CP. The plan opposes the continued subdivision and urban development at sites containing coastal vegetation.

Resource condition and management action targets for South East South Australia are outlined in the *South East Natural Resource Management Plan* (SENRCC 2003). The plan endorses the implementation of national recovery plans and recognises their role in the management of threatened species and priority ecosystems.

The Victorian *West Victoria Comprehensive Regional Biodiversity Assessment* (CVRFASC 2000) provides an overview of the biodiversity of the region. The document identifies 63 plant taxa of high regional priority for management, including *Caladenia calcicola*.

In Victoria, natural resources management is addressed on a regional basis through Regional Catchment Strategies that identify threats to native vegetation and associated management priorities. *Pterostylis tenuissima* and *Caladenia calcicola* occur in the Glenelg Sub-catchment of the Glenelg Hopkins Catchment and the West Gippsland Catchment. *Pterostylis tenuissima* also occurs in the Corangamite, Port Phillip and Westernport Catchments in Victoria. *P. tenuissima* also occurs in other catchments in Victoria, however, they are not discussed in this plan. Similarly, *Caladenia calcicola* occurs in other catchments in Victoria, however, as with *P. tenuissima* they are also not discussed in this plan.

The *Glenelg Hopkins Regional Catchment Strategy* (GHCMA 2003) recognises the high number of threatened plant species in the Lower Glenelg, and Portland Coastal sub-catchments in comparison to other sub catchments in the region. The strategy also sets out Interim Resource Condition Targets that aim to double the cover of depleted Ecological Vegetation Classes (EVCs) by 2030. This is significant as all three species are found in highly threatened ecological communities. *Pterostylis tenuissima* is primarily found in the highly threatened Swamp Scrub, *Caladenia calcicola* in the Damp Sands Herb-rich Woodland /Grassy Woodland, and *C. richardsiorum* in Dryland Tea-tree-Drooping Sheoak (*Allocasuarina verticillata)* low woodland. Swamp Scrub is referred to as Silky Tea-tree Scrub in South Australia and herein will be referred to as Silky Tea-tree Scrub to avoid confusion. The habitats of *P. tenuissima* and *C. calcicola* have been given the bioregional conservation statuses of Endangered and Vulnerable respectively (A. Oates *pers. comm*. 2004) and the habitat of *C. richardsiorum* is regionally assessed as Endangered in South Australia (Croft *et al.* 1999).

The *Corangamite Regional Catchment Strategy* 2003 identifies Silky Tea-tree Scrub (Swamp Scrub) as a priority EVC. The plan endeavours to protect 2,500 hectares of high priority Silky Tea-tree Scrub remnant vegetation on private land by 2007. Whilst this plan does not identify key actions for the Port Phillip Regional Catchment, the Port Phillip and Western Port Regional Catchment Strategy (PPWCMA, 2004) recognises Silky Tea-tree Scrub as one of the 14 EVCs with less than 10 percent of

their original coverage remaining. Biodiversity targets outlined in the strategies plan to reduce the number of threatened flora species with no further regional extinctions. This will be achieved by carrying out on-ground actions, monitoring threatened species populations and conducting research. The strategy recognises the importance of Regional Biodiversity Action Plans, National Recovery Plans and State Action Statements in the planning of threatened species recovery.

Storage of Spatial and Other Data

Data relating to the location and management of threatened species and communities is stored in a range of information systems within the Department for Environment and Heritage (DEH) and the Department of Sustainability and Environment (DSE).

In South Australia, DEH curates the Herbarium Database, Florlist and the Threatened Plant Species Population Database, Reserves Database and Survey Database. These enable threatened flora survey and monitoring data to be recorded and accessed by departmental staff. A regional relational-database is currently under construction in South East South Australia and will store more detailed information including monitoring data as well as having a mapping capability.

The Victorian Rare or Threatened Population Database (VROTPop), curated by DSE, stores similar monitoring data. 'Biosites', is another Victorian system that provides site data including land tenure, land managers, threatening processes as well as references to associated projects and literature. Threatened orchid data is also stored on the Flora Information System and in DSE's Corporate Library in the form of GIS layers. The ABC Information System stores specific management information that enables DSE officers to identify management requirements for threatened species and undertake recovery planning.

Data relating to habitat critical to the survival of the species outlined in this plan is stored on these information systems as well as departmental files. Data collected through the implementation of this recovery plan (including critical habitat descriptions) will be added to these databases.

Site Confidentiality

The impacts of excessive visitation and illegal orchid collection, although infrequent, remains a high risk to threatened orchid taxa where population sizes have become very low or where the habitat is very sensitive to trampling. As a result, data relating to exact site locations have been withheld in this document and are stored in confidential appendices, departmental files and on the information systems described above.

Threats Common to All Three Species

The region provides a wide range of opportunities for primary production. Predominant land use includes grazing, cropping, viticulture and forestry. In South East, South Australia, 87% of the original native vegetation has been cleared and the majority of wetlands drained for these purposes. Given its coastal setting, tourism also plays an important role in the regional economy. Coastal development and inappropriate subdivision continues to have a significant impact on coastal ecosystems in South Australia and Victoria (Department for Environment and Heritage 2004; Victorian Coastal Council 2002). As a result, much of the existing habitat occurs in small isolated fragments, particularly in South East South Australia.

The most serious threats to native vegetation therefore include clearance of habitat and their subsequent fragmentation and isolation; grazing by domestic, native and introduced fauna; invasion by non-indigenous plants; as well as altered hydrological regimes and inappropriate fire regimes (Croft *et al.* 1999).

Vegetation Clearance

Clearance of native vegetation still remains a significant threat to biodiversity in the region. The Silky Tea-tree Scrub (Swamp-Scrub) habitat of *Pterostylis tenuissima* is mostly distributed across prime agricultural land and as a result continues to be threatened by clearance and grazing. *Caladenia richardsiorum* and *C. calcicola* habitats are still subject to potential grazing and clearance, however much of their habitats now occur within the Reserve System and as such are comparatively protected from illegal clearance.

Fragmentation and Isolation of Native Vegetation

Australian terrestrial orchids typically depend on specific pollinators and mycorrhizae (soil root fungi). *Caladenia* and *Pterostylis* species do not support their pollinators with food rewards and as a result these pollinators require other plant species for their food supply (Bates & Weber 1990).

Little research has been undertaken regarding the specific ecological needs of orchid mycorrhizae; however it is believed that *Caladenia* and *Pterostylis* species are dependent on these fungi for nutrient exchange, particularly during germination (Bates & Weber 1990). It is also known that that both *Caladenia richardsiorum and C. calcicola* each have a highly specific relationship with a male thynnid wasp pollinator (family Tiphiidae, sub-family Thynninae) (Bower 2007), which is required for successful reproduction. Threatening processes can lead the required fungi and pollinator species to become locally extinct, which in turn leads to the local extinction of the associated orchid species. Subsequently, the orchid taxa discussed in this recovery plan require intact vegetation in order to maintain these complex relationships. The edge effects associated with fragmentation and isolation of vegetation are likely to lead to a decline in habitat condition, causing flow-on effects to mycorrhizae and pollinators.

Grazing

Some *Caladenia richardsiorum* and *Pterostylis tenuissima* sub-populations occur on private property and are subject to the impacts of grazing by stock. Orchids can be preferentially grazed due to their palatability. Associated damage to habitat from grazing such as soil compaction, altered nutrient levels and erosion can also significantly compromise the likelihood of survival of a sub-population. Disturbance caused by grazing can also result in increased weed invasion particularly by pasture species.

Grazing by sheep currently threatens one of the largest *C. richardsiorum* sub-populations at Nora Creina. As this site is privately owned, ongoing negotiations with the owner are critical.

Pterostylis tenuissima colonises very moist soils under dense Silky Tea-tree (*Leptospermum lanigerum),* sometimes only millimetres above the water table. These waterlogged soils tend to be very soft and easily damaged. As such, grazing can damage the orchid's sensitive microhabitat by pugging these soils, crushing and / or submerging plants.

Grazing by Eastern Grey Kangaroos (*Macrocarpus giganteus*) and Emus (*Promaius novaehollandiae)* has been observed in *Caladenia calcicola* habitat. These herbivores can remove or trample orchid biomass that may prevent flowering and photosynthesis ultimately exhausting the energy reserves of orchid tubers (Croft *et al.* 1999). Emus have removed tags and pins at *Caladenia calcicola* sub-populations and may cause associated damage to individual plants as a result (A. Pritchard *pers. obs. 2004)*. Grazing by rabbits appears to be a significant threat to *Caladenia richardsiorum* on private land. Warren construction and diggings can also threaten orchid populations.

Environmental Weed Invasion

A large number of orchid sub-populations listed in this Recovery Plan are subject to weed invasion. Weed invasion is the most serious threat to *Caladenia richardsiorum.* Weeds of particular concern to all orchid species include Bridal Creeper (*Asparagus asparagoides*), "Western Cape" form of Bridal Creeper, Myrtle-leaf Milkwort (*Polygala myrtifolia*), Bluebell Creeper (*Billardiera heterophylla),* Italian Buckthorn (*Rhamnus alaternus*), Blue Periwinkle (*Vinca major*), Freesia (*Freesia* sp.) and Arum Lily (*Zantedeschia aethiopica*).

Bridal Creeper and the recently recognised "Western Cape" form pose the greatest threat of any weed in South-East South Australia (Croft *et al.* 1999). It has a climbing habit and stores its energy in numerous underground tubers. Bridal Creeper smothers trees, shrubs and ground covers and is capable of preventing light from reaching herbs and geophytes such as orchids. Bridal Creeper reproduces both sexually and vegetatively, making its management extremely difficult. The introduction of pathogenic rust as a biological control has had some success. The rust can limit flowering, seed set and plant biomass by reducing the plant's photosynthetic surface (DWLBC 2006). The "Western Cape" form has been found to be resistant to all biological controls, except possibly at seedling stage, which suggests that the Western Cape form has the potential to displace Bridal Creeper affected by biological controls (DWLBC 2006). Bridal Creeper has invaded large tracts of coastal vegetation at Robe and in Little Dip and Beachport Conservation Parks and Coorong National Park, threatening sub-populations in these areas. It may have eliminated another sub-population of

Caladenia richardsiorum in this region (D Jones *pers. comm*. 2001). The level of infestation is so great at some sites that further control is restricted given current government resources.

Coast Wattle (*Acacia longifolia* var. *sophorae*), an Australian species of debated natural distribution, has spread extensively across the coastal regions of South West Victoria and South East South Australia and threatens all orchid species discussed in this plan. Its growth is dense and its presence appears to be detrimental to the survival of ground flora. Research has found a significant decline in understorey diversity of native species following invasion by Coast Wattle (McMahon *et al.* 1996). The wattle has also been known to compromise the survival of other threatened orchids in the region (Carr 1993).

The South African Orchid, *Disa bracteata,* is a potential threat to *C. calcicola* populations given their close proximity to pine plantations where the species has formed heavy infestations. Due to its relatively low profile, little is known of the ecological impact to threatened orchid populations by this species. Research is required to identify such impacts as well as measures to manage outbreaks.

Inappropriate Fire Regimes

Whilst studies have investigated the response of terrestrial orchids to fire in native grasslands (Lunt 1994, Coates *et al.* 2006), the role of fire ecology for many spider-orchids and greenhoods is not well understood. However, it is likely to be an important factor, particularly for spider-orchids, which have been observed to flower strongly post-fire, e.g. *C. dilatata.* and *C. hastata* in South West Victoria (A Pritchard *pers. obs*. 1997 & 2002, respectively). In Mediterranean climates, such as southern Australia, fire is important in maintaining many ecosystems in which orchids are known to occur (Roberts 2003). Fire creates more open space, thereby increasing light availability, releases photoactive materials such as ethylene, and provides a burst of nutrients (Roberts 2003). Brundrett (2007) comments that in South West Western Australia altered fire regimes in semi-urban and rural areas, in combination with other threats, are known to be contributing to the decline of terrestrial orchids.

Timing and frequency of fires is particularly important as it stimulates different responses from different species of terrestrial orchids. Summer fires have been observed to produce the strongest post-fire flowering events, including in *Caladenia* (Jones 2006). It is reasoned the best time for a burn to occur in *Caladenia* populations is late summer to early autumn, after seed dispersal but prior to new shoot growth (Duncan & Coates 2007). For the above reasons, fuel reduction burns conducted in spring and autumn are considered to be threatening process for many orchid species.

Caladenia richardsiorum, C. calcicola and *Pterostylis tenuissima* do not require fire to flower, and the latter is found in wet habitat rarely subjected to fire. Inappropriate fire regimes may threaten all three species. Further research is needed into habitat burning requirements and how various regimes influence the recruitment of these three orchid species.

Currently little attention is given to the impact of fire on orchid pollinators when planning fire regimes for threatened orchids. The knowledge of invertebrate response to fire in Australia is limited, and is complicated by the variability of invertebrate populations through time in response to many environmental factors which may override the changes seen post fire (Friend 1994). Friend (1994) recommends caution when planning fire regimes in reference to invertebrates, highlighting that post-fire invertebrate populations do not necessarily return to pre-fire levels and that invertebrate populations in mesic conditions are particularly sensitive to fire disturbance. It is thought that fire is generally not detrimental to thynnid wasp pollinators whilst they are dormant (December to July), however, little is known about thynnids and their relationship with fire (C. Bower *pers. comm.* 2007, G. Brown *pers. comm.* 2007). No information is known regarding the potential impact of fire regimes on the pollinators of *Pterostylis* species.

Inappropriate fire regimes also have the potential to impact on orchid mycorrhizae by changing the conditions in which they grow. Orchids and their mycorrhizae have been found to have a strong relationship with soil texture, coarse organic matter and leaf litter (Brundrett *et al.* 2003). Brundrett (2007) highlights that this relationship requires further investigation as frequent fire, as experienced in Western Australia, has the potential to reduce the amount of coarse organic material and leaf litter that mycorrhizae and orchids rely on as a key resource.

Recovery Plan Objectives

The primary objective of the Recovery Plan is to minimise the likelihood of extinction of all three species. This will be achieved through the process of recovery by ensuring that the most viable sub-populations across the range become self-sustaining.

Recovery of these species will be achieved through the implementation of a range of the following objectives and demonstrated by the associated performance criteria.

1. Acquire accurate information for conservation status assessments.
2. Identify critical, common and potential habitat to orchid and pollinator.
3. Conserve targeted sub-populations on private land.
4. Manage threats to sub-populations.
5. Determine growth rates and viability of sub-populations.
6. Develop and undertake fine-scale site management practices.
7. Establish/maintain sub-populations in cultivation.
8. Establish new and re-stock sub-populations from cultivated plants or seed stock
9. Build a network of government and non-government organisations and individuals.
10. Cooperate in bioregional policy implementation and manage recovery plan implementation.

Photo Credit: Andrew Pritchard

Recovery Plan for *Caladenia richardsiorum*, (Little Dip Spider-orchid).

Part A: Species Information and General Requirements

Nomenclature

This plan uses the current nomenclature in South Australia and Victoria for *Caladenia richardsiorum* (Little Dip Spider-orchid) and follows the authority of Jones (1991). The taxonomic review of the genera *Caladenia* by Jones *et al*. (2001) has resulted in the nomenclature change of *Caladenia richardsiorum* to *Arachnorchis richardsiorum*; however this review is yet to be accepted by any State Herbarium in Australia. Until such a change is accepted by the State Herbarium of South Australia (SHSA) and National Herbarium of Victoria, Melbourne (NHV) the former nomenclature remains.

Taxonomic Description

Caladenia richardsiorum is a perennial spider-orchid with a lanceolate leaf 16-22 cm in length and densely hairy on both laminae. Its generally singular yellowish-green flower, up to 40 mm wide, arises from a stem 20-40 cm in length. Sepals have prominent blackish clubs 8-10 mm long. The labellum is greenish-cream with maroon calli and toothed margins. Flowering occurs from late September to early November, remaining dormant when conditions are unsuitable (Jones 1991).

Caladenia richardsiorum has affinities with *C. hastata,* a Critically Endangered species, occurring within the Victorian section of the region covered by these plans. *C. hastata* can be distinguished by a much smaller leaf, whiter flower, and slimmer sepals and petals that both possess osmophores (Jones 1991).

Conservation Status

Caladenia richardsiorum is listed as Nationally Endangered under the Commonwealth *EPBC Act*, and as Endangered in South Australia under the *National Parks and Wildlife Act* 1972 (NPW Act). An assessment under the IUCN Red List Categories and Criteria ranks the species as Endangered: EN B1b(i, v)c(iv) (Table 1).

Table 1. IUCN Red List Criteria for *Caladenia richardsiorum*

IUCN Criteria	Justification
EN B1	It has an extent of occurrence of less than 5,000 km^2.
EN B1b(i)	There is a projected continuing decline in extent of occurrence.
EN B1b(v)	There is a projected continuing decline in number of mature individuals.
EN B1c(iv)	There are extreme fluctuations in the number of mature individuals.

Ecology

Mycorrhizae

Caladenia species are generally found growing in association with the mycorrhizal fungus *Sebacina vermifera* (Warcup 1971, 1981, 1988) or closely related fungi (Huynh 2003, Raleigh 2005, Bougoure *et al.* 2005, Bonnardeaux *et al.* 2007, Wright 2007). Orchids require the infection of an appropriate mycorrhizal fungus to germinate under natural conditions (Rasmussen 1995). This association continues into adulthood, with the mycorrhizal fungus supplying the orchid with carbon and nitrogen (Brundrett 2002, Cameron *et al.* 2006, Girlanda *et al*. 2006). The obligate nature of their mycorrhizal associations makes them vulnerable to extinction (Rasmussen 1995), therefore, identification and subsequent mapping of suitable fungi is essential in the process of threatened orchid recovery. Currently the mycorrhizal fungi have not been isolated for *C. richardsiorum* however techniques for isolating mycorrhizal fungi for the propagation of *Caladenia* species are well established.

Pollination

In the spring of 2000, most sub-populations were known to be naturally pollinated and producing seedlings. The pollination rate at Nora Creina was estimated to be around five percent.

Pollination of *Caladenia richardsiorum* is primarily achieved by male thynnid wasps (family Tiphiidae, sub-family Thynninae), as is also the case for other *Caladenia,* Section *Calonema* species. Orchids in this group are thought to mimic the sexual pheromone produced by a female thynnid wasp, emitting a kairomone or allomone from the glandular tip of their sepals to attract the male wasp (Stoutamire 1983). As the male wasp attempts to copulate (pseudocopulation) with the labellum, it collects the sticky pollinia on its body which is then transferred to the stigma of another flower (Stoutamire 1983). *Caladenia* pollinated by sexual deception have a highly specific, usually one to one, relationship with their wasp pollinator (Bower 1992). Sexually deceptive *Caladenia* are usually odourless, with dull yellow, green, maroon, or cream and maroon flowers, with maroon calli and a hinged labellum (Stoutamire and Bates 1990).

In 2006, pollinator baiting was conducted to identify the wasp pollinator of *Caladenia richardsiorum.* Initially the pollinator was identified as *Phymatothynnus* near *pygidialis* which was also found to pollinate the morphologically distinct *Caladenia fragrantissima* in South West Victoria (C. Bower *pers. comm*. 2007, G. Brown *pers. comm.* 2007). However, field pollinator choice tests have shown that two different but morphologically similar wasps respond assertively to the two orchids, suggesting the wasps have different sex pheromones and the orchids have different allomones, which indicates the wasps are likely to be a pair of closely related cryptic species (C. Bower *pers. comm*. 2007). The wasp species attracted to *C. richardsiorum* was found to be relatively common in South West Victoria (C. Bower *pers. comm.* 2007). It is currently assumed that the pollinator is also relatively common in South Australia as there is a comparatively good pollination rate at most sub-populations. The pollinator abundance will be confirmed in future pollinator baiting trials. Based on the results of field trials and the pollination rate at natural sub-populations it is considered unlikely that the factor limiting the distribution and abundance of *C. richardsiorum* is the pollinator (Bower 2007).

Part B: Distribution and Location

Distribution

Caladenia richardsiorum is endemic to the South East Herbarium Region, South Australia, and is found in coastal vegetation primarily between Southend and Robe no more than six kilometres from the coast (Figure 1.). A new sub-population was identified and formally determined in 2004 near Meningie by D Jones (CSIRO Canberra), however, the sub-population was resurveyed in 2007 and re-determined as *C. saxatilis* (R. Bates *pers. comm.* 2008). Further work is needed to clarify this sub-population. The species has a distribution from Southend to Meningie of approximately 900 km^2, and occupies no more than 10 km^2.

Habitat Critical to the Survival of the Species

Caladenia richardsiorum is found in several coastal and sub coastal vegetation types along the Limestone Coast of South Australia. At Nora Creina and in Canunda National Park it occurs in Coast Daisy-bush (*Olearia axillaris*) – Coast Beard-heath (*Leucopogon parviflorus*) shrubland complex (Croft *et al.* 1999). Associated species include Thyme Riceflower (*Pimelea serpyllifolia*), Bower Spinach (*Tetragonia implexicoma*), Coast Swainson-pea (*Swainsona lessertiifolia*) and Coast Velvet-bush (*Lasiopetalum discolor*). This vegetation complex ranges from low coastal heathland on exposed cliff tops to shrubland on the protected side of coastal fore dunes and is significant as it supports the larger and denser sub-populations of *C. richardsiorum*.

C. richardsiorum also occurs in deep leaf litter under White Coast Mallee (*Eucalyptus diversifolia* ssp. *diversifolia*) open mallee in the Robe and Beachport regions. Associated understorey and groundcover species include Coast Beard-heath, Old Man's Beard (*Clematis microphylla*), Stinking Pennywort (*Hydrocotyle laxiflora*) and Coast Velvet-bush. At Potters Scrub, Coorong National Park, *C. richardsiorum* occurs under a dense White Coast Mallee stunted mallee and Golden Wattle (*Acacia*

pycnantha/leiophylla) with a sparse understorey dominated by the weed species Bridal Creeper *(Asparagus asparagoides*).

On council land at Beachport it also occurs under Dryland Tea-tree (*Melaleuca lanceolata*) – Drooping Sheoak (*Allocasuarina verticillata*) low woodland. Here, associated species include Golden Wattle, Myrtle Wattle (*Acacia myrtifolia*), Coast Beard-heath (*Leucopogon parviflorus*), Sea Box (*Alyxia buxifolia*), Coast Cherry (*Exocarpus syrticola*), Coast Pomaderris (*Pomaderris paniculosa*), Pale Turpentine Bush (*Beyeria lechenaultii*), Muntries (*Kunzea pomifera*) and Blunt Leaf Ground-berry (*Acrotriche cordata*).

Existing *C. richardsiorum* sub-populations are under threat from fragmentation, weeds and isolation. Given current knowledge of the ecology of *Caladenia* species, it is likely that this species has a unique relationship with mycorrhizal fungi and its pollinator. Thus, maintaining and improving the quality of the associated vegetation is essential to the survival of this species.

Any of the previously described habitats within the known extent of occurrence of the species should be considered to be critical habitat for *C. richardsiorum.* Preventing any further fragmentation of existing vegetation that supports this species will be crucial to its long-term survival.

Figure 1. Current and historic distribution of *Caladenia richardsiorum*, Little Dip Spider-orchid.

Target Sub-populations

The total estimated number of mature plants of *C. richardsiorum* was 8,070, consisting of 40 sub-populations. The high number of sub-populations is a reflection of the highly fragmented distribution of *C. richardsiorum* habitat. A number of anecdotal records exist in addition to the target populations outlined in this document. The validity of these records will be investigated during the implementation of this recovery plan.

Exact details regarding site locations have been withheld from this document to ensure confidentiality. This information is stored with DEH and DEWHA. Reserved and unreserved sub-populations are listed below (Table 2).

Table 2. Reserved and unreserved sub-populations of *Caladenia richardsiorum* in South Australia.

Reserved Populations

Location	Manager	No. of individuals	No. of sub-populations	Year
Canunda National Park, Southend, SA	DEH	117	3	2006
Little Dip Conservation Park, Robe, SA	DEH	<107	7	2007
Coorong National Park, SA** (to be validated)	DEH	200	1	2004
Total		**424**	**11**	

Unreserved Populations

Location	Manager	No. of individuals	No. of sub-populations	Year
Nora Creina PP1, SA	Private Property	1188	1	2003
Nora Creina PP2, SA	Private Property	5	1	2002
Nora Creina PP3, SA	Private Property	50	1	2002
Nora Creina PP4, SA	Private Property	219	3	2002
Nora Creina PP5, SA	Private Property	5400	6	2002
Sunland PP1, SA	Private Property	49	4	2007
Robe Heritage Agreement, SA	Private Property	97	1	2007
Beacon Hill Council Reserve, Robe, SA	Robe District Council	<10	1	2004
Pool of Siloam, Beachport, SA	Wattle Range District Council	30	1	2002
Lanky's Well, Beachport, SA	Wattle Range District Council	189	2	2007
Rivoli Bay, Beachport, SA	Wattle Range District Council	240	2	2007
Woolly Lake, Beachport, SA	Wattle Range District Council	5	3	2006
Lake George, Nora Creina, SA	Wattle Range District Council	49	1	2002
Roadside, Nora Creina, SA	Wattle Range District Council	67	2	2002
Total		**7646**	**29**	

Reservation Status

Caladenia richardsiorum has a narrow distribution on a section of the South Australian coast, which is not well conserved in the government reserve system. Of the 40 sub-populations recorded in the last 15 years, eleven are in conservation reserves and one in a Heritage Agreement.

Part C: Strategy for Recovery

Current Threats

Threats to all species are outlined earlier in this document. Threats relating specifically to *C. richardsiorum* are:

- Vegetation clearance for intensive coastal development, leading to fragmentation and isolation of sub-populations.
- Environmental weed invasion by, but not limited to, Bridal Creeper (*Asparagus asparagoides*), "Western Cape" form of Bridal Creeper, Myrtle-leaf Milkwort (*Polygala myrtifolia)*, Blue Periwinkle (*Vinca major*), Italian Buckthorn (*Rhamnus alaternus*), Coast Wattle (*Acacia longifolia* var. *sophorae*), Coast Teatree (*Leptospermum laevigatum*), Gazania *(Gazania linearis)* and Bluebell Creeper (*Billardiera heterophylla)*.
- Potential damage to populations from off-road vehicles, especially four wheel drives and motorbikes, and pedestrian traffic on public and private land at Robe and Nora Creina. Visitation is very high in the Robe district and at least one sub-population is threatened from off-road vehicles driving across sensitive coastal vegetation to gain access to the beach.
- Grazing by rabbits threatens some sub-populations in the Canunda region. Herbivory by exotic terrestrial snails may also threaten some sub-populations as they have been found in abundance at some coastal sites. Grazing by Western Grey Kangaroo (*Macropus fuliginosus)* has the potential to be a problem in the Nora Creina area, a reduction of kangaroo numbers is being undertaken under the licence of DEH.
- Visitor impacts from naturalists and field officers also threaten some sub-populations. The best intentions of many enthusiasts and staff can sometimes be to the detriment of these species. Excessive visitation can damage plants, cause soil compaction, introduce and spread weeds and potential pathogens.
- Although there has been no evidence of illegal collection of the three species by plant enthusiasts in the past, it is considered that there is a moderate threat of illegal collection as *C. richardsiorum* is an attractive species with many easily accessible sub-populations.

Existing Conservation Measures

Ecologists have been employed to plan and implement recovery of *C. richardsiorum* between 2000 and 2002 and then again between 2004 and 2009. Conservation measures have also been undertaken by National Parks and Wildlife staff and the Bush Management Advisor (DEH).

The following management actions were undertaken:

- Baseline data collected.
- Recovery strategies developed and implemented.
- Monitoring plots established and surveys undertaken for additional populations.
- Site management statement for a council reserve completed.
- Weed control activities carried out on public and private land.
- Liaison and awareness–raising activities undertaken with land managers.
- Threats to orchid sub-populations identified.
- Track re-aligned and bollards erected to prevent damage to sub-populations by off-road vehicles.
- Pollinator identified.
- Negotiation for germplasm and mycorrhizal fungi storage conducted.
- Existing data collated.

- Relational-database development for storage of spatial, monitoring and management data undertaken.

The importance of community support cannot be underestimated in the conservation of *C. richardsiorum*. Two local groups, the Friends of Little Dip and Butchers Gap Conservation Parks and the Beachport District Development Corporation have made a significant effort to protect this species. Extinction of some sub-populations would have almost certainly taken place without their support. The Natural History Society of South Australia has also undertaken extensive weed control work in potential *C. richardsiorum* habitat. These works have included identification of new populations, weed control and raising awareness of the significance of this species within the community and government sphere.

Managing Threats

Recovery of *Caladenia richardsiorum* is being achieved through the work of departmental staff as well as the involvement of local individuals and groups in the management of sub-populations. For the life of this Plan the overall direction for recovery of the species will be coordinated by the Multi-species Recovery Team, which includes the Threatened Flora Recovery Officer, Regional Ecologist and Threatened Species Ecologists from DEH as well as representatives from the Friends of Little Dip and Butcher Gap Conservation Parks and the Beachport District Development Association.

Where sub-populations occur on private property, landholders will be invited to become involved in the recovery process. Members of these groups and interested landholders may be trained in habitat management and monitoring of sub-populations in accordance with prescribed management actions.

For the duration of this plan, recovery will be focussed on:

- Demographic monitoring.
- Assessment of the recently recorded sub-population near Meningie.
- Survey of potential habitat between Robe and Meningie; and Southend and Port MacDonnell.
- Clarification of pollinator and habitat.
- Development of relationships with private landholders with a view to legal protection of the population at Nora Creina.
- Reduction in the impact of weeds on public and private land at Robe and Beachport.
- Construction of protective barriers at the roadside at Robe.
- Storage of seed and mycorrhizal material from target sub-populations.
- Dissemination of spatial data regarding *C. richardsiorum* sub-populations to government and private landholders.

Biodiversity Benefits

The Coast Daisy-bush (*Olearia axillaris)* – Coast Beard-heath (*Leucopogon parviflorus)* shrubland in which *Caladenia richardsiorum* is found also provides habitat for a number of national and state listed species, some of which are Endangered. Nationally Endangered taxa include Sand Ixodia (*Ixodia achillaeoides* ssp. *arenicola)* and the Critically Endangered Orange-bellied Parrot *(Neophema chrysogasta),* which was flushed from near a sub-population of *C. richardsiorum* at Nora Creina (E Lawson *pers. comm*. 2007). South Australian species listed as Vulnerable under the NPW Act are Dune Fanflower (*Scaevola calendulacea)* and Slender Speedwell *(Veronica gracilis)*. The Rufous Bristlebird (*Dasyornis broadbenti)* is also found in this habitat and is listed as Vulnerable in South Australia.

Common Caladenia (*Caladenia vulgaris*) listed as Rare in South Australia, has also been found growing in association with *C. richardsiorum* in *Eucalyptus diversifolia* ssp*. diversifolia* habitat. Many actions that improve the habitat for the target species at these sites may also advantage associated species such as *C. vulgaris*. Such outcomes are consistent with the priorities of the Biodiversity Plan for the South East of South Australia (Croft *et al.* 1999), as this habitat falls into the "priority coastal area" outlined in the plan.

Part D: Recovery Objectives, Criteria and Actions

Table 3. Recovery actions and performance criteria for *Caladenia richardsiorum* in South Australia

Action	Description	Performance Criteria	Priority
Specific objective 1: Acquire accurate information for conservation status assessments			
1.1	Continue to acquire baseline data. **Responsibility: DEH**	• Updated records in departmental files and databases. • Accurate information and maps of all population locations. • Updated regional IUCN assessment. • Completion of Threatened Orchid relational-database. • Clarify taxonomic status of Meningie sub-population. • Clarify identity of pollinator.	3
Specific objective 2: Identify critical, common and potential habitat to orchid and pollinator			
2.1	Survey and assess known habitat in spring. Determine the presence of species for unconfirmed records. **Responsibility: DEH**	• Critical habitat mapped and added to SA Threatened Orchid relational-database and disseminated to relevant land managers including councils. • Assessment of the recently recorded site near Meningie. • Anecdotal records validated / refuted.	1
2.2	Identify and survey potential habitat using geospatial habitat modelling. **Responsibility: DEH**	• Identification of potential habitat including targeted sites between Robe and Meningie; Southend and Port MacDonnell. • Potential habitat mapped and recorded as GIS layers and added to Threatened Orchid relational-database.	2
Specific objective 3: Conserve targeted sup-populations on private land			
3.1	Protect populations on private land. **Responsibility: DEH**	• Negotiate protection with private land manager at Nora Creina. Initiate a Heritage Agreement if possible.	1

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 4: Manage threats to sub-populations			
4.1	Control pest plants using herbicide application, biological control and / or hand removal. **Responsibility: DEH**	• Integrated weed management strategy developed for Heritage Agreement at Robe. • Measurable decline in extent of *Asparagus asparagoides, Polygala myrtifolia, Acacia sophorae* and *Vinca major* at Heritage Agreement at Robe. • Measurable decline in extent of *Polygala myrtifolia, Freesia* spp., *Gazania linearis*, *Rhamnus alaternus*, *Leptospermum laevigatum, Billardiera heterophylla, Asparagus asparagoides* and *Vinca major* in the council reserve at Beachport. • Establish a weed-free buffer at priority populations.	1
4.2	Investigate and control grazing impacts. **Responsibility: DEH**	• Grazing impacts investigated/quantified at 4 sites. • Negotiations undertaken regarding a change in grazing regimes at Nora Creina private land site if appropriate. • Rabbit control strategies developed and implemented where appropriate. • Impacts by exotic terrestrial snails investigated and controlled if necessary.	1
4.3	Control site disturbance by protecting sites. **Responsibility: DEH**	• Protective barriers constructed at Little Dip Conservation Park, council owned roadside at Robe and other sites if required. • Signage erected to ensure visitors keep to the walking tracks.	1
Specific objective 5: Determine the growth rates and viability of sub-populations			
5.1	Measure population trends and responses to recovery actions. **Responsibility: DEH**	• Demographic information collected, including recruitment and mortality, timing of life history stages and morphological data. • Population Viability Analysis completed for selected populations.	3
5.2	Collate, analyse and report on census data and compare with management histories. **Responsibility: DEH**	• SA Threatened Orchid relational-database completed and maintained using updated census records. • Management assessed and prescriptions revised if necessary.	3

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 6: Develop and undertake fine-scale site management practices			
6.1	Manage microhabitat for seedling recruitment at target sub-populations. **Responsibility: DEH**	• Measurable increase in recruitment at target sub-populations. • No decline in recruitment target sub-populations.	3
6.2	Hand-pollinate to boost recruitment. **Responsibility: DEH**	• Hand pollination protocol developed and selected individuals hand pollinated in selected sub-populations.	2
6.3	Enhance pollinator habitat. **Responsibility: DEH**	• Site rehabilitation works undertaken to support pollinator populations at selected sites if necessary.	3
Specific objective 7: Establish/maintain sub-populations in cultivation			
7.1	Establish cultivated plants *ex situ* to safeguard from the unforeseen destruction of the wild population. **Responsibility: DEH**	• Representative mature plants in cultivation.	3
7.2	Establish a threatened orchid seed and fungi bank and determine seed viability. **Responsibility: DEH SE Region & DEH Germplasm Research Centre**	• Collars collected from selected sub-populations and fungi isolated. • Seed from selected populations in long term storage.	1
7.3	Maintain a database of threatened plants in cultivation. **Responsibility: DEH SE Region & DEH Germplasm Research Centre**	• Seed Bank database established.	3
Specific objective 8: Establish new or restock sub-populations from cultivated plans or seed stock			
8.1	Restock selected sub-populations using plants cultivated *ex-situ* Responsibility: **DEH SE Region & DEH Germplasm Research Centre**	• Long-term survival of, and recruitment from plants used for restocking at selected sites.	3
Specific objective 9: Build a network of government and non-government organisations and individuals			
9.1	Undertake community extension by encouraging individuals to report sightings of *Caladenia richardsiorum* to regional DEH personnel, as well as promoting threatened flora conservation. **Responsibility: DEH**	• Community members actively search for *C. richardsiorum.*	3

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 9: Build a network of government and non-government organisations and individuals			
9.2	Encourage and support research by Higher Education Institutions and other research partners. **Responsibility: DEH & Research partner(s)**	• Collaborative research partnerships formed and funding applications prepared.	3
Specific objective 10: Cooperate in bioregional policy implementation and manage recovery plan implementation			
10.1	Facilitate a regional recovery team for *Caladenia richardsiorum* and other regional threatened flora. **Responsibility: DEH SE**	• Convene one Threatened Orchid Recovery Team meeting annually. • Annual work plans prepared.	3
10.2	Coordinate recovery and exchange knowledge with government agencies. **Responsibility: DEH**	• Maintain regular communication with State, interstate and Federal agencies to advance management and implement legislation and policies.	3

Management Priority 1 = high, 2 = moderate, 3 = low

Part E: Budget

Table 4. Estimated costs of recovery actions for *Caladenia richardsiorum* in South Australia.

Action	Description	Cost estimate ($)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
1: Acquire accurate information for conservation status assessments							
1.1	Acquire baseline population data	2 000	1 000	500	500	500	**4 500**
2: Identify critical, common and potential habitat for orchid and pollinator							
2.1	Survey & assess known habitat	2 000	2 000	2 000	2 000	2 000	**10 000**
2.2	Identify & survey potential habitat	1 000	1 000	1 000	1 000	1 000	**5 000**
3: Conserve targeted sup-populations on private land							
3.1	Protect private land habitat	1 000	4 000	0	0	0	**5 000**
4: Manage threats to sub-populations							
4.1	Control pest plants	7 000	7 000	7 000	7 000	7 000	**35 000**
4.2	Investigate and control grazing impacts	500	1 000	1 000	1 000	1 000	**4 500**
4.3	Control site disturbance	000	1 000	1 000	500	500	**4 000**
5: Determine the growth rates and viability of sub-populations							
5.1	Collect census data	1 000	1 000	1 000	1 000	1000	**5 000**
5.2	Collate, analyse and report	500	500	500	500	500	**2 500**
6: Develop and undertake fine-scale site management practices							
6.1	Manage microhabitat	2 000	2 000	1 000	1 000	1 000	**7 000**
6.2	Hand pollinate and collect seed	2 000	2 000	1 000	1 000	1 000	**7 000**
6.3	Enhance pollinator habitat	1 000	3 000	1 000	1 000	1 000	**7 000**
7: Establish/maintain sub-populations in cultivation							
7.1	Establish cultivated plants	2 000	2 000	3 000	3 000	3 000	**13 000**
7.2	Establish a seed & fungi bank	3 000	2 000	1 000	1 000	1 000	**8 000**
7.3	Maintain a database	1 000	500	500	500	500	**3 000**
8: Establish new & re-stock sub-populations from cultivated plants or seed stock							
8.1	Restock selected sub-populations using plants cultivated *ex-situ*	1 000	1 000	1 000	1 000	1 000	**5 000**
9: Specific objective: Build a network of government and non-government organisations and individuals							
9.1	Community extension	1 000	1 000	1 000	1 000	1 000	**5 000**
9.2	Encourage supporting research	0	1 000	1 500	0	0	**2 500**
10: Cooperate in bioregional policy implementation and manage recovery plan implementation							
10.1	Establish a regional recovery team	500	500	500	500	500	**2 500**
10.2	Coordinate recovery with local and interstate agencies	500	500	500	500	500	**2 500**
Total		**$29 000**	**$34 000**	**$26 000**	**$24 000**	**$24 000**	**$137 000**

Photo Credit: Kate Vlcek

Recovery Plan for *Caladenia calcicola* (Limestone Spider-orchid).

Part A: Species Information and General Requirements

Nomenclature

This plan uses the current nomenclature in South Australia and Victoria for *Caladenia calcicola* (Limestone Spider-orchid), following the authority of Carr (1986). As with *C. richardsiorum, t*he taxonomic review of the genera *Caladenia* by Jones *et al.* (2001) has resulted in the nomenclature change of *Caladenia calcicola* to *Arachnorchis calcicola*; however this review is yet to be accepted by any State Herbarium in Australia. Until such a change is accepted by the State Herbarium of South Australia (SHSA) and National Herbarium of Victoria, Melbourne (NHV) the former nomenclature remains.

Taxonomic Description

Caladenia calcicola is a perennial spider-orchid with a single, lanceolate leaf up to 15 cm long with dense hairs on both laminae and one or sometimes two glossy flowers, up to 40 mm in width (Backhouse & Jeanes 1995). The flowering stem is 10-28 cm in length. Petals and sepals are pale yellow in colour with up to two central maroon stripes. Sepals are up to 9 mm long and have prominent clubs varying in colour from yellow to red. Flowering occurs from mid-September to early November. The plant remains dormant when conditions are unsuitable (Bates and Weber 1990; Backhouse and Jeanes 1995; Bishop 1996; Carr 1986). For a formal description of the species see Carr (1986).

Initial investigations identified a number of plants at Padthaway that bore a strong resemblance to *C. calcicola*. Further investigation into the taxonomy of these individuals found that the individuals in question were *C. reticulata*. *Caladenia calcicola* was previously known to occur in the Mt Burr Range, South Australia. However, this population is now extinct and no extant sub-populations are known to exist in South Australia. *Caladenia calcicola* was also previously included in the *Caladenia reticulata* complex.

Conservation Status

Caladenia calcicola is listed as Vulnerable under the Commonwealth EPBC Act, Endangered under the South Australian NPW Act, and is listed in Victoria under the *Flora and Fauna Guarantee Act 1988*. Fieldwork in 2007 has resulted in a reassessment of the conservation status of the species that will need to be reflected in its Commonwealth classification under the *EPBC Act, 1999*. *Caladenia calcicola* has been assessed as Critically Endangered (CR B1ab(iii)) under the IUCN criteria (Table 5).

Table 5. IUCN Red List Criteria for *Caladenia calcicola.*

IUCN Criteria	Justification
CR B1	It has an extent of occurrence of less than 100 km^2.
CR B1a	Sub-populations are severely fragmented.
CR B1b(iii)	There is a projected continuing decline in the area and quality of habitat.

Ecology

Mycorrhizae

As discussed for *C. richardsiorum*, *Caladenia* species are generally found growing in association with the mycorrhizal fungus *Sebacina vermifera* (Warcup 1971, 1981, 1988) or closely related fungi (Huynh 2003, Raleigh 2005, Bougoure *et al.* 2005, Bonnardeaux *et al.* 2007, Wright 2007). Orchids require the infection of an appropriate mycorrhizal fungus to germinate under natural conditions (Rasmussen 1995). This association continues into adulthood with the mycorrhizal fungus supplying the orchid with carbon and nitrogen (Brundrett 2002, Cameron *et al.* 2006, Girlanda *et al*. 2006). The obligate nature of their mycorrhizal associations makes them vulnerable to extinction (Rasmussen 1995). Therefore, identification and subsequent mapping of suitable fungi is essential in the process of threatened orchid

recovery. Mycorrhizal fungi have been isolated from a Victorian population of *C. calcicola*, with plants propagated with the fungi reintroduced into natural habitat in 2007.

Pollination

Pollination of *Caladenia calcicola* is primarily achieved by sexually deceiving male thynnid wasps (family Tiphiidae, sub-family Thynninae), as for other *Caladenia,* Section *Calonema* species (for more detail about sexual deception see: *C. richardsiorum,* Pollination). Natural pollination of *C. calcicola* is very low throughout its range. In 2006, pollinator baiting was conducted by FloraSearch (Bower, 2007). The pollinator of *C. calcicola* was identified as a Thynnine wasp, *Phymatothynnus* near *nitidus,* by entomologist Dr. G Brown (Bower 2007). *Phymatothynnus* nr. *nitidus* was found to pollinate two other closely related orchid species, *C. reticulata and C. australis,* during the same trial period (Bower 2007). Further research is needed on the *C. reticulata* complex and its pollinator, *P* nr. *nitidus,* to identify whether the pollinator actually comprises of separate cryptic species which each only pollinate one species of *Caladenia* or whether the *Caladenia reticulata* complex is one biological species (Bower 2007). *Phymatothynnus* nr. *nitidus* was found to be scarce around the existing populations of *C. calcicola*, but locally common throughout the rest of the Wildlife Reserve.

Observations indicated that 5% - 10% of plants were pollinated annually at the Wildlife Reserve sub-population (Department for Natural Resources and Environment 1992). However, in 2007 natural pollination rate for all sub-populations was less than 5% (A. Pritchard *pers. obs*. 2007).

Part B: Distribution and Location

Distribution

Caladenia calcicola currently occurs on shallow, terra-rossa soil on limestone ridges in South West Victoria and South East South Australia. Although now very restricted, it may have been more widespread prior to European settlement. The species has a distribution of approximately 90 km^2 and occupies no more than 10 km^2. No suitable vegetation remains in its previous habitat around Mt. Burr Range in South Australia.

Habitat Critical to the Survival of the Species

The total naturally occurring population in 2007 comprised approximately 211 mature plants in 6 sub-populations. At Bats Ridge it occurs in Limestone Ridge Woodland. Dominant species include Manna Gum (*Eucalyptus viminalis* ssp. *cygnetensis*), Golden Wattle (*Acacia pycnantha*), Coast Wattle (*Acacia longifolia* var. *sophorae*), Sweet Bursaria (*Bursaria spinosa*) and Coast Beard-heath (*Leucopogon parviflorus*) (Carr 1986). In the Lower Glenelg National Park at Nelson it occurs in Limestone Woodland. Dominant species include Drooping Sheoak (*Allocasuarina verticillata*), Swamp Gum (*Eucalyptus ovata*), Golden Wattle, Myrtle Wattle (*Acacia myrtifolia*), Common Heath (*Epacris impressa*) and common Correa (*Correa reflexa*). On private land at Portland it occurs in a Grassy Woodland/Hills Herb-rich Woodland/Damp Sands Herb-rich Woodland mosaic. Dominant species include Manna Gum, Silver Banksia (*Banksia marginata*), and Bracken Fern (*Pteridium esculentum*).

Habitat critical to the survival of this species includes areas for future recruitment of sub-populations. The entire tract of vegetation in which *Caladenia calcicola* occurs should be considered critical habitat, including vegetation with the appropriate floristic composition described above. Preventing any further fragmentation of existing vegetation that supports this species is crucial to its long-term survival.

To maintain a self-sustaining population of *C. calcicola* it is also vital to conserve the pollinator's habitat. While the exact habitat requirements of the pollinator, *Phymatothynnus* near *nitidus* are not well understood, it is known that Thynnids feed on a range of flowering plants, particularly from the Myrtaceae and Proteaceae families. It is important for the pollinator population that flowering food plants are available before, during and after the flowering period of *C. calcicola,* as the pollinators have been observed to be present for a few months before and after the orchid flowering period (C. Bower *pers. comm.* 2007)

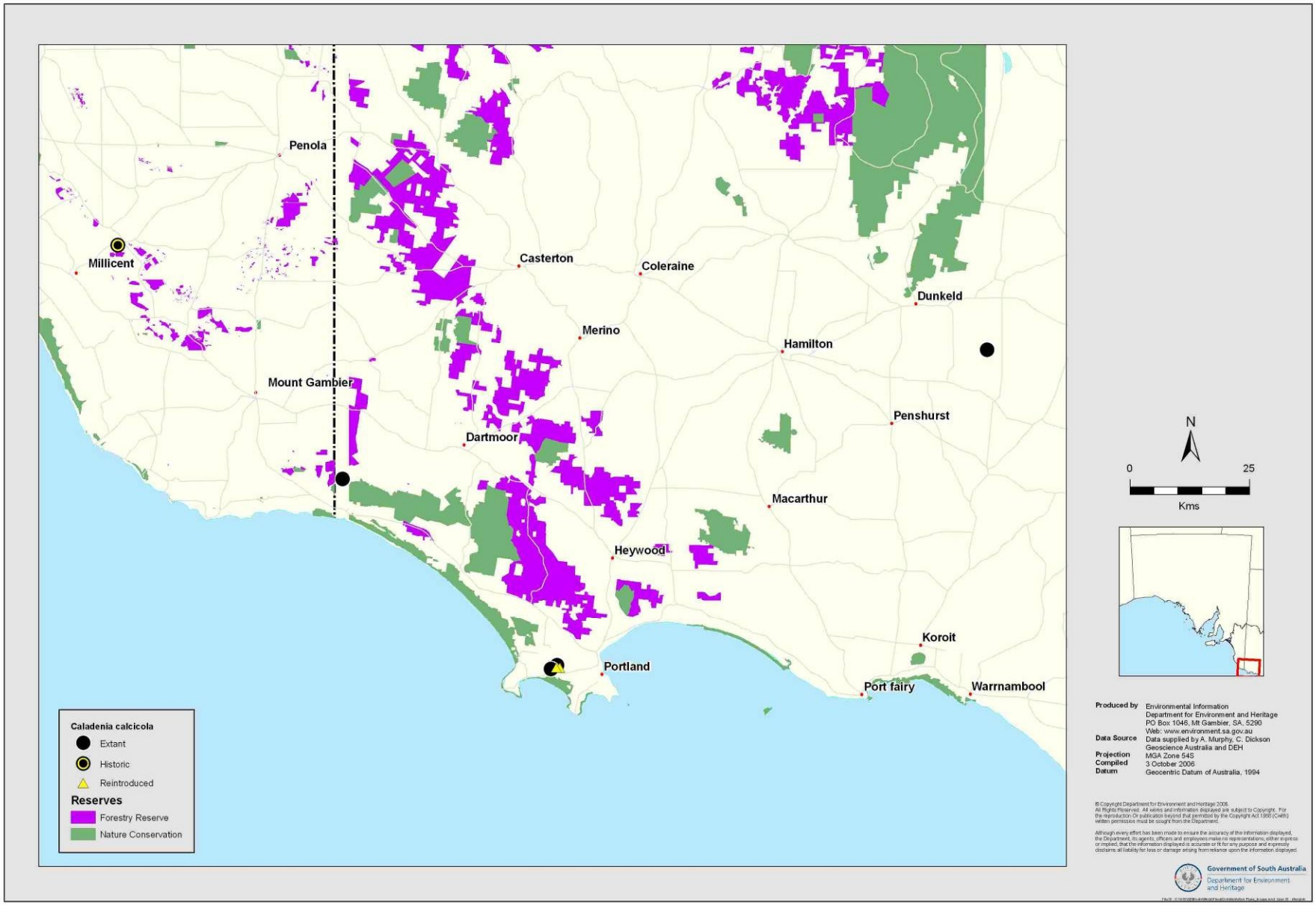

Figure 2. Current and historic distribution of *Caladenia calcicola*, Limestone Spider-orchid.

Target Sub-populations

The total population of mature plants of *C. calcicola* in 2007 was 277, consisting of 211 individuals in 6 naturally occurring sub-populations located in Victoria. Four of these occur within a Wildlife Reserve near Portland, one on private land near Dunkeld and one at a highly threatened site in National Park near Nelson, Victoria.

The sub-populations at the Wildlife Reserve are found within an area of less than 10 km^2. Surveys undertaken between 1989 and 1992 and again in 2000 found the sub-population to be in decline (Department of Natural Resources and Environment 1992). Previously the largest known sub-population nearby on private land was partially destroyed by quarrying between 1980 and 1984 (Carr 1986). A sub-population was discovered in 2006 on the Wildlife Reserve, 100 m from the previously known sub-population. It is believed to be part of the original sub-population.

The sub-population on private land near Dunkeld was first reported in November 1989, when it numbered two individuals (D. Munro *pers. comm*. 2001). In October 1994, five flowering plants were located in the Lower Glenelg National Park near Nelson. This number has remained constant over time.

Exact details regarding site locations have been withheld from this document to ensure confidentiality. This information is stored in departmental files within DSE. Reserved and unreserved sub-populations are listed below (Table 6).

Table 6. Reserved and unreserved sub-populations of *Caladenia calcicola* in Victoria.

Reserved Populations

Location	**Manager**	**No. of individuals**	**No. of sub-populations**	**Year**
Natural sub-populations				
National Park, Nelson, Vic	Parks Victoria	5	1	2008
Wildlife Reserve, Portland, Vic	Parks Victoria	205	4	2007
Re-introduced sub-populations				
Wildlife Reserve, Portland, Vic	Parks Victoria	66	2	2007
Total		276	7	
Unreserved Populations				
Location	**Manager**			
Dunkeld PP, Vic	Private Property	1	1	2007
Total		1	1	

Reservation Status

Currently seven sub-populations are represented in conservation reserves. Six are located in a Wildlife Reserve near Portland and one in a National Park in Nelson. All seven sub-populations are managed by Parks Victoria. Despite their legal protection all reserved sub-populations are highly threatened due to their low numbers.

Part C: Strategy for Recovery

Current Threats

Threats common to all species are outlined earlier in this document. Threats relating specifically to *C. calcicola* are:

- Grazing by native and introduced herbivores, including rabbits, kangaroos and emus for all sub-populations.
- Weed invasion. Bridal Creeper (*Asparagus asparagoides),* Italian Buckthorn *(Rhamnus alaternus),* Arum Lilies (*Zantedeschia aethiopica*) and *Hypochoeris* sp. pose a problem at the Wildlife Reserve site. South African Weed Orchid (*Disa bracteata)* poses a potentially high level threat to the Nelson sub-population, given its close proximity to other significant outbreaks nearby.
- Inappropriate burning regimes. Optimal fire regimes for maintaining or re-creating, the appropriate vegetation age-class and structure have not been determined however it is recognised that many terrestrial Australian *Caladenia* species respond favourably to fire events that reduce canopy biomass. In the future the effect of inappropriate burning regimes on the pollinator and the associated mycorrhizal fungi also needs to be considered if self-sustained sub-populations are to be maintained.
- Accidental site damage as a result of off road activity by vehicles. This threat affects the Wildlife Reserve and the Nelson sub-populations and is considered a high risk at all public land sites.
- Visitation-related impacts. These include either monitoring activities or tourism for all public land sites. Illegal collection is also a potential threat at all sites, given the rarity of this species.
- Lack of pollinators. Observations in recent years suggest that pollination rates at all sites may be too low to maintain a stable population size.
- Visitor impacts from naturalists and field officers also threaten some sub-populations. Excessive visitation can damage plants, cause soil compaction, introduce and spread weeds and potential pathogens.

Existing Conservation Measures

An ecologist has been employed to plan and implement recovery of *C. calcicola* since 1994. Conservation measures have been undertaken by DSE, Parks Victoria (PV) and DEH. These activities include the following:

- Annual censuses at all sites since 1994.
- Collection of demographic life history data at five sites.
- Baiting for mycorrhizal fungi using slide baits.
- Mycorrhizal fungus isolated and placed in long term storage.
- Conservation Covenant established at the private property site.
- Control of Italian Buckthorn (*Rhamnus alaternus*) at Wildlife Reserve, Portland.
- Fencing at the National Park, Nelson site.
- Liaison with private industry and government organisations and stakeholders to raise awareness of issues relating to the conservation of *C. calcicola*.
- Management priorities incorporated into the Glenelg Hopkins Catchment Management Authority Regional Catchment Strategy.
- Information relating to the distribution of the species included in the DSE and PV's Fire Operation Plans to minimise accidental damage during fire control activities.
- Potential habitat mapped.

- Regional Recovery Team created and facilitated by DSE.
- Taxonomic determination of the sub-population at Padthaway, South Australia in 2001.
- Pollinator identified and distribution investigated.
- Ex-situ sub-population cultivated and maintained at the Royal Botanic Gardens, Melbourne (RBG).
- 66 individuals have been re-introduced at two sites in a Wildlife Reserve, Portland.
- Individual plants caged at Wildlife Reserve sub-populations, Portland.

Managing Threats

Monitoring has been undertaken at all public land sites since 1994 and began at the Portland Wildlife Reserve site in 1992. In recent years, life history data has been collected at three sites. This provides greater insight into population demographic dynamics for each site and aids management significantly. The overall trends suggest that the all sub-populations are currently in decline.

Slide baiting of soils was undertaken in 2004 to extract mycorrhizal fungi, but was unsuccessful, so an alternative method of taking a slice of the orchid's collar was used to gather material. The mycorrhizal fungi has been isolated and cultured from a slice of the plants collar by the RBG and placed in long-term storage. This has enabled an active *in-situ* conservation program to be carried out by the RBG. Preliminary data from the RBG has found that taking a slice of the plant collar has no detrimental effect on future growth and reproductive ability (M. Wright *pers. comm.* 2007).

Following the discovery that pollination rates were not high enough to sustain the population, hand pollination has been performed at targeted sub-populations to enhance seed set. The results of a pollinator baiting experiment in 2006 (Bower 2007), indicated the Thynnid pollinator was scarce in the immediate vicinity of known sub-populations, yet locally common along tracks in the same Wildlife Reserve (within 300 m of the extant sub-populations). Currently the adjacent area has a good population of pollinators, but is unsuitable for *C. calcicola* as the vegetation has become very dense. The change in vegetation structure is predominantly attributed to the invasion of Coast Wattle (*Acacia longifolia* ssp. s*ophorae*) and lack of fire within the Reserve.

To achieve natural pollination and create a self-sustaining population of *C. calcicola,* Bower (2007) suggests potentially reintroducing *C. calcicola* to the areas of the Reserve with a good pollinator population. The reintroduction site would need to be prepared to create a more open environment suitable for the orchid. It would be possible to create the appropriate vegetation structure by conducting a prescribed burning regime during the dormancy periods of the orchid and pollinator, or by undertaking manual vegetation removal. Both methods will require ongoing management to maintain the habitat in a suitable condition for the orchid and its pollinator.

Fencing has been undertaken at the Portland Wildlife Reserve to exclude rabbits and on private land at Portland to exclude stock. A fence has also been erected at Nelson to prevent machinery from creating further damage to the site. Additional plants have also been caged at a number of sites to protect them from both native and exotic herbivores.

Mapping of potential habitat has been undertaken by both the Victorian and South Australian Government Departments. Searches for additional populations have been undertaken by the DSE and DEH both in Victoria and South Australia with mixed success. The location of two new populations in 2006 by DSE in Victoria can be attributed to the habitat mapping undertaken, thus highlighting the value of this technique in identifying additional sub-populations of threatened plants.

In recent years the taxonomy of the sub-population at Padthaway Conservation Park has been re-examined. The individuals in question are now considered to be *C. reticulata* complex.

Liaison with stakeholders in South West Victoria has been ongoing, and has included members of Parks Victoria, Hancocks Pty. Ltd. and private landholders. A multi-species recovery team has also been set up for threatened flora in South West Victoria and a number of meetings with regional stakeholders have taken place to manage the recovery of a number of these species, including *C. calcicola.*

For the duration of this plan recovery will be focussed on:

- Surveys and assessments of known habitat.

- Pest plant control.
- Management of grazing impacts.
- Reassessment of the conservation status by undertaking and submitting a Species Profile and Threats information sheet to Commonwealth Department of Environment, Water, Heritage and the Arts.
- Hand pollination to increase seedling recruitment.
- Seed collection for short and long term and storage.
- Expansion of the number of sub-populations through a re-introduction program.
- Maintenance of a viable *ex situ* population.
- Investigation of the potential for ecological burns to maintain orchid and pollinator habitat.

Biodiversity Benefits

Two of the vegetation communities in which the species occurs (Limestone Ridge Woodland and Limestone Woodland) are considered Rare in the West Victoria region. A third community, Grassy Woodland/Hills Herb-rich Woodland/Damp Sands Herb-rich Woodland mosaic is Endangered within this region (Commonwealth and Victorian RFA Steering Committee 2000). Any actions that improve the habitat for *C. calcicola* will also benefit these communities.

Part D: Recovery Objectives, Criteria and Actions

Table 7. Recovery actions and performance criteria for *Caladenia calcicola* in Victoria and South Australia.

Action	Description	Performance Criteria	Priority
Specific objective 1: Acquire accurate information for conservation status assessments			
1.1	Continue to acquire baseline population and species data. **Responsibility: DSE**	• Updated records in departmental files and databases. • Accurate information and maps of all population locations.	3
1.2	Conduct a current conservation status assessment **Responsibility: DSE**	• A Species Profile and Threats (SPRAT) review under taken and national conservation status updated if appropriate.	2
Specific objective 2: Identify critical, common and potential habitat to orchid and pollinator			
2.1	Survey and assess known habitat in spring. **Responsibility: DSE**	• Critical habitat mapped and added to departmental files.	1
2.2	Identify and survey potential habitat using geospatial habitat modelling. **Responsibility: DSE**	• Identification of potential habitat. • Potential habitat mapped and recorded as GIS layers and added to departmental files. • Surveys of potential habitat conducted.	2
Specific objective 3: Conserve targeted sub-populations on private land			
	Non-applicable	•	
Specific objective 4: Manage threats to sub-populations			
4.1	Control pest plants using herbicide application, biological control and / or hand removal. **Responsibility: DSE**	• Integrated weed management strategy developed for sites where weed invasion threatens sub-populations. • A weed-free buffer established at all sub-populations.	1
4.2	Investigate and control grazing impacts. **Responsibility: DSE**	• Individual target plants caged to protect from grazing.	1
4.3	Control site disturbance by protecting site. **Responsibility: DSE**	• Fence maintained at Lower Glenelg National Park site, Nelson.	1
4.4	Investigate and implement appropriate fire regimes. **Responsibility: DSE**	• Optimal fire regimes determined for Lower Glenelg National Park site, Nelson and Wildlife Park, Portland. • Burn plan developed and implemented at Lower Glenelg National Park site, Nelson and Wildlife Park, Portland.	2

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 5: Determine the growth rates and viability of sub-populations			
5.1	Measure population trends and responses against recovery actions. **Responsibility: DSE**	• Annual census completed for all populations, of demographic information including recruitment and mortality, timing of life history stages and morphological data. • Population Viability Analysis completed for targeted populations.	2
5.2	Collate, analyse and report on census data. **Responsibility: DSE**	• Updated data added to departmental files. • Management assessed and prescriptions revised if necessary.	3
Specific objective 6: Develop and undertake fine-scale site management practices			
6.1	Manage microhabitat for seedling recruitment at target sub-populations. **Responsibility: DSE**	• Mycorrhizal fungi mapped at selected sites when seed available. • Measurable increase in recruitment at all sub-populations.	3
6.2	Enhance pollinator habitat. **Responsibility: DSE**	• Pollinator identified and site rehabilitation works undertaken to support pollinator populations at selected sites if necessary.	3
6.3	Hand-pollinate to boost recruitment. **Responsibility: DSE**	• Hand pollination protocol developed and implemented.	1
Specific objective 7: Establish/maintain sub-populations in cultivation			
7.1	Maintain cultivated plants *ex situ* to safeguard from the unforeseen destruction of the wild population. **Responsibility: DSE and RBG**	• At least 50 mature plants maintained in cultivation at a number of locations.	1
7.2	Maintain the established threatened orchid Seed and Fungi Bank and determine seed viability. **Responsibility: DSE and RBG**	• Isolated fungi maintained in storage. • Seed from selected populations in long term storage.	3
7.3	Maintain a Seed and Fungi Bank database. **Responsibility: DSE and RBG**	• Relevant details entered in Seed and Fungi Bank database and maintained.	3
Specific objective 8: Establish new & re-stock sub-populations from cultivated plants or seed stock			
8.1	Investigate the historic site at Mt Burr for a potential reintroduction. **Responsibility: DEH**	• Consultation undertaken with Forestry SA • Preparation of a site reintroduction plan. • Successful pollinator baiting trials.	3
8.2	Achieve maximum survival of plants and/or germination of seed through thorough site preparation **Responsibility: DEH and DSE**	• Techniques implemented as described in the site reintroduction plan to successfully reintroduce mature individuals.	3

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority

Recovery Plans: Little Dip Spider-orchid (*Caladenia richardsiorum),* Limestone Spider-orchid (*Caladenia calcicola)* and Swamp Greenhood *(Pterostylis tenuissima*).

Specific objective 8 cont.: Establish new/Re-establish sub-populations from cultivated plants or seed stock			
8.3	Reintroduce and monitor plants at Wildlife Reserve and Mt Burr Range sites. **Responsibility: DEH & DSE**	• Measurable population increase at historic Wildlife Reserve and Mt Burr Range sites.	3
Specific objective 9: Build a network of government and non-government organisations and individuals			
9.1	Continue to liaise with industry and government stakeholders to ensure the protection of *Caladenia calcicola*. **Responsibility: DSE**	• Information provided to relevant private and public management bodies as well as State and Commonwealth Governments.	3
9.2	Encourage and support research by Higher Education Institutions and other research partners. **Responsibility: DSE & Research partner(s)**	• Collaborative research partnerships formed and funding applications prepared.	3
Specific objective10: Cooperate in bioregional policy implementation and manage recovery plan implementation			
10.1	Facilitate a Regional Recovery Team for *Caladenia calcicola* and other regional threatened flora. **Responsibility: DSE**	• Convene one Threatened Orchid Recovery Team meeting annually. • Annual work plans prepared.	3
10.2	Coordinate recovery and exchange knowledge with government agencies. **Responsibility: DSE**	• Maintenance of regular communication with State, interstate and Commonwealth agencies to advance management and implement legislation and policies.	3

Management Priority 1 = high, 2 = moderate, 3 = low

Part E: Budget

Table 8. Estimated costs of recovery actions for *Caladenia calcicola* in Victoria and South Australia.

Action	Description	Cost estimate ($)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
1: Acquire accurate information for conservation status assessments							
1.1	Acquire baseline population data	500	500	500	500	500	**2 500**
1.2	Review conservation status	3 000	2 000	0	0	0	**5 000**
2: Identify critical, common and potential habitat to orchid and pollinator							
2.1	Survey & assess known habitat	500	500	500	500	500	**2 500**
2.2	Identify & survey potential habitat	2 000	1 000	1 000	1 000	500	**5 500**
3: Conserve targeted sub-populations on private land							
	Non-applicable						
4: Manage threats to sub-populations							
4.1	Control pest plants	2 000	2 000	1 000	1 000	1 000	**7 000**
4.2	Investigate & control grazing impacts	500	1 000	1 000	1 000	1 000	**4 500**
4.3	Control site disturbance	0	0	0	0	1 000	**1 000**
4.4	Investigate & implement fire regimes	1 000	3 000	3 000	1 000	1 000	**9 000**
5: Determine the growth rates and viability of populations							
5.1	Collect census data	1 000	1 000	1 000	1 000	1 000	**5 000**
5.2	Collate, analyse & report	500	500	500	500	500	**2 500**
6: Develop and undertake fine-scale site management practices							
6.1	Manage microhabitat	2 000	2 000	1 000	1 000	1 000	**7 000**
6.2	Enhance habitat	1 000	3 000	1 000	1 000	1 000	**7 000**
6.3	Hand pollinate & collect seed	500	500	500	500	500	**2 500**
7: Establish/maintain populations in cultivation							
7.1	Maintain cultivated plants	2 000	2 000	2 000	2 000	2 000	**10 000**
7.2	Maintain a seed & fungi bank	1 000	1 000	1 000	1 000	1 000	**5 000**
7.3	Maintain database	500	500	500	500	500	**2 500**
8: Establish new & re-stock sub-populations from cultivated plants or seed stock							
8.1	Assess & evaluate historic site	0	2 000	500	0	0	**2 500**
8.2	Prepare site	0	0	2 000	1 000	0	**3 000**
8.3	Introduce & monitor plants	0	0	0	3 000	2 000	**5 000**

Action	Description	Cost estimate ($)					
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
9: Build a network of government and non-government organisations and individuals							
9.1	Liaise with stakeholders	500	500	500	500	500	**2 500**
9.2	Encourage supporting research	500	500	500	500	500	**2 500**
9: Cooperate in bioregional policy implementation and manage recovery plan implementation							
10.1	Facilitate Regional Recovery Team	500	500	500	500	500	**2 500**
10.2	Coordinate recovery with local and interstate agencies	500	500	500	500	500	**2 500**
Total		**$20 000**	**$24 500**	**$19 500**	**$19 000**	**$16 500**	**$99 000**

Photo Credit: Anna Murphy

Recovery Plan for *Pterostylis tenuissima*, (Swamp Greenhood)

Part A: Species Information and General Requirements

Nomenclature

This plan uses the currently accepted nomenclature in South Australia and Victoria for *Pterostylis tenuissima* (Swamp Greenhood), following the authority of Nicholls (1950). The taxonomic review of the genera *Pterostylis* by Jones and Clements (2002a) has resulted in the nomenclature change of *P. tenuissima* to *Diplodium tenuissimum.* Until such a change is accepted by the State Herbarium of South Australia (SHSA) and National Herbarium of Victoria, Melbourne (NHV) the former nomenclature remains.

Taxonomic Description

Pterostylis tenuissima is a perennial terrestrial greenhood orchid. When in the non-reproductive stage it appears as a rosette, however, the rosette is absent when in flowering form. The flowering form has up to five stem-sheathing leaves (10-30 mm long) along its flower stem. The stem reaches up to 300 mm in length and supports a single, nodding flower. The modified sepal known as the hood is translucent white in colour with pale green stripes ranging in length from 15-20 mm. Lateral sepals are held erect with long fine tips up to 20 mm rising above the hood. Flowering occurs mainly between October and March but is frequently observed at other times throughout the year. Non-flowering plants form a ground hugging rosette of three to eight dark green, glossy ovate leaves. *Pterostylis tenuissima* can remain dormant as an underground tuber when conditions are unsuitable (Bates and Weber 1990; Backhouse and Jeanes 1995; Jessop and Toelken 1986).

Conservation Status

Pterostylis tenuissima is listed as Nationally Vulnerable under the Commonwealth EPBC Act, Vulnerable in South Australia under the NPW Act and is listed under the Victorian FFG Act. An assessment under the IUCN Red List Categories and Criteria has found that *P. tenuissima* meets the criteria of Vulnerable (VU B1b(iii)c(iv)) (Table9).

Table 9. IUCN Red List Criteria for *Pterostylis tenuissima.*

IUCN Criteria	Justification
VU B1	It has an extent of occurrence of less than 20,000 km^2.
VU B1b(iii)	There is a projected continuing decline in the area and quality of habitat.
VU B1c(iv)	There are extreme fluctuations in the number of mature individuals.

Ecology

Mycorrhizae

Many terrestrial Australian orchid species have highly specialised relationships with mycorrhizal fungi (Warcup 1971). *Pterostylis* species generally are found growing in association with mycorrhizal fungi (Warcup 1971, Clements 1988), often in association with *Ceratobasidium* species (Warcup 1981, Irwin *et al.* 2007), and *Thanatephorus* species (Bougoure *et al*. 2005). The fungi that form mycorrhizal relationship with *P. tenuissima* have not yet been isolated however the techniques for isolation are well established. As there is little knowledge available regarding the mycorrhizal associations of this particular species, identification and subsequent mapping of suitable fungi is essential in its recovery.

Pollination and Asexual Reproduction

Pterostylis tenuissima belongs to a group of *Pterostylis* that are pollinated by small gnats and mosquitoes. It is thought that they are attracted to the flower by a scent undetectable by humans (Jones 2006). The pollinator(s) of *P. tenuissima* is/are currently unidentified. The *Pterostylis* flowers achieve pollination by utilizing a hinged labellum that is triggered when an insect crawls over its surface, propelling the insect forward onto the column. The column, labellum and galea 'trap' the insect, which is then forced to push past the anther to be able to exit the flower, where a previously

acquired pollinia could be deposited (Backhouse & Jeanes 1995, Jones & Clements 2002b). The labellum then resets itself after approximately five to thirty minutes, awaiting the next pollinator visit.

There is no data on the pollination rates for most sites however field observations indicate that rates are higher in larger sub-populations. Observations have determined that the ratio of flowering plants to non-flowering rosettes is frequently low. *Pterostylis tenuissima* is able to reproduce vegetatively from tubers located beneath the ground (A. Pritchard *pers. obs.* 2005), which may reduce its dependence on sexual reproduction. Consequently asexual reproduction may be an important factor in building population size.

Part B: Distribution and Location

Distribution

Pterostylis tenuissima is found between Wilsons Promontory National Park in eastern Victoria and West Dairy Range in South East South Australia. The species is mainly restricted to the coastal plains of South East South Australia and South West Victoria, with one sub-population recorded 90 km inland near Poolaijelo in Victoria. Although widespread, the habitat for this species has been significantly depleted resulting in a significant reduction in numbers across its range. The species is known to 55 sites. Given the historical distribution of suitable habitat across South East South Australia and South West Victoria, it is likely that the species was once far more widespread and abundant than it is today. *Pterostylis tenuissima* is distributed across approximately 1,000 km^2 and occupies no more than 10 km^2.

Habitat Critical to the Survival of the Species

Pterostylis tenuissima occurs exclusively in Silky Tea-tree (*Leptospermum lanigerum*) tall Scrub, known as Swamp Scrub in Victoria. This vegetation community will be referred to as Silky Tea-tree Scrub throughout this document. Silky Tea-tree Scrub occurs on delicate, alkaline soils in swamps and along the edges of rivers and creeks. Seasonal inundation can occur within these communities, however in South Australia these wetlands are predominantly fed by freshwater springs with low level seasonal influence. Co-dominant canopy species often include Scented Paper-bark (*Melaleuca squarrosa)* and Tree Daisy (*Ozothamnus ferrugineus)* (Backhouse and Jeanes 1995; Croft and Carpenter 2000).

The extent of Silky Tea-tree Scrub has been heavily depleted through extensive clearance and drainage for agriculture in both South Australia and Victoria. Remnants on private land are often subject to grazing by cattle and sheep. Stock often force their way through the dense understorey, opening up the overstorey and damaging the soil structure. Small sub-populations are found under mature Silky Tea-tree plants only millimetres above the water table. These delicate, waterlogged soils are highly susceptible to pugging. Significant changes in canopy cover can lead to the invasion of more light tolerant species (often exotic pasture species) that can out-compete *P. tenuissima.* They may also lead to increased water loss from the soil through evaporation (Bachmann 2002). Silky Tea-tree Scrub is adapted to relatively stable environmental conditions and responds very poorly to clearance and stock disturbance.

Pterostylis tenuissima occupies a very narrow ecological niche. Drainage associated with agriculture can lead to widespread loss of *P. tenuissima* habitat. Impacts to water quality can also lead to habitat loss, with some remnants along creek lines in Victoria being subject to increased levels of groundwater salinity as a result of vegetation clearance.

Given the above land modifications in the region, Silky Tea-tree habitat is considered under threat from fragmentation and isolation. All areas of Silky Tea-tree Scrub should be considered critical habitat for the survival of this species.

Critical Habitat in South Australia

Numerous large wetlands once stretched across the Lower South East of South Australia (Bachmann 2002). In 1863, construction of the first of many large drains began at Kingston (South East Wetlands Committee 1984), eventually leading to an extensive drainage system that has converted the majority

of these wetlands to pasture. Drain construction still continues today. By 2002, only five percent of this habitat remained, leaving highly degraded remnants in many places (Bachmann 2002). Wetland drainage continues to pose a serious threat to these communities, particularly on private land where small remnants are under considerable pressure from adjacent agricultural land.

In recent years, a drop in the level of the unconfined aquifer in the Lower South East of South Australia has led to a reduction of flow to near-coastal springs. This may be the result of a number of factors, including below average rainfall in recent years, an increase in groundwater extraction for irrigated agriculture and a reduced recharge to the watertable as a result of the extensive establishment of plantation forests and widespread surface drainage (L. Schmidt *pers. comm*.2001). Consequently, many springs that previously provided a regular flow of water to Silky Tea-tree swamps throughout the year now have reduced flow during summer, making habitat unsuitable for the moisture-dependent, summer-flowering *P. tenuissima*.

Conversely, a rise in water levels may also threaten sub-populations through inundation. In the case where land managers wish to manipulate water table levels, extreme care must be exercised and the habitat requirements of threatened flora including *P. tenuissima* must be given priority.

Victorian Critical Habitat

In Victoria critical habitat for *P tenuissima,* defined as Silky Tea-tree Scrub (Swamp Scrub), is widespread but highly fragmented and threatened by agricultural land use practices, grazing, altered hydrology and weed invasion. Silky Tea-tree Scrub is listed as Endangered within the western region, with only 2,415 ha of the original 53,649 ha remaining (CVRFASC 2000). It is estimated that throughout its range in Victoria this vegetation type has declined by 95% (G. Carr *pers. comm.* 2003).

Silky Tea-tree Scrub occurs along the Curdies and Gellibrand Rivers, their associated tributaries, and coastal wetlands in the far south west of the State. Currently the largest and most intact remnants of Silky Tea-tree Scrub occur in the South West coastal region of Victoria. South West Victoria also contains the only areas of reserved coastal Silky Tea-tree Scrub in Victoria, at Snape Reserve Princetown and Ralph Illiage Trust For Nature Sanctuary.

Silky Tea-tree Scrub primarily occurs on private land that is used for dairy, beef or sheep production. Grazing is considered a major threat to this habitat type. Several known *P. tenuissima* sub-populations on private properties in the Curdies and Gellibrand River systems have been fenced to protect the *P. tenuissima* sub-populations and the Silky Tea-tree Scrub. However, weed invasion is a significant and ongoing threat to those fenced remnants, particularly as many are long narrow strips where the edge effects are highly pronounced.

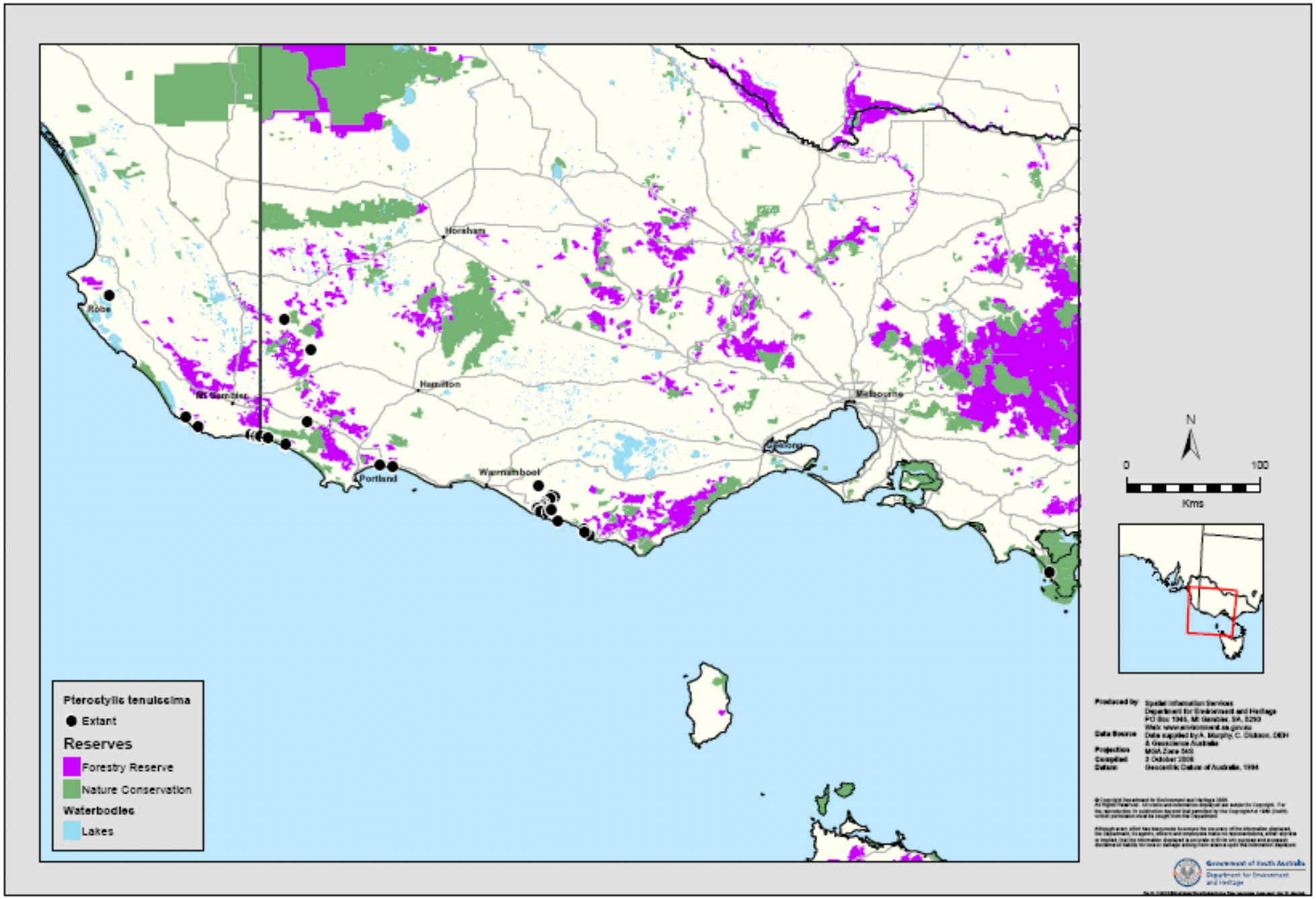

Figure 3. Current and historic distribution of *Pterostylis tenuissima,* Swamp Greenhood.

Target Sub-populations

The estimated total number of mature plants of *P. tenuissima* is 17,703 consisting of 57 sub-populations located in Victoria and South Australia. The high number of sub-populations reflects the highly fragmented nature of the distribution of this species. Five sub-populations are protected within National Parks in Victoria and one in a Wildlife Reserve. Two sub-populations have been recorded at Piccaninnie Ponds Conservation Park, South Australia and at least one is known to occur at Pick Swamp which was the recently purchased and reserved by DEH. It is likely that this number will increase, following searches of these newly reserved sites. The density of plants at Pick Swamp was reasonably high and as such the total number of plants could be in excess of 1,000. This site was highly threatened by drainage and the effects of grazing. The property will be gazetted as a State Conservation Reserve. The total number of plants and sub-populations at this site is currently unknown but will be investigated in future years.

Currently 46 of the 57 known sub-populations are found on private property, most of which are subject to agricultural land uses. Only one of these properties is protected by a Trust for Nature Conservation Covenant. In Victoria four sub-populations occur on roadsides managed by local government and one occurs in a council reserve. Target sub-populations are outlined in Table 10.

Table 10. Reserved and unreserved sub-populations of *Pterostylis tenuissima* in South Australia and Victoria.

Reserved Populations

Location	Manager	No. of individuals	No. of sub-populations	Year Surveyed
Piccaninnie Ponds Conservation Park, SA	DEH	314	2	2004
Pick's Swamp, SA	DEH	725	1	2004
Discovery Bay Coastal Park, Nelson, Vic	Parks Victoria	24	1	2004
Lower Glenelg National Park, Nelson, Vic	Parks Victoria	22	2	2004
Port Campbell National Park, Port Campbell, Vic	Parks Victoria	<10	1	2004
Serpentine Ck Wildlife Reserve, Princetown, Vic	Parks Victoria	<50	2	2004
Wilsons Promontory National Park	Parks Victoria	15	2	2006
Total		1,160	11	

Unreserved Populations

Location	Manager	No. of individuals	No. of sub-populations	Year Surveyed
Blackfellows Caves, SA	Private Property	53	1	2004
Nene Valley, SA	Private Property	22	1	2004
West Dairy Range PP1, Robe, SA	Private Property	1,750	2	2004
West Dairy Range PP2, Robe, SA	Private Property	56	1	2004
Brucknell PP1, Vic	Private Property	200	1	2004
Brucknell, Vic	Private Property	420	1	2004
Chappel Vale, Vic	Private Property	20	1	2004
Curdie Vale PP1, Vic	Private Property	500	2	2004
Curdie Vale PP2, Vic	Private Property	4,000	7	2004
Curdie Vale PP3, Vic	Private Property	Data Deficient	2	
Curdie Vale PP4, Vic	Private Property	>4,500	5	2007
Curdie Vale PP5, Vic	Private Property	90	2	2004
Curdie Vale, Vic	Private Property	300	1	2004
Curdies River, Vic	Private Property	200	1	2004
Curdies River, Vic	Private Property	180	1	2004
Curdies River, Vic	Private Property	122	1	2004
Curdies River, Vic	Private Property	70	1	2004
Curdies River, Vic	Private Property	223	1	2004
Curdies River, Vic	Private Property	117	1	2004
Curdies River, Vic	Private Property	1,500	1	2004
Narringal East, Vic	Private Property	> 200	1	2004
Poolaijello, Vic	Private Property	200	1	2004

Table continued on next page
Table 7. *Continued from previous page.*

Location	Manager	No. of individuals	No. of sub-populations	Year Surveyed
Princetown, Vic	Private Property	300	1	2004
Red Cap Creek, Vic	Private Property	24	1	2004
Terang, Vic	Private Property	7	1	2004
Trust for Nature Sanctuary, Naringal East, Vic	Private Property	41	1	2004
Tyrendarra, Vic	Private Property	< 50	1	2004
Princetown Recreation Reserve, Princetown, Vic	Corangamite Shire Council	1,000	1	2004
Roadside 1, Lower Heytesbury, Vic	Corangamite Shire Council	46	1	2004
Roadside 2, Lower Heytesbury	Corangamite Shire Council	30	1	2004
Roadside, Brucknell, Vic	Moyle Shire Council	300	1	2004
Roadside, Curdie Vale, Vic	Moyle Shire Council	22	1	2004
Total		16,543	46	

Reservation Status

Pterostylis tenuissima is reserved in one Conservation Park in South Australia and in three National Parks and one Coastal Park in Victoria. It is also located on recently purchased Crown Land in South Australia and on one private property in Victoria protected by a Conservation Covenant.

Part C: Strategy for Recovery

Current Threats

Threats common to all species are outlined earlier in this document. Threats relating specifically to *P. tenuissima* are:

- Habitat loss.

  In South Australia the distribution of Silky Tea-tree Scrub has been reduced from 10,740 to 2,380 hectares as a result of extensive drainage, clearance and increasing salinity (Croft *et al*. 1999; Croft and Carpenter 2000). *Leptospermum lanigerum* shrubland (Silky Tea-tree Scrub) is regionally Vulnerable in South East South Australia.

  In western Victoria, Swamp Scrub (or Silky Tea-tree Scrub) is considered Endangered as only 2,415 of the original 53,649 hectares of this habitat remains (Commonwealth and Victorian RFA Steering Committee 2000). Native vegetation clearance continues to threaten sub-populations found on private property at Gellibrand Creek and Curdies River.

- Grazing by livestock. The majority of sites on private property are subject to stock grazing. This can lead to vegetation degradation, initially along the edges of remnants and ultimately across the entire habitat. The fragile habit of *P. tenuissima* plants makes them highly susceptible to trampling and grazing.

- Drainage works. Surface drainage works in and adjacent to Silky Tea-tree Scrub in recent decades, combined with extensive vegetation clearance, have resulted in the loss and degradation of large areas of habitat in the Nene Valley and at Blackfellows Cave in South Australia. Ongoing drainage and clearance of *P. tenuissima* habitat near Blackfellows Cave will likely lead to an extinction of the species at this site in future years. Drainage began in the early 1990's and resulted in almost complete desiccation of this swamp for the first time during the summer of 2000-01. By then, remaining areas of available water supported only 53 *P. tenuissima* plants, down from 92. Under the current drainage regime, this sub-population may not survive another dry event

- Weeds. A variety of weed species threaten Swamp Greenhood sub-populations, including Blackberries (*Rubus* spp.), Buffalo Grass (*Stenotaphrum secundatum*), Arum Lilies (*Zantedeschia aethiopica*), New Zealand Mirror-bush (*Coprosma repens),* Cotoneaster (*Cotoneaster simonsii*) and various pasture species. At Spring and Whiskey Creeks in Victoria, the long, narrow shape of *P. tenuissima* habitat results in a higher ratio of edge to core area and an increased susceptibility to external influences such as weed invasion.

- Erosion. This is particularly a problem at Spring and Whiskey Creeks in Victoria. Plants growing along the water's edge are vulnerable to advancing erosion, and the potential to be washed away.

- A continuing reduction in groundwater threatens some sub-populations in SA at Piccaninnie Ponds CP. This has reduced the suitability of the site as *P. tenuissima* habitat and has led to the gradual invasion of Coast Wattle (*Acacia longifolia* var. *sophorae*). Efforts to reverse the effects of this water loss are ongoing; however extreme caution is required to prevent the inundation of existing sub-populations. Consequently, actions to reinstate the hydrology of these wetlands may also threaten these sub-populations.

- Visitor impacts from naturalists and field officers also threaten some sub-populations. Excessive visitation can damage plants, cause soil compaction, introduce and spread weeds and potential pathogens. Monitoring activities are often time consuming and can lead to damage, particularly of the soft soils of *P. tenuissima* habitat.

Existing Conservation Measures

Ecologists have been employed by DEH and DSE since 2000 to plan and manage the recovery of *P. tenuissima.* Liaison with private landholders has been undertaken both in Victoria and South Australia to locate and protect Silky Tea-tree Scrub.

Through the *Silky Tea-tree & Cutting Grass Wetland Rehabilitation Project* in South Australia, assistance was provided to landholders to fence remnants on private property. The success of rehabilitation works was also evaluated and additional searches were undertaken to locate new populations of threatened flora, including *P. tenuissima*. Incentives will continue to be available for fencing the remaining patches of *P. tenuissima* habitat. This work was undertaken with the assistance of DSE in Victoria.

Ongoing drainage and damage by stock threatened one population on private land in South Australia until recently when the property was purchased by DEH. This has led to benefits to a range of other rare and threatened species at the site and contributed to the development of a wetland corridor in the Lower South East of South Australia.

The following management actions have been undertaken since 2000:

- Baseline data collected at all sites.
- Collection of demographic life history data at sites in Victoria and South Australia.
- Threats to sub-populations identified.
- Recovery strategies developed and implemented.
- Surveys and mapping to locate additional populations.
- Collation of data and development of Threatened Orchid Database.
- Land purchased in South Australia to protect *P. tenuissima* and a range of other threatened flora and fauna.
- Landholder liaison and subsequent threat abatement at sites out on private property sites in both South Australia and Victoria.
- Negotiations to protect *P. tenuissima* sub-populations in relation to the reinstatement of hydrology in Piccaninnie Ponds wetland complex in South East South Australia. The reinstatement of hydrology at Piccaninnie Ponds is likely to benefit *P. tenuissima.* Mapping of some of the most vulnerable sub-populations has been undertaken however further work is still required. A weir was installed in 2006 and further works are proposed.
- Control of weeds at priority sites within Curdies River - Gellibrand Management zone.
- Fencing undertaken at numerous private land sites in South Australia and Victoria.
- Management priorities incorporated into the GHCMA and CCMA Regional Catchment Strategies.
- Information relating to the distribution of the species included in the DSE and PV's Fire Operation Plans to minimise accidental damage during fire control activities.
- Victorian Regional Recovery Team coordinated by DSE.
- South Australian Regional Recovery Team coordinated by DEH.

Managing Threats

For the duration of this plan recovery will be focussed on:

- Protection of sub-populations on private land.
- Pest plant control.
- Control of grazing impacts by fencing sites.
- Collation and analysis of census data and subsequent reporting.

- Identification and isolation of mycorrhizal fungi.
- Establishment of a threatened orchid seed and fungi bank.
- Establishment of cultivated plants in ex situ collections.
- Coordination of Regional Recovery Team meetings.
- Reassessment of the conservation status by undertaking and submitting a Species Profile and Threats information sheet to Commonwealth Department of Environment, Water, Heritage and the Arts.

Biodiversity Benefits

Leptospermum lanigerum, Silky Tea-tree Scrub, is Vulnerable in South East South Australia and Endangered in Western Victoria, so habitat protection and restoration work on these remnants will benefit this threatened ecological community. The habitat also supports sub-populations of many plant species of high conservation significance at the State and regional level (Croft & Carpenter 2000). Some benefits have already been made as a result of fieldwork associated with this project; for example new records have been made for three orchid taxa previously unrecorded in South Australia, namely *Pterostylis lustra*, *Corybas* sp. aff. *diemenicus* and *Microtis* sp. aff. *rara*. Any restoration of *P. tenuissima* habitat will also benefit these significant species.

The recovery of *P. tenuissima* is coordinated by DEH and DSE through Regional Threatened Flora Recovery Teams and includes government and non-government stakeholders.

Part D: Recovery Objectives, Criteria and Actions

Table 11. Recovery actions and performance criteria for *Pterostylis tenuissima* in Victoria and South Australia.

Action	Description	Performance Criteria	Priority
Specific objective 1: Acquire accurate information for conservation status assessments			
1.1	Continue to acquire baseline population data. **Responsibility: DEH & DSE**	• Updated records of new sub-populations entered in departmental files and databases. • Accurate information and maps of all population locations. • Updated regional IUCN assessment. • Completion of SA Threatened Orchid relational-database	3
1.2	Conduct a current conservation status assessment **Responsibility: DSE**	• Under take a Species Profile and Threats (SPRAT) review – Determine and update Federal conservation status.	2
Specific objective 2: Identify critical, common and potential habitat to orchid and pollinator			
2.1	Survey known habitat. **Responsibility: DEH & DSE**	• Critical habitat mapped and added to SA Threatened Orchid relational-database and disseminated to relevant land managers including councils. • Annual or biennial censuses of selected sub-populations completed. • Soil testing undertaken at selected sub-populations to identify potential threat of salinity. • Sub-populations located and mapped at Piccaninnie Ponds CP and Pick Swamp.	2
2.2	Identify and survey potential habitat using geospatial habitat modelling. **Responsibility: DEH & DSE**	• Potential habitat in Victoria mapped and recorded as GIS layers and added to departmental datasets. • Potential habitat at Piccaninnie Ponds CP and selected sites in South Australia mapped and recorded as GIS layers and added to Threatened Orchid relational-database.	2
Specific objective 3: Conserve targeted sub-populations on private land			
3.1	Protect populations on private land. **Responsibility: DEH & DSE**	• Protection negotiated with private land managers. Heritage Agreements or Conservation Covenants initiated where possible.	1

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 4: Manage threats to sub-populations			
4.1	Control pest plants at selected sub-populations. **Responsibility: DEH & DSE**	• Measurable decline in weed infestation at selected sub-populations.	1
4.2	Control grazing impacts by fencing sites. **Responsibility: DEH & DSE**	• Measurable seedling recruitment in affected private land populations.	1
4.3	Control site disturbance by protecting sites with strategic fences and modifying land management activities. **Responsibility: DEH & DSE**	• Continued liaison undertaken with land managers at West Dairy Range, Blackfellows Cave and Curdies River. • Measurable reduction in damage to plants in affected populations.	1
Specific objective 5: Determine the growth rates and viability of sub-populations			
5.1	Measure population trends and responses against recovery actions by collecting demographic information including recruitment and mortality, timing of life history stages and morphological data. **Responsibility: DSE**	• Population Viability Analysis completed for selected sub-populations in Victoria.	3
5.2	Collate, analyse and report on census data and compare with management histories. **Responsibility: DEH & DSE**	• Management assessed and prescriptions revised if necessary.	1
Specific objective 6: Develop and undertake fine-scale site management practices			
6.1	Manage microhabitat for seedling recruitment at target sub-populations. **Responsibility: DEH & DSE**	• Mycorrhizal fungi mapped for future reintroduction at Piccaninnie Ponds CP. • Measurable increase in recruitment at selected sub-populations including Piccaninnie Ponds CP. • No decline in recruitment at priority sub-populations including Piccaninnie Ponds CP.	3
6.2	Collect seed and test viability **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Seed from selected sub-populations in storage. • Seed viability analysis undertaken.	2
Specific objective 7: Establish/maintain sub-populations in cultivation			
7.1	Establish cultivated plants *ex situ* to safeguard from the unforeseen destruction of the wild population. **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Seed collected from selected sub-populations. • At least 40 mature plants from Piccaninnie Ponds CP in cultivation.	1
7.2	Identify and isolate mycorrhizal fungi **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Fungal baiting undertaken at selected sites including Piccaninnie Ponds CP. • Fungi isolated.	1

Management Priority 1 = high, 2 = moderate, 3 = low

Action	Description	Performance Criteria	Priority
Specific objective 7 cont.: Establish/maintain sub-populations in cultivation			
7.3	Establish a threatened orchid seed and fungi bank and determine seed viability. **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Seed and fungi from selected sub-populations in long-term storage.	1
7.4	Maintain a database of threatened plants in cultivation including provenance, numbers, cultivation technique and other relevant information. **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Seed Bank database established.	2
Specific objective 8: Establish new & re-stock sub-populations from cultivated plants or seed stock			
8.1	Restock target sub-populations. **Responsibility: DEH (SE Region & Germplasm Research Centre), DSE & RBG**	• Long-term survival of, and recruitment from, plants used for restocking at selected sub-populations including Piccaninnie Ponds CP.	3
Specific objective 9: Build a network of government and non-government organisations and individuals			
9.1	Encourage and support research by Higher Education Institutions and other research partners, and disseminate research results through meetings and scientific journals. **Responsibility: DEH, DSE & Research partner(s)**	• Collaborative research partnerships formed and funding applications prepared.	3
Specific objective 10: Cooperate in bioregional policy implementation and manage recovery plan implementation			
10.1	Consolidate threatened flora recovery in South Australia and Victoria. **Responsibility: DEH & DSE**	• Coordinate two Regional Recovery Team meetings annually. • Annual work plans prepared.	1
10.2	Coordinate recovery and exchange knowledge with government agencies and organisations to assist in the implementation of related legislation and policies. **Responsibility: DEH & DSE**	• Maintain regular communication with government agencies and organisations to advance management and implement legislation and policies.	3

Management Priority 1 = high, 2 = moderate, 3 = low

Part E: Budget

Table 12. Estimated costs of recovery actions for *Pterostylis tenuissima* in Victoria and South Australia.

Action	Description	Cost estimate ($)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
1: Acquire accurate information for conservation status assessments							
1.1	Acquire baseline population data	2 000	2 000	1 000	1 000	1 000	**7 000**
1.2	Review conservation status	3 000	2 000	0	0	0	**5 000**
2: Identify critical, common and potential habitat for orchid and pollinator							
2.1	Survey & assess known habitat	1 000	1 000	1000	0	0	**3 000**
2.2	Identify & survey potential habitat	4 000	1 000	1 000	1 000	0	**7 000**
3: Conserve targeted sub-populations on private land							
3.1	Protect private land habitat	2 000	2 000	1 000	1 000	0	**6 000**
4: Manage threats to sub-populations							
4.1	Control pest plants	3 000	2 500	2 500	2 500	2 500	**13 000**
4.2	Control grazing	1 000	1 000	1 000	1 000	0	**4 000**
4.3	Control site disturbance	1 000	1 000	500	0	0	**2 500**
5: Determine the growth rates and viability of populations							
5.1	Collect census data	1 000	1 000	1 000	1 000	1 000	**5 000**
5.2	Collate, analyse and report	500	500	500	500	500	**2 500**
6: Develop and undertake fine-scale site management practices							
6.1	Manage microhabitat	2 000	2 000	1 000	1 000	1 000	**7 000**
6.2	Collect seed, test viability.	2 000	2 000	1 000	0	0	**5 000**
7: Establish/maintain sub-populations in cultivation							
7.1	Establish cultivated plants	2 000	2 000	2 000	2 000	2 000	**10 000**
7.2	Identify and isolate mycorrhizal fungi	2 000	2 000	0	0	0	**4 000**
7.3	Establish a seed and fungi bank	0	1000	1 000	1 000	1 000	**4 000**
7.4	Maintain a database	500	500	500	500	500	**2 500**
8: Establish new & re-stock sub-populations from cultivated plants or seed stock							
8.1	Restock target sub-populations with seed.	500	500	500	500	500	**2 500**
9: Build a network of government and non-government organisations and individuals							
9.1	Encourage supporting research	500	500	500	500	500	**2500**
10: Cooperate in bioregional policy implementation and manage recovery plan implementation							
10.1	Coordinate regional recovery teams	500	500	500	500	500	**2500**
10.2	Coordinate recovery with local and interstate agencies	500	500	500	500	500	**2500**
Total		**$29 000**	**$25 500**	**$17 000**	**$14 500**	**$11 500**	**$97 500**

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