INTERIM RECOVERY PLAN NO. 302 (Revised)

UNDERGROUND ORCHID

(*RHIZANTHELLA GARDNERI*)

INTERIM RECOVERY PLAN

2010-2015

June 2010

Department of Environment and Conservation
Kensington

Australian Government

Kings Park & Botanic Garden
Botanic Gardens & Parks Authority

The University of Western Australia

Government of Western Australia

Department of Environment and Conservation
Our environment, our future

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50. Note: the Department of CALM formally became the Department of Environment and Conservation (DEC) in July 2006. DEC will continue to adhere to these Policy Statements until they are revised and reissued.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

DEC is committed to ensuring that threatened taxa are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible and, in the case of Critically Endangered (CR) taxa, always within one year of endorsement of that rank by the Minister.

This IRP replaces IRP 127, prepared by Andrew Brown, Andrew Batty, Mark Brundrett and Kingsley Dixon in 2003.

This IRP will operate from June 2010 to May 2015 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Critically Endangered (CR) this IRP will be reviewed after five years and the need further recovery actions assessed.

This IRP was given regional approval in July 2010 and approved by the Director of Nature Conservation in July 2010. The allocation of staff time and provision of funds identified in this IRP is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

Information in this IRP was accurate at June 2010.

IRP PREPARATION

This IRP was prepared by Andrew Brown[1], Andrew Batty[2], Mark Brundrett[3], Jeremy Bougoure[4] and Kingsley Dixon[5].

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ACKNOWLEDGMENTS

The following people have provided assistance and advice in the preparation of this IRP:

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Bret Beecham	Regional Ecologist, DEC Wheatbelt Region
Ryan Butler	Former Conservation Officer, DEC Esperance District
Greg Durell	Manager, DEC Great Southern District
Mike Fitzgerald	Former Nature Conservation Coordinator, DEC Esperance District

We would like to thank the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information.

Cover photograph by Bert Wells

CITATION

This IRP should be cited as:

Department of Environment and Conservation (2010) Underground Orchid (*Rhizanthella gardneri*) Interim Recovery Plan 2010-2015. Interim Recovery Plan No. 302. Department of Environment and Conservation, Western Australia.

SUMMARY

Scientific Name:	***Rhizanthella gardneri***	**Common Name:**	Western Australian Underground Orchid
Family:	Orchidaceae	**Flowering Period:**	May to July
Dept Region:	Wheatbelt	**DEC District:**	Esperance, Great Southern, Yilgarn
Shires:	Corrigin, Ravensthorpe, Bruce Rock	**Recovery Teams:**	Esperance, Great Southern, and Yilgarn Threatened Flora Recovery Teams

Illustrations and/or further information: Bougoure, J (2004) *Rhizanthella gardneri* PhD project proposal; Brown, A. (2002) Endangered, Underground Orchid. *Landscope* - WA's Conservation, Parks and Wildlife Magazine 17(3): 42; Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Perth, Western Australia; Dixon, K. W., *et al.* (1990) The Western Australian fully subterranean orchid *Rhizanthella gardneri*. *Orchid Biology, Reviews and Perspectives*. V. J. Arditti. Portland, Oregon, Timber Press. 5: 37-62; Dixon, K. W. and Pate, J. S. (1984) Biology and Distributional Status of *Rhizanthella gardneri* Rogers. *Kings Park Research Notes* 9; Grierson, P.F, Brundrett, M.C., Brown, A.P. and Sivasithamparam, K. (2004) The role of mycorrhizal fungi in nutrient supply and habitat specificity of the rare underground orchid (*Rhizanthella gardneri*), Australian Research Council Linkage Project LP0454276; Jones, D.L. and Clements, M.A. (2006) *Rhizanthella omissa*, a new species of Underground Orchid from south eastern Queensland. *The Orchadian* 15(3): 131-133; Warcup, J. H. (1991) The Rhizoctonia endophytes of *Rhizanthella* (Orchidaceae). *Mycological Research* 95: 656-659; Warcup, J. H. (1985) *Rhizanthella gardneri* (Orchidaceae), its Rhizoctonia endophyte and close association with *Melaleuca uncinata* (Myrtaceae) in Western Australia. *New Phytologist* 99: 273-280.

Analysis of outputs and effectiveness of Interim Recovery Plan (IRP) No.127 (2003-2008), prepared by Andrew Brown, Andrew Batty, Mark Brundrett and Kingsley Dixon.

The criteria for success in the previous plan (the number of individuals within populations and/or the number of populations have increased) has been met, as follows:

The number of mature individuals have increased from 19 in 2003 to 42 in 2009.

Actions carried out in the previous plan include:

Action 1 Coordinate recovery actions. The Esperance, Great Southern (previously Narrogin and Katanning) and Yilgarn (previously Merredin) Districts Threatened Flora Recovery Teams (EDTFRT, GSDTFRT and YDTFRT) are overseeing the implementation of recovery actions for *Rhizanthella gardneri* and are including information on progress in their annual report to the Department's Corporate Executive and funding bodies.

Action 2 Liaise with land managers and achieve long-term protection of habitat. Staff from the BGPA and the Department's Esperance, Great Southern and Yilgarn Districts have liaised with land landowners and managers to ensure that populations are not accidentally damaged or destroyed.

Action 3 Monitor populations. Monitoring of populations and associated habitat has occurred on an annual basis.

Action 4 Collect seed and associated mycorrhizal fungi from all populations and develop suitable long-term storage protocols. This has been achieved for most extant populations.

Action 5 Obtain biological and ecological information. Studies by BGPA and a PhD student have been undertaken.

Action 6 Population genetics. As part of a Masters Student Project supervised by the University of Western Australia (UWA) and BGPA, preliminary genetic data was obtained through DNA extraction from floral bract and fungal material collected during the 2001 season by BGPA staff.

Action 7 In situ seed germination. Seed collected in retrievable pouches from several *Rhizanthella gardneri* locations has been trialled to assess viability under field conditions. This study has just started and it will take several years to evaluate its success.

Action 8 Conduct further surveys. Further surveys by BGPA, Departmental staff and community volunteers have been conducted during the flowering period of the species but no new populations have been found.

Action 10 Conduct research into the reasons for habitat degradation. Research is currently being carried out.

Action 14 Promote awareness. A newspaper article on the species was published in the Albany *Extra*. Posters illustrating the species and providing contact information if it is found have been produced and distributed.

Action 15 Review the need for a full Recovery Plan and prepare if necessary. A review of the plan is provided here. It has been decided not to produce a full RP but instead develop a revised IRP.

These and other recovery actions included in the previous plan are ongoing and are also included in this revised plan. New recovery actions included in this plan are:

Action 6 Fence at-risk populations

Action 9 Rehabilitate habitat

Action 16 Characterise *Rhizanthella gardneri* habitat

Action 17 Characterise the effects of seasonal climatic variation on *Rhizanthella gardneri* habitat

Action 18 Characterise the fungal symbiont/s and its/their presence at existing and potential *Rhizanthella gardneri* sites and relate to specificity of the three *Melaleuca* species involved in the *R. gardneri* association

Action 19 Examine the magnitude and timing of the transfer of isotopically labelled Carbon and Nitrogen within the *Rhizanthella gardneri* tripartite relationship

Current status: *Rhizanthella gardneri* was declared as Rare Flora in November 1980 and is currently ranked as Critically Endangered (CR) under World Conservation Union (IUCN 2001) Red List criteria B2ab(ii,iii,v); C2a(i); D. The main threats are little remaining habitat due to clearance for agriculture, gradual loss of remaining habitat (due to the death of the associated *Melaleuca* species), poor recruitment, human damage when searching for plants, drought and weeds.

Habitat requirements: *Rhizanthella gardneri* is known from two areas some 260 km apart: The Munglinup - Oldfield River area in the south-eastern Wheatbelt and the Corrigin - Babakin area in the Central Wheatbelt (Brown *et al*. 1998). In the Corrigin - Babakin area *R. gardneri* grows in association with *Melaleuca scalena* while in the Munglinup - Oldfield River area it grows with *M. uncinata* and *M. hamata*. These *Melaleuca* species were previously included under the single name *M. uncinata* (Craven *et al*. 2004). In both areas the species grows with a specific mycorrhizal fungus that forms a three-way relationship. Habitat is mallee heath.

Habitat critical to the survival of *Rhizanthella gardneri*, and important populations: Given that *Rhizanthella gardneri* is ranked as CR, it is considered that all known habitat for wild populations is critical to the survival of the species, and that all wild populations are important populations. Habitat critical to the survival of *R. gardneri* includes the area of occupancy of important populations; areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators); additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations; and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Benefits to other species/ecological communities: There are no listed threatened species or Threatened Ecological Communities (TECs) in the immediate vicinity of *Rhizanthella gardneri*. However, recovery actions implemented to improve the quality or security of the habitat of the species, such as weed control and rehabilitation, will benefit the habitat in which it occurs.

International Obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. The species is listed under the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES), however this IRP does not affect Australia's obligations under any other international agreements.

Indigenous Consultation: Involvement of the Indigenous community is being sought through the South West Aboriginal Land and Sea Council (SWALSC) and Department of Indigenous Affairs to determine whether there are any issues or interests identified in the plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register has identified that there are no sites of Aboriginal significance at or near populations of the species covered by this IRP. Where no role is identified for the indigenous community associated with this species in the development of the recovery plan, opportunities may exist through cultural interpretation and awareness of the species. Indigenous involvement in the implementation of recovery actions will be encouraged. Continued liaison between DEC and the indigenous community will identify areas in which collaboration will assist implementation of recovery actions.

Social and economic impacts: The implementation of this recovery plan is likely to have some social and economic impact as one population of *Rhizanthella gardneri* occurs on private property and negotiations between DEC and the landowners have ensured that the area directly supporting the species will be left uncleared. Negotiations will continue with regard to the future management of the population. Other populations occur in Nature Reserves, a Townsite Reserve and Unallocated Crown Land.

Affected interests: Stakeholders include the Shires of Corrigin, Ravensthorpe and Bruce Rock, DEC and the owners of private property.

Evaluation of the Plan's Performance: DEC, in conjunction with the Esperance, Great Southern and Yilgarn Districts Threatened Flora Recovery Teams will evaluate the performance of this IRP. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan is to be reviewed following four years of implementation.

Existing Recovery Actions: The following recovery actions have been or are currently being implemented –

1. Relevant landowners and managers and owners have been made aware of the location and threatened status of *Rhizanthella gardneri*.

2. Two reserves near Babakin, containing populations of *Rhizanthella gardneri*, have been vested in the Conservation Commission as Class A Nature reserves for the Conservation of Flora and Fauna.
3. In November 2001 and 2002, 500 and 1000 seeds respectively were collected from Population 1. In November 2003, 1000 seeds were collected from Population 2 and in the same month 100 seeds were collected from Population 3. Seed failed to develop on plants found at a third Wheatbelt reserve (Pop. 3) and on plants found in southern populations. Seed used for research into propagation methods and *ex-situ* seedling establishment is currently held within the BGPA seed store while some seed (germplasm) along with mycorrhizal fungal isolates from Babakin collections were placed into interim cryostorage at the BGPA. Duplicates of this material have been lodged with the Millenium Seed Bank Project, Kew.
4. Mycorrhizal fungi have been isolated from sections of rhizome from three populations. These isolates have been used by the BGPA to effectively inoculate *Melaleuca scalena* hosts *ex-situ* and have enabled the germination and subsequent development of *Rhizanthella gardneri* rhizomes in glasshouse pot culture.
5. Genetic variation in *Rhizanthella gardneri* was examined by BGPA using a non destructive sampling technique for DNA extraction from floral bract material collected in 2001.
6. Preliminary *in situ* seed baiting trials were conducted by the BGPA in 2002, 2003 and 2005.
7. A research project was developed through the BGPA, UWA and DEC to examine some of the key issues associated with the biology and ecology of the orchid. The ARC Linkage funded PhD project (LP0454276), titled 'The role of mycorrhizal fungi in nutrient supply and habitat specificity of the rare underground orchid (*Rhizanthella gardneri)'* commenced mid 2004.
8. Population 6 (Kunjin) was fenced in 2004.
9. An irrigation system was set up at Population 6 (Kunjin) in 2005.
10. A system of logging moisture probes was installed in conjunction with the irrigation system.
11. A two sided poster containing photographs of the species, description and threat information, and outlining current recovery actions was produced by DEC and distributed.
12. Interpretative signage was placed at Babakin by the Bruce Rock Landcare Group.
13. Surveys of all known populations were undertaken by DEC, UWA and BGPA staff between 2004 and 2009.
14. DEC's Esperance, Great Southern and Yilgarn Districts Threatened Flora Recovery Teams (EDTFRT, GSDTFRT and YDTFRT) along with the BGPA are overseeing the implementation of this IRP and will include information of progress in their annual report to DEC's Corporate Executive and funding bodies.
15. Staff from the BGPA and DEC's Species and Communities Branch and Esperance, Great Southern and Yilgarn Districts, regularly monitor populations of the taxon.

IRP Objective: The objective of this IRP is to continue to abate identified threats and maintain or enhance viable *in situ* populations to ensure the long-term preservation of the species in the wild.

Recovery Criteria

Criteria for success: The number of populations have increased or the number of individuals within populations have increased by twenty percent or more over the term of the plan.

Criteria for failure: The number of populations have decreased or the number of individuals within populations have decreased by twenty percent or more over the term of the plan.

Recovery actions

1. Coordinate recovery actions	13. Collect seed and associated mycorrhizal fungi
2. Map habitat critical to survival of *Rhizanthella gardneri*	14. Develop suitable long-term storage protocols for orchid seed and associated mycorrhizal fungi
3. Liaise with land managers/owners and Indigenous groups	15. Obtain biological and ecological information
4. Achieve long-term protection of habitat	16. Characterise *Rhizanthella gardneri* habitat
5. Develop and implement a fire management strategy	17. Characterise the effects of seasonal climatic variation on *Rhizanthella gardneri* habitat
6. Fence at-risk populations	18. Characterise the fungal symbiont/s and its/their presence at existing and potential *Rhizanthella gardneri* sites and relate to specificity of the three *Melaleuca* species involved.
7. Conduct annual monitoring of all known populations	19. Examine the magnitude and timing of the transfer of isotopically labelled Carbon and Nitrogen within the *Rhizanthella gardneri* tripartite relationship
8. Conduct research into the reasons for habitat degradation	20. Determine the genetic variation of the orchid and associated mycorrhizal fungus in the disjunct northern and southern populations
9. Rehabilitate habitat	21. Trial *in situ* seed germination of *Rhizanthella gardneri*
10. Develop and implement a translocation proposal	22. Promote awareness
11. Conduct further surveys	23. Review this plan and assess the need for further recovery actions
12. Undertake weed control	

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History

John Trott discovered *Rhizanthella gardneri* on his farm near Corrigin on the 23rd of May 1928 when he uncovered a plant during ploughing. Richard Rogers described the species in August of the same year, naming it in honour of Charles Gardner, then the assistant to the Economic Botanist and Plant Pathologist in Department of Agriculture, and later (1929) Government Botanist and Curator of the State Herbarium (George 1980/1981; Dixon *et al.* 1984/1990; Brown *et al.* 1998). Between 1928 and 1959 *Rhizanthella gardneri* was found six more times, on each occasion, by chance during ploughing of recently rolled and burnt bushland. All discoveries up until this time were made between Corrigin and Dowerin. Nearly twenty years elapsed before the orchid was seen again, when in 1979 it was sighted by a private landowner on his farm at Munglinup some 300 kilometres south of the previously known locations. Subsequent surveys of broom honey-myrtle (*Melaleuca uncinata*) thickets in the Munglinup area by Dr Kingsley Dixon and members of the WA Native Orchid Study and Conservation Group (WANOSCG) uncovered 24 plants in three separate populations. Following these southern sightings the team searched areas of suitable habitat near the original sighting at Corrigin and in 1981 and 1982 located two more populations, together containing over 114 flowering plants. In 1985 a further population was discovered west of Corrigin and some 36 flowering plants were located at the site during surveys in 1989. Since then no new populations have been located and most existing populations in the northern area have shown a marked decline in flowering numbers and habitat health. The habitat of *Rhizanthella gardneri* within the southern area is in much better condition and a new cluster of *R. gardneri* plants were located in 2004. These were found immediately adjacent to a previously recorded population that had been destroyed by the construction of an emergency firebreak in 2003.

The health of flowering plants and their associated habitat in the southern area may be due to higher summer rainfall and more consistent winter rainfall. Extensive surveys in 1995 located just one flowering plant in each of the northern and southern areas. However, surveys in 2006 were much more successful following the good summer rainfall that fell in both areas, with 29 flowering plants found in the northern area and 10 in the southern area. Note, however, that these surveys were not comprehensive and it is likely that more plants were flowering in both areas.

A combination of funding from DEC, WWF Communities Grant, ARC Linkage and Natural Heritage Trust was used to implement some of the recovery actions listed in the previous IRP (and again in this IRP) and enabled the University of Western Australia (UWA) and Botanic Gardens and Parks Authority (BGPA) to conduct seed collection, monitoring, propagation, experimental translocation and research into the mycorrhizal association of the species.

In 2007 a four year Lotterywest funded project began, involving collaboration between the Western Australian Native Orchid Study and Conservation Group (WANOSCG), the School of Plant Biology at the University of Western Australia (UWA), the Friends of Kings Park, and the Department of Environment and Conservation (DEC). The project aims to help conserve Critically Endangered orchids in the Western Australian Wheatbelt by obtaining knowledge required for sustainable management and directly contributing to recovery actions.

Description

Rhizanthella gardneri was initially thought to be a monotypic genus confined to the south-west of Western Australia. However, in 1984, a second underground orchid, formerly known as *Cryptanthemis slateri*, was placed in *Rhizanthella* (Clements and Cribb 1985) and in 2006 a third presumed extinct Queensland species, *Rhizanthella omissa*, was described based on herbarium material collected in 1958 (Jones and Clements 2006). The latter two species are known from central-eastern New South Wales and south-eastern Queensland respectively and, like the western Underground Orchid, live out their entire life cycle under the surface of the soil.

All three species are leafless and lack chlorophyll.

The name *Rhizanthella* was coined by Richard Rogers in 1928 and refers to the rhizome-like tubers of the three orchids.

Flowering of *Rhizanthella gardneri* begins in mid May, early June in the northern populations and in late June, mid July for the southern populations, when each plant produces up to 100 small, inward facing, cream to reddish coloured flowers, surrounded by 6 to 12 large, cream or pinkish-cream bracts. These bracts form a tulip-like head that curves over the flowers forming a small opening at the soil surface. A layer of leaf and bark litter covers this opening. The plants have a horizontal rhizome 6 to 12 cm below the ground level, which, like the rest of the plant, is succulent and produces a formalin-like odour when cut. Once pollinated each flower produces a berry-like indehiscent fleshy fruit containing 20 to 150 seeds. This type of fruit is unique amongst the Western Australian orchids as species in all other orchid genera produce a dehiscing pod from which thousands of minute seeds are dispersed by the wind.

Distribution and habitat

Rhizanthella gardneri is known from two disjunct areas some 300 km apart - between Corrigin and Babakin, and northwest of Munglinup. Plants occur under leaf and bark litter in thickets of broom honey-myrtle with scattered emergent *Eucalyptus* and *Acacia* species. Soil is either sandy-clay or sandy-loam.

Table 1: Summary of population land vesting, purpose and management

Population Number and Location	DEC District	DEC Region	Shire	Vesting	Purpose	Manager
1. Babakin	Yilgarn	Wheatbelt	Bruce Rock	WA Conservation Commission	Conservation of Flora and Fauna	DEC
2. W of Babakin	Yilgarn	Wheatbelt	Bruce Rock	WA Conservation Commission	Conservation of Flora and Fauna	DEC
3. Oldfield River	Esperance	South Coast	Ravensthorpe	Unvested	Unallocated Crown Land	DoP
4. NW of Munglinup	Esperance	South Coast	Ravensthorpe	WA Conservation Commission	Conservation of Flora and Fauna	DEC
5. NW of Munglinup	Esperance	South Coast	Ravensthorpe	Private property	Private property	Landowner
6. Kunjin	Great Southern	Wheatbelt	Corrigin	Unvested	Town reserve	Shire

Note: The Department of Environment and Conservation is the management agency for fire prevention, feral animals and weeds in areas of Unallocated Crown Land in WA. Due to the CR status of this species all populations are considered to be important populations.

Biology and ecology

Rhizanthella is similar to other orchids in that it relies on an association with a mycorrhizal fungus (Warcup 1985; Greirson *et al.* 2004). However the orchid's subterranean habit and lack of photosynthetic capacity, suggests its dependence on this association is likely to be greater than that for other autotrophic (photosynthetic) orchid taxa. This enhanced relationship of *Rhizanthella* with the mycorrhizal fungus (*Thanatephorus gardneri*) which forms a link between the orchid and associated plant species (*Melaleuca scalena*, *M. hamata* and *M. uncinata*) is unusual in the Orchidaceae (Warcup 1985; Dixon *et al.* 1990; Craven *et al.* 2004). This suggests that the survival of *Rhizanthella* is dependent upon the presence of the autotrophic *Melaleuca* spp. through the shared mycorrhizal fungus. Laboratory based germination and growth trials support this hypothesis.

It is currently unknown why the orchid occurs under some thickets of *Melaleuca scalena*, *M. hamata* and *M. uncinata* and apparently not under others. However, given that a recent taxonomic revision has found there to be 11 recognisable taxa within the previously single widespread *Melaleuca uncinata* complex (Craven *et al.* 2004) it is possible that the orchid occurs with some of these taxa and not others. It is also not known why the orchid appears in two disjunct areas some 300 km apart. Distribution of essential mycorrhizal fungi may be a determining factor for its distribution. However, research using seed baiting methods developed by BGPA for detection of suitable mycorrhizal fungi, may provide further information. There is also some genetic evidence to suggest that these geographically disjunct groups of populations may be sufficiently distinct to warrant separate treatment with respect to recovery actions. However further study is required to identify if and at what level this distinction may be regarded taxonomically.

Small fungal gnats pollinate flowers of the underground orchid. These are small enough to get through the gaps in the leaf and bark litter that covers the tulip-like inflorescence of the orchid. The gnats crawl through the litter into the tiny opening at the top of the floral bracts and down to the flowers that encircle the inside of the

capitulum. Other insects such as termites and mosquitoes have been seen on flowers of an exposed capitulum and may also be incidental pollinators.

It is currently unknown how seed is dispersed but it is thought that small marsupials may eat the succulent fruits produced by the plant and deposit seed in their faeces.

A major research initiative has been conducted through the BGPA, UWA and DEC which examined some of the key issues associated with the biology and ecology of the orchid. An ARC Linkage **(**LP0454276) and DEC funded project (Jeremy Bougoure PhD) was also undertaken with the objective of understanding the role of mycorrhizal fungi in nutrient supply and habitat specificity of the myco-heterotrophic *Rhizanthella gardneri*. This research was focused on both species and ecosystem (habitat) scales.

Threats

Rhizanthella gardneri was declared as Rare Flora in November 1980 and is currently ranked as Critically Endangered (CR) under World Conservation Union (IUCN 2001) Red List criteria B2ab(ii,iii,v); C2a(i); D. However, as further plants were located in existing populations during surveys in 2005 and 2006, the species now meets CR under B2ab(iii) due to the extreme fragmentation of populations and a continuing decline in the area, extent and quality of habitat. *Rhizanthella gardneri* is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The orchid's specialized habitat survives as disjunct remnants in the central and southern wheatbelt. In the central wheatbelt altered and sporadic climatic conditions resulting in a lack of rainfall at crucial stages of *Melaleuca scalena* growth has affected key habitat characteristics, which have resulted in declining *Rhizanthella gardneri* numbers. Little recruitment of *M. scalena* is also evident in this area and the once large thickets are becoming smaller and more open. Similar events are evident at southern wheatbelt sites although their effects are less dramatic.

The main threats are altered climatic conditions - particularly rainfall, poor recruitment, lack of suitable habitat, degraded habitat, road and firebreak maintenance, death of associated *Melaleuca* species due to senescence and other factors, rising saline water tables (Meston 2001), weeds, inappropriate fire regimes and human damage during searches for the orchid. Threats include:

- **Altered climatic conditions** resulting in decreased annual rainfall appear to be a major threat to the habitat of *Rhizanthella gardneri* in the central Wheatbelt. The lack of moisture availability for *M. scalene* at key growth stages may be impacting on productivity (biomass accumulation and litter fall). A reduction in productivity will in turn impact on soil nutrient cycling, soil moisture retention and fungal activity. These phenomena are evident at southern wheatbelt sites but are less dramatic.

- **Degraded or loss of habitat** is a current and continuing threat to known and potential populations. All known populations occur in small natural remnants subject to stresses from surrounding land use.

- **Road and firebreak maintenance** threatens several southern populations. Part of a population was destroyed by the creation of an emergency fire break in response to a wildfire in 2003.

- **Rising saline water tables** are possibly already causing deaths amongst the associated *Melaleuca scalena* and are likely to become an increasing future threat.

- **Death of associated *Melaleuca* species** due to senescence, changed hydrology, poor rainfall and other factors.

- **Weed invasion** is a minor threat to all populations. The effect of weeds is uncertain but they are likely to compete for soil moisture and nutrients needed by the orchid and associated fungi. Weeds also increase the fire hazard due to the easy ignition of high fuel loads produced annually by many grass weed species.

- **Inappropriate fire** may threaten populations of *Rhizanthella gardneri* as it is likely to alter the habitat of the species. There is a lack of knowledge of appropriate fire regimes, although, past experiences suggest

that extreme/high fire intensities may result in a major change in vegetation structure and be catastrophic for *R. gardneri* survival.

- **Human damage** during searches for the orchid is a potential threat. The method used to locate plants is destructive, requiring the removal of leaf litter beneath *Melaleuca scalena*. The litter, when replaced, is mixed with soil resulting in soil compaction.

- **Poor recruitment and declining populations** are a major threat to the orchid. In areas where many flowering plants were located during surveys in the 1980s few plants were found during surveys in 2001 and 2002. In 2004 only one plant was located in the northern populations.

- **A lack of a seed dispersal agent and severe habitat fragmentation** may prevent recruitment into new habitats.

The intent of this plan is to provide actions that will deal with immediate threats to *Rhizanthella gardneri*. Although climate change may have a long-term effect on the species, actions taken directly to prevent the impact of climate change are beyond the scope of this plan.

Table 2: Summary of population information and threats

Pop. No. & Location	Year	No. plants	Condition	Threats
1. Babakin	1982	110	Moderate	Altered climatic conditions and subsequent effects on habitat, future rising saline water tables, human damage, senescence of associated *Melaleuca*, habitat degradation from surrounding land use
	2001	15		
	2002	10		
	2003	1		
	2004	0		
	2005	0		
	2006	14		
	2009	8		
2. W of Babakin	1982	4	Moderate	Altered climatic conditions and subsequent effects on habitat, future rising saline water tables, human damage, senescence of associated *Melaleuca*, habitat degradation from surrounding land use
	2001	6		
	2002	2		
	2004	1		
	2005	1		
	2006	10		
	2009	2		
3. Oldfield River	1982	4	Good	Altered climatic conditions and subsequent effects on habitat, human damage, habitat degradation from surrounding land use, road and firebreak maintenance
	2002	2		
	2003	3		
	2004	16		
	2005	1		
	2006	2		
	2009	4		
4. NW of Munglinup	1982	4	Poor, area recovering from fire	Altered climatic conditions and subsequent effects on habitat, human damage, habitat degradation from surrounding land use, inappropriate fire regime
	2002	0		
	2003	0		
	2004	0		
	2005	0		
	2006	0		
	2009	0		
5. NW of Munglinup	1981	10	Good	Altered climatic conditions and subsequent effects on habitat, human damage, habitat degradation from surrounding land use, road maintenance
	2002	2		
	2003	2		
	2004	14		
	2005	0		
	2006	8		
	2009	22		
6. Kunjin	1989	38	Poor	Altered climatic conditions and subsequent effects on habitat, future rising saline water tables, human damage, senescence of associated *Melaleuca*, habitat degradation from surrounding land use
	2001	2		
	2002	3		
	2003	0		
	2004	0		
	2005	0		
	2006	5		
	2009	6		

Guide for decision-makers

Section 1 provides details of current and possible future threats. Developments and/or land clearing (including on-ground works such as firebreaks, roadworks etc) in the immediate vicinity of *Rhizanthella gardneri* require assessment. Developments or clearing should not be approved unless the proponents can demonstrate that their actions will have no significant impact on the species, its habitat or potential habitat, or on the local surface and ground water hydrology, such that drainage in the habitat of the species would be altered. Any fire control measures, such as construction of fire breaks should only be carried out in consultation with DEC. Emergency fire control contingencies should be directed by a co-ordination and communication strategy between DEC and those agencies and individuals responsible for fire control. This strategy should refer to the protection of orchid populations and associated habitat critical to the survival of the species.

Habitat critical to the survival of *Rhizanthella gardneri*, and important populations

Given that *Rhizanthella gardneri* is ranked as CR, it is considered that all known habitat for wild populations is critical to the survival of the species, and that all wild populations are important populations. Habitat critical to the survival of *R. gardneri* includes the area of occupancy of important populations; areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators); additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations; and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Benefits to other species and/or ecological communities

There are no other known listed threatened species or ecological communities in the immediate vicinity of *Rhizanthella gardneri*. However, recovery actions implemented to improve the quality or security of the habitat of the species, such as weed control and habitat rehabilitation, will benefit the remnant bushland habitat in which it occurs.

International Obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. The species is listed under the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES), however this IRP does not affect Australia's obligations under any other international agreements.

Indigenous Consultation

Involvement of the Indigenous community is being sought through the South West Aboriginal Land and Sea Council (SWALSC) and Department of Indigenous Affairs to determine whether there are any issues or interests identified in the plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register has identified that there are no sites of Aboriginal significance at or near populations of the species covered by this IRP. Where no role is identified for the indigenous community associated with this species in the development of the recovery plan, opportunities may exist through cultural interpretation and awareness of the species. Indigenous involvement in the implementation of recovery actions will be encouraged.

Continued liaison between DEC and the indigenous community will identify areas in which collaboration will assist implementation of recovery actions.

Social and economic impacts

One population of *Rhizanthella gardneri* occurs on private property and negotiations between DEC and the landowners have ensured that the area directly supporting the species has been left uncleared. Negotiations will continue with regard to the future management of the population. The implementation of this recovery plan does therefore have some social and economic impact. Other populations occur in Nature Reserves, a Townsite Reserve and Unallocated Crown Land.

Affected interests

Stakeholders potentially affected by the implementation of this plan include the Shires of Corrigin, Ravensthorpe and Bruce Rock, DEC, the Conservation Commission, and the owners of private property.

Evaluation of the Plan's Performance

DEC, in conjunction with the Yilgarn District, Great Southern District and Esperance District Threatened Flora Recovery Teams will evaluate the performance of this IRP. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan is to be reviewed following four years of implementation.

2. RECOVERY OBJECTIVE AND CRITERIA

Objectives

The objective of this IRP is to continue to abate identified threats and maintain or enhance viable *in situ* populations to ensure the long-term preservation of the species in the wild.

Criteria for success: The number of populations have increased or the number of individuals within populations have increased by twenty percent or more over the term of the plan.
Criteria for failure: The number of populations have decreased or the number of individuals within populations have decreased by twenty percent or more over the term of the plan.

3. RECOVERY ACTIONS

Existing recovery actions

Relevant landowners and managers and owners have been made aware of the location and threatened status of *Rhizanthella gardneri*. Notification details the Declared Rare status of the species and legal obligations to protect it.

Two reserves near Babakin, containing populations of *Rhizanthella gardneri*, have been vested in the Conservation Commission as Class A Nature reserves for the Conservation of Flora and Fauna.

In November 2001 and 2002, 500 and 1000 seeds respectively were collected from Population 1. In November 2003, 1000 seeds were collected from Population 2 and in the same month 100 seeds were collected from Population 3. Seed failed to develop on plants found at a third Wheatbelt reserve (Pop. 3) and on plants found in southern populations. Seed used for research into propagation methods and *ex-situ* seedling establishment is currently held within the BGPA seed store while some seed (germplasm) along with mycorrhizal fungal isolates from Babakin collections are placed in interim cryostorage at the BGPA. Duplicates of this material have been lodged with the Millenium Seed Bank Project, Kew.

Mycorrhizal fungi have been isolated from sections of rhizome from three populations. These isolates have been used by the BGPA to effectively inoculate *Melaleuca scalena* hosts *ex-situ* and have enabled the germination and subsequent development of *Rhizanthella gardneri* rhizomes in glasshouse pot culture. One of these plants produced an inflorescence however it and all other seedlings died from unknown causes. These plants were raised from the Babakin seed collections. Future *ex-situ* plants represent a potential source of germplasm for northern populations in the event that they are unable to sustain future collection. Further germination trials are planned for 2006.

Genetic variation in *Rhizanthella gardneri* was examined by BGPA using a non destructive sampling technique for DNA extraction from floral bract material collected in 2001. Preliminary data indicates that the Northern and Southern populations show evidence of genetic as well as geographic isolation and may be sufficiently distinct to confer separate taxonomic status. However these data also suggest that particular features of the *R. gardneri* genome will require the development and application of specialist molecular genetic "finger-printing" techniques. For example, identifying characteristic patterns of genome micro-satellite occurrences may help to determine the nature and degree of genetic separation between populations.

Preliminary *in situ* seed baiting trials were conducted by the BGPA in 2002. These were not successful and failure of seedlings to develop beyond the germination stage was attributed to a lack of soil moisture. A similar study was attempted in 2003 but failed to produce germination. The trials were again set-up in2005 at all known habitats and including irrigated and non-irrigated sites. Germination occurred but plants did not survive the first summer.

A research project was developed through the BGPA, UWA and DEC to examine some of the key issues associated with the biology and ecology of the orchid. The ARC Linkage funded PhD project (LP0454276), titled 'The role of mycorrhizal fungi in nutrient supply and habitat specificity of the rare underground orchid (*Rhizanthella gardneri)'* commenced mid 2004.

Population 6 (Kunjin) was fenced in 2004.

An irrigation system was set up at Population 6 (Kunjin) in 2005.

A system of logging moisture probes was installed in conjunction with the irrigation system. These probes monitor the moisture availability.

A two sided poster containing photographs of the species, description and threat information, and outlining current recovery actions was produced by DEC and distributed.

Interpretative signage was placed at Babakin by the Bruce Rock Landcare Group.

Surveys of all known populations were undertaken by DEC, UWA and BGPA staff between 2004 and 2009.

DEC's Esperance, Great Southern and Yilgarn Districts Threatened Flora Recovery Teams (EDTFRT, GSDTFRT and YDTFRT) along with the BGPA are overseeing the implementation of this IRP and will include information of progress in their annual report to DEC's Corporate Executive and funding bodies.

Staff from the BGPA and DEC's Species and Communities Branch and Esperance, Great Southern and Yilgarn Districts regularly monitor populations of the species.

Future recovery actions

Where populations occur on lands other than those managed by DEC, permission has been or will be sought from appropriate owners/land managers prior to recovery actions being undertaken. The following recovery actions are generally in order of descending priority, influenced by their timing over the life of the plan. However this should not constrain addressing any of the actions if funding is available and other opportunities arise.

1. Coordinate recovery actions

Threatened Flora Recovery Teams (TFRTs) that coordinate recovery actions for *Rhizanthella gardneri* and other Declared Rare Flora in DECs Esperance, Great Southern and Yilgarn Districts, will include information on progress in their annual reports to DEC's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: DEC (SCB, Esperance, Great Southern and Yilgarn Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $3,500 per year

2. Map habitat critical to survival of *Rhizanthella gardneri*

It is a requirement of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) that spatial data relating to habitat critical to the survival of threatened species be determined. Although this is alluded to in Section 1, all the areas described have not yet been accurately mapped and will be addressed under this action. If additional populations are located, then habitat critical to their survival will also be determined and mapped.

Action: Map habitat critical to survival of *Rhizanthella gardneri*
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $1,800 in the first year

3. Liaise with land managers/owners and Indigenous groups

Staff from DEC's Yilgarn, Great Southern and Esperance Districts will continue liaison with land landowners and land managers to ensure that populations are not accidentally damaged or destroyed. Input and involvement will also be sought from any Indigenous groups that have an active interest in areas that are habitat for *Rhizanthella gardneri.*

Action: Liaise with land managers/owners and Indigenous groups
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $1,500 per year

4. Achieve long-term protection of habitat

Staff from DEC's Yilgarn, Great Southern and Esperance Districts will seek ways and means of improving the security of populations and their habitat. This may include land purchase, conservation covenants or utilising the Land for Wildlife scheme. Populations at Kunjin and Oldfield River are currently on Crown land and it is desirable for the long-term conservation of the species that these areas be vested in the Conservation Commission as Class A Nature Reserves for the purpose of Conservation of Flora and Fauna.

Action: Achieve long-term protection of habitat
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $1,000 in the first year, $200 per year thereafter. Note: if land is purchased the cost will be considerably higher

5. Develop and implement a fire management strategy

The effect of fire on *Rhizanthella gardneri* and associated native species is unknown. One southern population has not reappeared following fire indicating that fire should, if possible be excluded from areas in which orchid populations are known or likely to occur until more is understood about its affect.

In addition, there is a need for emergency fire response coordination such that control measures will have minimum adverse impact on populations. A fire management strategy will be developed to determine appropriate fire control measures and fire frequency as well as ensure that where possible fire control agencies coordinate activities with reference to the conservation requirements of *Rhizanthella* populations and their associated habitat.

Action: Develop and implement a fire management strategy
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $2,400 in the first year and $1,000 in subsequent years (if required)

6. Fence at-risk populations

As part of habitat management and protection, Populations 1 and 2 may require fencing. This will also provide security for research plots.

Action: Fence at-risk populations
Responsibility: DEC (Yilgarn District) through the Great Southern District TFRT
Cost: $7,000 for installation, ($400 per year thereafter for maintenance)

7. Conduct annual monitoring of all known populations

Annual monitoring of factors such as population stability (expansion or decline), habitat degradation, pollinator activity, seed production, recruitment, longevity and predation is essential. Particular attention should be paid to the level of threat posed by the decline of *Melaleuca scalena*. In addition to those areas supporting existing populations of *Rhizanthella gardneri*, monitoring is also required in areas containing healthy stands of *M. scalena* to establish the occurrence of mycorrhizal fungi including *Thanatephorus gardneri* and potential sites for orchid translocation.

Monitoring should include the recovery of habitat and populations following wildfires. Population 4 north-west of Munglinup was burnt in 2001 and no *Rhizanthella gardneri* have been located there since. The reserve was burnt again in 2005.

Monitoring should be conducted on the phenology of *Rhizanthella gardneri* to identify the optimum period and conditions for viable seed collection so that any detrimental impact on populations will be minimised.

One of the threats to this species is human damage during surveys/monitoring and a monitoring protocol should therefore be developed to minimise the threat of future monitoring. The protocol should detail the correct procedures to use at all sites, as well as specific instructions for each population, including such things as:

- pre-survey briefing
- how to access
- precautions to take – boot clean, equipment required
- safety issues
- things that need to be observed and recorded.

The establishment of long-term monitoring sites is desirable and should include undisturbed controls as well as sites set up for experimentally manipulated litter augmentation and moisture (irrigation) studies to be undertaken under recovery action 15.

Action: Conduct annual monitoring of all known populations
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $4,750 per year

8. Conduct research into the reasons for habitat degradation

The habitat of *Rhizanthella gardneri* in the areas of Populations 1 and 2 is under severe threat as the *Melaleuca scalena* thickets under which it grows, and on which it relies for its mycorrhizal nutrient link, are showing signs of severe stress with many mature plants dead or dying. The reasons for these deaths is unknown but may be due to either senescence, drought or rising saline water tables or a combination of all three. Research is needed to ascertain the causes so that management decisions may be made in an effort to reverse the trend.

Action: Conduct research into the reasons for habitat degradation
Responsibility: DEC (Science Division, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $8,000 for the first two years

9. Rehabilitate habitat

If identified as a need during monitoring DEC will undertake habitat restoration including the re-introduction of endemic plant species to sites. This would be part of an overall habitat management program focused on long term protection of habitat.

Action: Rehabilitate habitat
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs

Cost: $6,000 per year (if required)

10. Develop and implement a translocation proposal

As the number of extant adult plants is low and populations are not secure from threats, a translocation proposal will be developed and suitable translocation sites selected. Site selection will make reference to information arising from fungal symbiont characterisation and seed baiting trials carried out as part of the PhD project which examined *Rhizanthella gardneri* habitat relationships (see also recovery action 15). The translocation proposal will be developed by BGPA in conjunction with the Esperance and Great Southern District Threatened Flora Recovery Teams. Information on the translocation of threatened plants and animals in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*, and conform with the principles contained in the Translocation Guidelines developed by the Australian Network for Plant Conservation (Vallee *et al* 2004). All translocation proposals require endorsement by DEC's Director of Nature Conservation. Translocation is dependent on the development of suitable propagation protocols and the availability of appropriate translocation sites.

Action: Develop and implement a translocation proposal
Responsibility: BGPA and DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $7,000 in the second and $3,500 in the third and fourth years

11. Conduct further surveys

Further surveys by BGPA, DEC staff and community volunteers will be conducted during the flowering period of the species (May to July). Protocols developed for monitoring should also be adhered to when surveying to minimise the threat of accidental damage.

Action: Conduct further surveys
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $8,000 per year

12. Undertake weed control

Weeds are a minor threat in all populations. The following actions will be implemented:
1. Appropriate herbicides will be selected after determining which weeds are present.
2. Weed control will be scheduled to include spraying of other threatened flora populations within the Districts.

Action: Undertake weed control
Responsibility: DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $1,500 per year (if required)

13. Collect seed and associated mycorrhizal fungi

Of particular importance is the acquisition of seed and fungal material from the southern populations for which none currently exists.

Action: Collect seed and associated mycorrhizal fungi
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $3,200 for the first year and $1,000/year thereafter

14. Develop suitable long-term storage protocols for orchid seed and associated mycorrhizal fungi

Preservation of germplasm is essential to guard against extinction if wild populations are lost. Such collections are also needed to propagate plants for translocations. A small quantity of seed has been collected from two

populations but further collections are required from these and the other four known populations. The collection of specific mycorrhizal fungi is also necessary as this is required for seed germination and subsequent growth. Development of suitable long-term storage protocols for propagation material (seed and mycorrhizal fungi) is required.

Action: Develop suitable long-term storage protocols for orchid seed and associated mycorrhizal fungi
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $5,500 for the first two years and $2,000 in subsequent years

15. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *Rhizanthella gardneri* will provide a better scientific basis for its management in the wild. Partial funding was provided through the ARC Linkage Project 0454276 (Jeremy Bougoure PhD) and included preliminary work on actions 16, 17, 18, 19, 20, 21, 22 and 23.

Action: Obtain biological and ecological information
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $30,000 pa for the first three years

16. Characterise *Rhizanthella gardneri* habitat

Further analyse habitat characteristics, particularly nutritional characteristics, of isolated populations of *Rhizanthella gardneri*. Determining similarities and differences between the populations may show potential prerequisites and limitations to the survival of this species. This information will also have applications in the identification of other *R. gardneri* populations.

Action: Characterise *Rhizanthella gardneri* habitat
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: Covered by action 15

17. Characterise the effects of seasonal climatic variation on *Rhizanthella gardneri* habitat

Research the observed correlation between decreased *Rhizanthella gardneri* sightings and an increase in low rainfall conditions experienced throughout the range of the species. Determine how the individual and collective components of the *R. gardneri* tripartite relationship respond to normal seasonal climatic changes, especially moisture availability. This will involve a comparison between seasons and across sites of data obtained through trials that include litterfall measurements, photosynthesis of *Melaleuca scalena* fine root biomass production, fungal activity and soil moisture. Manipulation of soil moisture through the irrigation of selected northern sites will determine if it is general drought or a lack of summer rainfall that is effecting *R. gardneri* growth. This will be done by looking at the fungus and orchid/*Melaleuca* components individually and collectively.

Action: Characterise the effects of seasonal climatic variation on *Rhizanthella gardneri* habitat
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: Covered by action 15

18. Characterise the fungal symbiont/s and its/their presence at existing and potential *Rhizanthella gardneri* sites

Although the fungal partner of *R. gardneri* has been identified (Warcup 1985), the accuracy of this has recently been questioned. The previous identification was based on morphological characteristics of limited material. The confirmation or rejection of this identification will be based on a molecular sequencing approach. This

approach will also elucidate the specificity of the orchid-fungus relationship. This information can then be used to identify further populations of *R. gardneri*.

Action: Characterise the fungal symbiont/s and its/their presence at existing and potential *Rhizanthella gardneri* sites and relate to specificity to the three *Melaleuca* species involved in the *R. gardneri* association.
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: Covered by action 15

19. Examine the magnitude and timing of the transfer of isotopically labeled Carbon and Nitrogen within the *Rhizanthella gardneri* tripartite relationship

Sophisticated trials using a compartmentalized pot system are being established so as individuals of the tripartite system can be 'fed' isotopically labelled Carbon and Nitrogen. The isotopically labelled C and N can then be traced to assess their destination and rate of transfer. This will demonstrate the dependence of *R. gardneri* on both its fungal partner and the ectomycorrhizal *Melaleuca* spp.

Action: Examine the magnitude and timing of the transfer of isotopically labelled Carbon and Nitrogen within the *Rhizanthella gardneri* tripartite relationship
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: Covered by action 15

20. Determine the genetic variation of the orchid and associated mycorrhizal fungus in the disjunct northern and southern populations

Determine whether the geographically disjunct northern and southern populations are sufficiently distinct genetically to warrant separate treatment with respect to recovery actions. The examination of genome micro satellites may be needed to overcome problems with (AFLP's) and the large genome size of *Rhizanthella gardneri.* Such techniques will increase the time and resources required for genetic analysis.

Action: Determine the genetic variation between disjunct northern and southern populations
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: Covered by action 15

21. Trial *in situ* seed germination of *Rhizanthella gardneri*

Seed collected in retrievable pouches from known *Rhizanthella gardneri* locations will be used to assess seed viability under field conditions. If successful this method may be suitable for establishing new individuals of *R. gardneri* in field sites. These trials will be conducted at known *R. gardneri* populations in accordance with necessary regulations and permits.

Action: Trial *in situ* seed germination of *Rhizanthella gardneri*
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) UWA and BGPA in association with the Great Southern & Esperance Districts TFRTs
Cost: Covered by action 15

22. Promote awareness

The importance of biodiversity conservation and the need for the long-term protection of wild populations of *Rhizanthella gardneri* will be promoted to the community through poster displays and the local print and electronic media. Formal links with local naturalist groups and interested individuals will also be encouraged. An information sheet, which includes a description of the plant, its habitat, threats and recovery actions has been produced and distributed.

A reply paid postal drop illustrating *Rhizanthella gardneri* and describing its distinctive features and habitat will be produced and distributed by DEC's Yilgarn, Great Southern and Esperance District offices to local farmers and other residents in Shires containing possible habitat of the taxon. The identification of any populations found through this action will be confirmed by staff from Yilgarn, Great Southern or Esperance Districts. Postal drops aim to stimulate interest, provide information about threatened species and provide a name and number to contact if new populations are found by members of the community.

Action: Promote awareness
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $1,300 in first year and $1,000 in subsequent years

23. Review this plan and assess the need for further recovery actions

If *Rhizanthella gardneri* is still ranked CR at the end of the five-year term of this IRP, the need for further recovery actions, or a review of this IRP will be assessed and a revised plan prepared if necessary.

Action: Review this plan and assess the need for further recovery actions
Responsibility: DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs
Cost: $9,000 in the fifth year (if required)

Table 3: Summary of recovery actions

Recovery Actions	Priority	Responsibility	Completion date
Coordinate recovery actions	High	DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Map habitat critical to survival of *Rhizanthella gardneri*	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	2010
Liaise with land managers/owners and Indigenous groups	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Achieve long-term protection of habitat	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Develop and implement a fire management strategy	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Developed by 2011 with implementation ongoing
Fence at-risk populations	High	DEC (Yilgarn District) through the Great Southern District TFRT	2011
Conduct annual monitoring of all known populations	High	DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Conduct research into the reasons for habitat degradation	High	DEC (Science Division, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	2012
Rehabilitate habitat	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Develop and implement a translocation proposal	High	BGPA and DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	2015
Conduct further surveys	High	DEC (SCB, Yilgarn, Great Southern and Esperance Districts) and BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing

Undertake weed control	High	DEC (Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Collect seed and associated mycorrhizal fungi	High	BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Develop suitable long-term storage protocols for orchid seed and associated mycorrhizal fungi	High	BGPA through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Obtain biological and ecological information	High	BGPA, DEC (SCB, Yilgarn, Great Southern and Esperance Districts) and UWA (Jeremy Bougoure PhD) through the Esperance, Great Southern and Yilgarn Districts TFRTs	2014
Promote awareness	Medium	DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	Ongoing
Review this plan and assess the need for further recovery actions	Medium	DEC (SCB, Yilgarn, Great Southern and Esperance Districts) through the Esperance, Great Southern and Yilgarn Districts TFRTs	2015

4. TERM OF PLAN

This IRP will operate from June 2010 to May 2015 but will remain in force until withdrawn or replaced. If the species is still ranked as CR after five years, the need for further recovery actions will be determined.

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6. TAXONOMIC DESCRIPTION

Adapted from Rogers, R.S. (1928/29) A new genus of Australian Orchid. *Journal of the Royal Society of Western Australia*, 15:1-7.

Rhizanthella gardneri is a small subterranean epi-parasitic herb. Rhizomes short, thickened, without roots, branching. Inflorescences erect, subsessile, solitary, terminal; those on the smaller lateral rhizomes with well developed bracteate stems. Capitula up to 5 cm in diameter; bracts rather large, ovate or oblong-lanceolate, imbricate, up to 5 cm long, slightly spreading at the apices, in my specimens about 12 in number. Flowers numerous, small, sessile, dark purple, crowded, facing the centre, arranged in 4 or 5 whorls. Sepals and petals erect, about 4 mm long, connate in a split tube 3-lobed at the apex. Dorsal sepal cucullate, adnate in its lower half with the petals and back of the column, triangular-ovate, rather wide, concave, abruptly incurved at the apex, ending in a short recurved apiculum; lateral sepals very fleshy, connate in their lower half, widely triangular, their apices short acute enclosing a sinus. Petals oblong-falcate, acute. Membranous, slightly shorter and much narrower than the sepals and hidden by the latter, adnate in the lower half by the posterior margins to the dorsal sepal and column, forming a galea with the former. Labellum reddish, attached to the apex of the column-foot by a delicate movable claw, linguiform, conspicuous, very large in comparison with the size of the flower, the apex subacute, glandular, undivided, very fleshy, erect against the column then recurved; lamina longitudinally concave, the tip slightly protruding from the galea. Column erect, almost equal in length to the sepals, not winged, terete, adnate to the petals and dorsal sepal, produced into a short foot at the base. Anther persistent, terminal, erect, without a point, rather obtuse, compressed laterally at the apex, rather widely attached to the posterior margin of the clinandrium, valvate, 2-celled. Clinandrium slightly concave. Pollinia 4, granular, almost sessile on the minute viscidium of the rostellum. Stigma prominent vertical, ovate, rather large. Rostellum erect, emarginate at the apex, much shorter than the anther. Ovary white, terete, up to 7mm long, the subtending bract lanceolate, equal to or sometimes longer than the ovary.