

INTERIM RECOVERY PLAN NO. 201

# YELLOW MOUNTAIN BELL (*DARWINIA COLLINA*)

## INTERIM RECOVERY PLAN

2005-2010

Renée Hartley<sup>1</sup> and Sarah Barrett<sup>2</sup>

<sup>1</sup> Technical Officer, CALM Albany Work Centre, 120 Albany Hwy, Albany 6330

<sup>2</sup> Flora Conservation Officer, CALM Albany Work Centre, 120 Albany Hwy, Albany 6330



Photo: Ellen Hickman

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Department of Conservation and Land Management  
Albany Work Centre  
South Coast Region  
120 Albany Hwy, Albany WA 6331

## 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.

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.

CALM 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.

This IRP will operate from April 2005 to March 2010 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Endangered, this IRP will be reviewed after five years and the need further recovery actions assessed.

This IRP was given regional approval on 26 October, 2005 and was approved by the Director of Nature Conservation on 26 October, 2005. The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at April 2005.

## ACKNOWLEDGMENTS

The following people have provided assistance and advice in the preparation of this Interim Recovery Plan:

Sandra Gilfillan	Conservation Officer, Albany Work Centre
Anne Cochrane	Manager, CALM Threatened Flora Seed Centre
Andrew Brown	Threatened Flora Coordinator, CALM Species and Communities Branch

Thanks also to staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and CALM Wildlife Branch for their assistance.

## SUMMARY

<b>Scientific Name:</b> <i>Darwinia collina</i>	<b>Common Name:</b> Yellow Mountain Bell
<b>Family:</b> Myrtaceae	<b>Flowering Period:</b> March to April & August to November
<b>CALM Regions:</b> South Coast	<b>CALM District:</b> Albany Work Centre
<b>Shires:</b> Gnowangerup, Plantagenet	<b>Recovery Team:</b> Albany District Threatened Flora Recovery Team

**Illustrations and/or further information:** Brown, A., Thomson-Dans, C. and Marchant, N. (Eds). (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia; Western Australian Herbarium (1998) FloraBase - Information on the Western Australian Flora. Department of Conservation and Land Management, Western Australia. <http://www.calm.wa.gov.au/science/>.

**Current status:** *Darwinia collina* was declared as Rare Flora in 1980 under the Western Australian *Wildlife Conservation Act 1950* and currently meets World Conservation Union (IUCN 2001) Red List Category Endangered (EN) under Criteria A2c due to its limited geographic range and decline in habitat quality. It is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The species is currently known from four populations in the Stirling Range National Park.

**Description:** *Darwinia collina* is a bushy shrub up to 1m high with the most rounded leaves (1cm by 5mm; minutely toothed) and bracts of any of the mountain bells. The bell is in fact a cluster of drooping flowers that are enclosed by broad, lemon-yellow petal-like leaves referred to as bracts. They have white petals and stigmas up to 2 cm long, also enclosed in the bracts.

**Habitat requirements:** *Darwinia collina* is endemic to mountain summit areas of the Stirling Range where it grows on shallow siliceous soils over sandstone and shale, in dense heath and thicket. The species is endemic to the Critically Endangered Threatened Ecological Community, Eastern Stirling Range Montane Heath and Thicket Community, which is found at high altitudes.

**Habitat critical to the survival of the species, and important populations:** The habitat critical to the survival of *Darwinia collina* comprises the area of occupancy of the known population; similar habitat within 200 metres of the known population; remnant vegetation that may link future populations; and additional nearby occurrences of similar habitat that do not currently contain the species but may have done so in the past and may be suitable for translocations. Given that this taxon is listed as Endangered it is considered that all populations are important populations.

**Benefits to other species/ecological communities:** *Darwinia collina* occurs exclusively within the Montane Threatened Ecological Community (Montane Heath and Thicket of the South West Botanical Province), which is listed as Critically Endangered under the Commonwealth *Environmental Protection and Biodiversity Act 1999* and contains a number of threatened species. Furthermore, Stirling Range National Park is habitat for seven threatened fauna species. Recovery actions put in place for *D. collina* will benefit the Montane TEC and the adjacent threatened fauna species and reciprocally, actions put in place for the recovery of the Montane TEC and the adjacent threatened fauna species will benefit *D. collina*.

**International obligations:** This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity and will assist in implementing Australia's responsibilities under that convention. The taxon is not listed under any specific international treaty and therefore this IRP does not affect Australia's obligations under any other international agreements.

**Role and interests of indigenous people:** According to the Department of Indigenous Affairs Aboriginal Heritage Sites Register, the registered site Kojaneerup (S01409) occurs within 20 kilometres of *Darwinia collina*. The Department has welcomed any future consultation that will seek input and involvement from any Noongar groups that have an active interest in the areas that are habitat for *D. collina* and this is discussed in the recovery actions

**Affected interests:** All known populations are on Crown land.

**Social and economic impacts:** The implementation of this recovery plan has minimal social and economic impact as all populations are on CALM-managed land.

**Evaluation of the Plan's Performance:** The Department of Conservation and Land Management (CALM), in conjunction with the Albany District Threatened Flora Recovery Team (ADTFRT) will evaluate the performance of this IRP.

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

1. All land managers have been notified of the location and threatened status of the species.
2. Seed collections have been made by staff from CALM Threatened Flora Seed Centre (TFSC).
3. Volunteers and staff from the CALM Albany Work Centre regularly monitor populations.
4. Phosphite is applied to three extant populations for control of *Phytophthora cinnamomi*.
5. An information sheet on mountain bells has been provided to the land manager to promote awareness.

**IRP Objective:**

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

**Recovery criteria**

**Criteria for success:** The number of populations and individuals within populations remains stable or increases over the five years of the plan.

**Criteria for failure:** The number of populations or the number of individuals within populations decreases over the five years of the plan.

**Recovery actions**

1. Coordinate recovery actions.
2. Monitor populations.
3. Collect seed.
4. Conduct further surveys.
5. Implement fire management.
6. Obtain biological and ecological information.
7. Implement *Phytophthora cinnamomi* management.
8. Investigate the methodology for future translocation(s).
9. Promote awareness and encourage involvement.
10. Map habitat critical to the survival of the species.
11. Review the IRP and assess the need for further recovery actions.

## 1. BACKGROUND

### History

A member of the Myrtaceae family, the genus *Darwinia* (which includes all mountain bells) was named by Rudge in 1815, after Erasmus Darwin (1731–1802), English physician and poet, grandfather of Charles Darwin. *Darwinia collina* was named in 1923 by C.A. Gardner, its specific epithet derived from the Latin *collina* ‘dweller on hills’.

The earliest collections on record are from Coyanarup Peak and Bluff Knoll in 1922. Since then, a number of collections have been made from those populations and in 1997 collections were made from Bakers Knob and East Bluff.

### Description

*Darwinia collina* is a bushy shrub to 1m high with minutely toothed leaves, 1cm by 5mm, and bracts that are the most rounded of any of the mountain bells. Each bell is in fact a cluster of drooping flowers with white petals and stigmas up to 2 cm long that are enclosed by broad, lemon-yellow petal-like leaf bracts. This species is known to hybridise with the common mountain bell (*Darwinia leiostyla*) (Brown *et al.* 1998)

### Distribution and habitat

The Stirling Range area has been identified as a centre of species richness and endemism in the Southwest Australian Floristic Region (Hopper and Gioia 2004). All nine mountain bells occur within the Stirling Range National Park and adjacent Hamilla Hills each with a distinct, well-defined distribution. It is thought that landscape dissection combined with climatic and microclimatic factors have facilitated taxonomic divergence in the genus *Darwinia* in the Stirling Range (Hopkins *et al.* 1983). The onset of drier conditions in the Holocene may have caused the contraction of *Darwinia* species to wetter upland and gully habitats that act as refugia for these species.

Historically, *Darwinia collina* has been recorded from nine locations in the eastern Stirling Range between Ellen Peak and Kyanorup Eminence. However, it is currently known from four extant populations at Bluff Knoll, Coyanarup Peak, Bakers Knob and East Bluff. All other populations are now presumed extinct as plants have not been located in them for 14 years or more. With the exception of that found on Kyanorup Eminence, all populations (extant and presumed extinct) are in habitat significantly affected by *Phytophthora cinnamomi*. However, the Kyanorup Eminence population has not been relocated since it was first found and the vegetation at this site appears to be unsuitable for this species (S Barrett, personal communication).

*Darwinia collina* is found on mountain summit areas in shallow siliceous soils over sandstone and shale in dense heath and thicket, and is endemic to the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (TEC), which is found at high altitudes (approximately 750 m to 1080 m above sea level). This community is listed as Critically Endangered in Western Australia and Endangered under the Commonwealth *Environmental Protection and Biodiversity Act 1999*.

There are a number of other species that are endemic to the Montane TEC including ten Threatened (Declared Rare) flora species. Of these, *Leucopogon gnaphalioides*, *Persoonia micranthera*, *Banksia brownii*, *Andersonia axilliflora* and *Dryandra montana*, are ranked as Critically Endangered under IUCN (World Conservation Union) criteria (Barrett 2000).

### Biology and ecology

Members of the genus *Darwinia* are often killed by fire and regenerate from soil-stored seed, at which time they form dense local stands (Keighery 1985). Many species flower two to five years after germination but reproductive maturity is not reached until seven to ten years. *Darwinia* seeds have no specialised means of dispersal and remain stored in the soil below adult plants until the next fire (Keighery

& Marchant 1993). Population health and numbers are thought to decline after a period of around twenty years as the surrounding vegetation becomes too dense for *Darwinia* individuals to survive (Keighery and Marchant 1993).

A minimum desirable fire interval may be estimated by a doubling of the primary juvenile period (time to first flower) (Gill and Nichols 1989). The juvenile period for *Darwinia collina* is thought to be approximately five years. The Bakers Knob population started to flower in 1996 after being burnt in 1991 (S. Barrett, personal observation). Therefore, a fire interval of at least ten years is required for *D. collina* to reproduce successfully. Rates of plant growth are extremely slow on exposed summit and plateau areas in comparison to those at lower altitudes or in more sheltered areas, particularly for obligate seed regenerating species (Barrett 2000). Therefore, many members of this the plant community require longer intervals between fire.

Furthermore, lack of vegetative cover post-fire may result in significant hydrological changes with an apparent increase in the rate of spread of *Phytophthora cinnamomi* by surface or sub-surface flow, particularly on mountain slopes (Barrett 2000; M. Grant personal communication). Notably, those populations now presumed extinct have experienced more frequent fire (in 1972, 1991 and 2000) with the exception of the Pyungoorup population. In contrast, significant recruitment since the 2000 fire has been observed at Bluff Knoll and Bakers Knob, in particular at the latter population, which was largely unburnt in 1972 and 1991.

In quadrats established to study the fire ecology of the Eastern Stirling Range Montane Heath and Thicket TEC, there were no *Darwinia collina* plants in long unburnt habitat (over 30 years old). The 2004 results show the species is very patchy in quadrats burnt in 1991, burnt in 2000 and burnt in both 1991 and 2000, with a maximum density of 1/m<sup>2</sup> in vegetation burnt in 2000 and 2/m<sup>2</sup> in vegetation burnt in 1991. In comparison, densities of *Darwinia wittwerorum* were on average 90/m<sup>2</sup> in *Phytophthora cinnamomi* infested habitat and 300/m<sup>2</sup> in *P. cinnamomi* free habitat at three years post fire.

*Phytophthora cinnamomi* is an introduced soil-borne plant pathogen. Infection results in plant death in susceptible species through the destruction of root systems. The impact of the disease on plant communities is variable between sites as it is dependent on temperature, soil type, nutrient and water status, and species susceptibility. The greatest impact usually occurs where soils are infertile and drainage is poor (Weste and Marks 1987; Shearer and Tippett 1989; Wilson *et al.* 1994).

*Darwinia collina*, like other mountain bells, is susceptible to *Phytophthora cinnamomi*. Under laboratory conditions 40 to 80% of plants died as a result of infection (<sup>3</sup>B. Shearer unpublished data). A *D. collina* sample was taken from Bluff Knoll in 1996 and tested positive for *P. cinnamomi*.

Populations 2 (Ellen Peak), 4 (Moongoongoonderup Hill), and 7 (Isongerup) have not been located since the 1991 fire although recruitment occurred after the same fire on East Bluff and Bluff Knoll. It is possible that subtle differences in soil and soil moisture characteristics resulted in an increased impact of *P. cinnamomi* at these sites, particularly in the early 1990s. Notably, there was relatively high rainfall in the years from 1989 to 1993. Similarly, Coyanerup has been subject to frequent fire, high *Phytophthora* impact and has a significantly reduced population.

All of the mountain bells are presumed to be pollinated by nectar-feeding birds (Keighery and Marchant 1993). As birds locate food by sight, *Darwinia* species are brightly coloured and live in dense populations in open areas to attract them. The flowers are pendulous to keep rain from the nectar and are quite large (Keighery 1985). They are positioned so that birds can probe the bell both from the ground and by perching on them.

Observed changes in vegetation structure and floristics caused by *Phytophthora cinnamomi* will also have an effect on the abundance of vertebrate pollinators in communities (Wills 1993). Possible effects on pollinators include loss of food sources, loss of habitat and increased predation risk (Wilson *et al.* 1994,

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<sup>3</sup> Dr. Bryan Shearer

Principle Research Scientist, CALM

Nichols 1998). As *Darwinia collina* may be bird pollinated, *P. cinnamomi* is likely to have an indirect effect on this species through a reduction in the abundance of its pollinators.

## Threats

*Darwinia collina* was declared as Rare Flora in 1980 under the Western Australian *Wildlife Conservation Act 1950* and currently meets World Conservation Union (IUCN 2001) Red List Category Endangered (EN) under Criteria A2c due to its limited geographic range and decline in habitat quality. It is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The species is currently known from four populations in the Stirling Range National Park.

All areas occupied by *Darwinia collina* are affected or potentially affected by one or more threats identified in this IRP. Threats include:

- ***Phytophthora cinnamomi* infestation:** Although some very small remnants of the Montane TEC may still remain healthy, most the eastern Stirling Range Montane Thicket and Heath TEC and all populations of *Darwinia collina* have been infected to some degree by *Phytophthora cinnamomi*. Just Kyanorup Eminence remains relatively healthy.
- **Inappropriate fire frequency:** All populations were burnt to varying degrees by fires in 1972, 1991 and 2000 with a nine-year fire frequency between the 1991 and 2000 fires having a detrimental impact on several members of the Montane community. While the relationship between fire and *P. cinnamomi* is unclear, their combined impact is likely to cause further decline in this species.
- **Grazing:** Both quokka (*Setonix brachyurus*) and rabbit (*Oryctolagus cuniculus*) are present on the eastern peaks of the Stirling Range and evidence of grazing on components of the plant community can be seen from Ellen Peak to Coyanarup Peak. However, there has been no indication of grazing having a negative effect on *Darwinia collina* to date, with adjacent species showing signs of heavier impacts, this requires on-going monitoring (S. Barrett, personal observation).
- **Recreation:** The Stirling Range National Park averages approximately 80,000 visitors per annum with the higher peaks of the eastern Stirling Range attracting visitors interested in bushwalking, nature observation and rock-climbing (Barrett 2000). Bluff Knoll receives the highest level of visitation, being the highest mountain in the southwest. It also provides opportunities for rock climbing and abseiling. The eastern peaks route, from Ellen Peak to Bluff Knoll, is a popular walk which takes between two and three days to complete, hence a number of camping areas have resulted. All *Darwinia collina* populations are at risk to some extent as a result of the recreational activity in the eastern Stirling Range.

Negative impacts resulting from recreational activity include the spread of *Phytophthora cinnamomi*, side path formation, path erosion, bare-ground occurrences, camp-fire remains, litter and nutrient enrichment of soils. Many of these impacts tend to be concentrated towards camping sites and the summit areas of the peaks (Barrett 2000). Effective path drainage is important in the reduction of both erosion and the spread of *P. cinnamomi* (Watson & Passmore 1993). Soils are moist on the higher peaks for much of the year, particularly near mountain summits, and pooling of water can occur. Wet areas provide ideal sites for the transfer of *Phytophthora* through soil collected on walking boots (Gillen & Watson 1993).

- **Drought:** Generally, soils on the peaks are moist and rainfall can be significantly greater than that at lower altitudes (Keighery and Marchant 1993). Local vegetation has evolved with these conditions and prolonged dry periods may be quite detrimental. In 1990, Greg Keighery noted that *Darwinia collina* plants were dead or dying as a result of drought on Bluff Knoll and Coyanarup Peak. However, 1989 and 1990 were not periods of low rainfall (681 and 688 mm at Moingup Springs, respectively). It is therefore more likely that the poor health of the plants was due to *P. cinnamomi* rather than drought (M. Grant, personal communication).

- Climate Change:** The Stirling Range lies between the moist, mild areas of the south-west where rainfall can exceed 1400mm a year, and the drier north where average annual rainfall is around 400mm. Rainfall on the eastern peaks may be up to double that on the surrounding plains, however rainfall varies significantly on all the peaks (Keighery and Marchant 1993). Temperatures are highly variable and the peaks can endure temperatures about five degrees less than the surrounding plain (Keighery and Marchant 1993). Clouds occur on some of the peaks approximately two out of every three days and snow and hail are not uncommon (Keighery and Marchant 1993). These unique climatic conditions caused the mid to upper slopes of the Stirling Ranges to become a refugia for several specialised flora and fauna species, including *Darwinia*. It is thought that the onset of drier conditions in the Holocene has caused the contraction of *Darwinia* to upland slopes and gullies (Hopkins, *et al.* 1983). Therefore, it must be considered that climate change could accelerate this process, significantly reducing the area of habitat suitable for *Darwinia collina*.

### Summary of population land vesting, purpose and tenure

Population	Vesting	Purpose	Tenure
1. Bluff Knoll	WA Conservation Commission	National Park	National Park
2. Ellen Peak	WA Conservation Commission	National Park	National Park
3. Coyanarup Peak	WA Conservation Commission	National Park	National Park
4. Moongoongoondurup Hill	WA Conservation Commission	National Park	National Park
5. Pyungoorup Peak	WA Conservation Commission	National Park	National Park
6A. Bakers Knob	WA Conservation Commission	National Park	National Park
6B. Saddle between Third Arrow and Bakers Knob	WA Conservation Commission	National Park	National Park

### Summary of population information and threats

Pop. No. & Location	Year/No. of plants adults (juveniles)	Condition	Threats
1. Bluff Knoll	1993 (1000)	Recently Burnt	Fire Disease Drought
	1995 50+	Healthy	
	1997 50+ (100+)	Healthy	
	1999 1000+/-	Healthy	
	2000 500+	Poor	
	2001 1000+/- (100+)	Healthy-Moderate	
	2003 1000 +/- (~100s)	Healthy	
	2004 500+ (1000+/-)	Moderate	
2. Ellen Peak	1986 common	Presumed extinct	Fire Disease
	1989 100+		
	2004 0 (0)		
3. Coyanarup Peak	1990 (several hundred drought affected)		Fire Disease Grazing
	2004 1 (<50)		
4. Moongoongoondurup Hill	1987 100+/-	Presumed extinct	Fire Disease
	2004 0 (0)		
5. Pyungoorup Peak	1979 common	Healthy	Fire Disease
	1986 0 (0)	Presumed extinct	
	1997 0 (0)		
	1998 0 (0)		
	1999 0 (0)		
	2000 0 (0)		
	2001 0 (0)		
	2002 0 (0)		
2003 0 (0)			
6A. Bakers Knob	1986 common	Healthy	Fire Disease Grazing
	1996 1000+	Healthy	
	1997 1000+	Healthy	
	1999 1000+	Healthy	
	2004 10+ (10,000+/-)	Moderate-Healthy	
6B. Saddle between Third Arrow and	1989 100+	Healthy	Fire Disease
	1996 0 (0)	Presumed extinct	



Bakers Knob	1997	0 (0)		Recreation
	1999	0 (0)		
	2004	0 (0)		
7. Isongerup Peak	1979	common	Healthy	Fire
	1997	0 (0)	Presumed extinct	Disease
	1998	0 (0)		
	1999	0 (0)		
	2000	0 (0)		
	2001	0 (0)		
	2002	0 (0)		
	2003	0 (0)		
	2004	0 (0)		
8. Kyanorup Eminence	1990	200+		Fire
	2000	0 (0)	Presumed extinct	Disease
9. East Bluff	1996	(1000+)	Healthy	Fire
	2000	200+/-	Moderate	Disease
	2004	100+/- (300+/-)	Moderate	? Grazing

### Habitat critical to the survival of the species, and important populations

Given that this species is listed as Endangered under the Commonwealth EPBC Act, it is considered that all known habitat is habitat critical to the survival of the species. In addition all populations, including any translocated populations, are considered important to the survival of the species. Habitat is defined as the biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms, or once occupied (continuously, periodically or occasionally) by an organism or group of organisms, and into which organisms of that kind have the potential to be reintroduced (*Environment Protection and Biodiversity Conservation Act 1999*). The area of occupancy of the currently known *Darwinia collina* populations has been mapped. However, other parts of the habitat critical to the survival of *D. collina* have not been mapped and an action outlined in this Interim Recovery Plan is to map all habitat as defined above.

The habitat critical to the survival of *Darwinia collina* therefore comprises:

- the area of occupancy of known populations;
- areas of similar habitat within 200 metres of known populations that provide potential habitat for natural recruitment;
- remnant vegetation that surrounds and links populations (this is necessary to allow pollinators to move between populations) and
- additional occurrences of similar habitat that do not currently contain the species but may have done so in the past (these represent possible translocation sites).

### Benefits to other species/ecological communities

*Darwinia collina* occurs exclusively within the Montane TEC (Montane Thicket and Heath of the South West Botanical Province, approximately 900m above sea level), which is listed as Endangered under the Commonwealth *Environmental Protection and Biodiversity Act 1999*. The Montane TEC contains an assemblage of plants that are susceptible to *P. cinnamomi* and many of which are threatened species.

Seven threatened fauna species occur within Stirling Range National Park. Three endangered fauna species; Carnaby's Cockatoo (*Calyptorhynchus latirostris*), the Dibbler (*Parantechinus apicalis*) and the Stirling Range Moggridgea spider (*Moggridgea* sp. (B.Y. Main 1990/24, 25)) and four vulnerable fauna species; Quokka (*Setonix brachyurus*), Numbat (*Myrmecobius fasciatus*), Malleefowl (*Leipoa ocellata*) and Baudin's Cockatoo (*Calyptorhynchus baudinii*).

Recovery actions put in place for *Darwinia collina* will benefit the Montane TEC and the seven threatened fauna species through threat abatement and close management. Reciprocally, actions put in place for the recovery of the Montane TEC and the seven threatened fauna species will benefit *D. collina*.

### 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 taxon is not listed under any specific international treaty, however and therefore this IRP does not affect Australia's obligations under any other international agreements.

### **Role and interests of indigenous people**

According to the Department of Indigenous Affairs Aboriginal Heritage Sites Register, the registered site Kojaneerup (S01409) occurs within 20 kilometres of *Darwinia collina*. The Department has welcomed any future consultation that will seek input and involvement from Noongar groups that have an active interest in the areas that are habitat for *D. collina* and this is discussed in the recovery actions.

### **Affected interests**

All known populations are on CALM land.

### **Social and economic impacts**

The implementation of this recovery plan has minimal social and economic impact as all populations are on CALM managed land.

### **Guide for decision-makers**

Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of populations or within the defined critical habitat of *Darwinia collina* require assessment. No developments should be approved unless the proponents can demonstrate that they will not have a detrimental impact on the species, its habitat or potential habitat.

### **Evaluation of the Plan's Performance**

The Department of CALM, in conjunction with the Albany District Threatened Flora Recovery Team will evaluate the performance of this recovery plan. In addition to annual reporting on progress against the criteria for success and failure, the plan is to be reviewed within five years of its implementation. Any changes to management and/or recovery actions made in response to monitoring results will be documented accordingly.

## **2. RECOVERY OBJECTIVE AND CRITERIA**

### **IRP Objective:**

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

### **Recovery criteria**

**Criteria for success:** The number of populations and individuals within populations remains stable or increases over the five years of the plan.

**Criteria for failure:** The number of populations or the number of individuals within populations decreases over the five years of the plan.

## **3. RECOVERY ACTIONS**

### **Existing or completed recovery actions**

Staff at CALM (Albany Work Centre) and the Senior Ranger (Stirling Range NP) are aware of the Declared Rare status *Darwinia collina* and the legal responsibility to protect it.

Populations are monitored as regularly as practicable. Population numbers, condition and threats are recorded.

Preservation of germplasm is essential to guard against the possible extinction of wild populations. Seed can also be used to propagate plants for future translocations. Seed is required from all populations where possible to maximise the genetic diversity of *ex situ* material. Staff at CALM's Threatened Flora Seed Centre (TFSC) have five collections of *Darwinia collina* seed. These collections are from Bluff Knoll (Population 1), East Bluff (Population 9) and Bakers Knob (Population 6A).

*Darwinia collina* seed is contained within a fruit and that is how the seed is stored. In the lab, the seed is excised from the fruit and germinated on agar containing 25mg/l Gibberellic acid (<sup>4</sup>A. Crawford, personal communication). Four of the five samples were used for germination tests. Initial germination yielded between 19% and 53% and retest germination resulted 20% to 50%. Smoke has been tested on this species on two occasions though it does not appear to have any positive effect on germination (A. Crawford, personal communication).

Kings Park and Botanic Gardens Nursery currently houses 24 *Darwinia collina* plants, representing four clones (<sup>5</sup>A. Shade, personal communication).

Phosphite has been shown to be effective in controlling *Phytophthora cinnamomi* in a number of native plant species (Shearer and Fairman 1991, 1997; Komorek *et al.* 1997; Ali and Guest 1998; Aberton *et al.* 1999; Wilkinson *et al.* 2001). Phosphite may have a direct fungicidal effect or act indirectly to enhance the host's defence response (Guest and Grant 1991). It cannot be used to eradicate the pathogen but can be used to control the disease.

Aerial phosphite application techniques enable the spraying of whole plant communities as well as individual target species (Komorek *et al.* 1997). Aerial spraying trials in the Montane Heath and Thicket TEC found that in *Phytophthora*-infested vegetation, percentage survival of plants in the Epacridaceae was significantly higher in the sprayed compared with non-sprayed quadrats for up to three years after spraying (Barrett 2003).

Phytotoxic effects have been demonstrated in a number of species and evaluations must consider phytotoxic effects on plants against the degree of control provided (Barrett 2001). Phosphite phytotoxicity trials by Sarah Barrett in 2001 on Bluff Knoll showed *Darwinia collina* to have a relatively low toxicity rating compared to other members of Myrtaceae (Barrett 2001).

All extant populations except Coynarup (relocated September 2004) are being sprayed with phosphite by aerial application. Bluff Knoll and East Bluff were first sprayed in 1997 and Bakers Knob in 1998 at a rate of 24kg per hectare. An application rate of 6kg per hectare in two separate sprays is currently applied to juvenile plants. Significant *Phytophthora* impact on *Darwinia collina* in vegetation burnt in 1991 has not been observed since phosphite application commenced in 1997 (S. Barrett, pers. obs.).

The Ranger in Charge has been provided with an information sheet on Mountain Bells for visitors to the Stirling Ranges.

#### **Future recovery actions (in order of priority)**

The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for 'lower' priorities and other opportunities arise.

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<sup>4</sup> Andrew Crawford

Senior Technical Officer, Threatened Flora Seed Centre, CALM

<sup>5</sup> Amanda Shade

Kings Park Botanic Gardens

### 1. Coordinate recovery actions

The Albany District Threatened Flora Recovery Team (ADTFRT) is coordinating recovery actions for *Darwinia collina* and will include information on progress in their annual report to CALM's Corporate Executive and funding bodies.

**Action:** Coordinate recovery actions  
**Responsibility:** CALM (Albany Work Centre) through the ADTFRT  
**Cost:** \$3,000 per year.

### 2. Monitor populations

Continue regular monitoring of all *Darwinia collina* populations. Monitoring of population dynamics and the stability and the impact of *P. cinnamomi* is required for effective management.

**Action:** Monitor populations  
**Responsibility:** CALM (Albany Work Centre)  
**Cost:** \$4,590 per year.

### 3. Collect seed

Seed collection will be ongoing to obtain seed from as wide a range of individuals as possible. Collections have previously been made from Bluff Knoll, East Bluff and Bakers Knob. Additional seed will be collected from these populations as well as the population on Coyanarup Peak.

**Action:** Collect seed  
**Responsibility:** CALM (Threatened Flora Seed Centre and Albany Work Centre)  
**Cost:** \$4,590 per year.

### 4. Conduct further surveys

Surveys supervised by CALM staff and with assistance from local naturalists and wildflower society members to be conducted during the species' flowering period (August to November). Potential habitat has been largely assessed but given the mountainous terrain the potential still exists for additional survey particularly near Kyanarup Emminence.

**Action:** Conduct further surveys  
**Responsibility:** CALM (Albany Work Centre)  
**Cost:** \$2,550 per year.

### 5. Implement fire management

A fire interval of at least ten years is recommended for *Darwinia collina*, however a longer fire-free interval may be required for other members of the Montane Heath and Thicket TEC (S. Barrett, unpublished data).

A Fire Management Strategy has been developed for the Stirling Range NP (Barrett, *et al.* 2004). The strategy recommends that demographic processes and life history attributes be used to identify fire sensitive species and ecological communities to determine their minimal tolerable fire frequency. Planned fire may be introduced to certain lowland areas to protect threatened species and communities. Under the current strategy fire will be excluded from *Darwinia collina* populations for at least the term of this Interim Recovery Plan (five years).

**Action:** Implement fire management  
**Responsibility:** CALM (Albany Work Centre)  
**Cost:** \$1,000 per year.

## 6. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *Darwinia collina* will provide a better scientific basis for management of the wild populations. An understanding of the following is particularly necessary for effective management:

1. Investigate soil seed bank dynamics and the role of disturbance, competition, drought and the interaction between fire and *P. cinnamomi* in germination and recruitment, plant longevity and population dynamics. Determine minimum and maximum tolerable fire intervals for the species.
2. The reproductive biology, pollination, phenology and seasonal growth of the species.
3. The population genetic structure, levels of genetic diversity and minimum viable population size.

**Action:** Obtain biological and ecological information  
**Responsibility:** CALM (Science Division and Albany Work Centre)  
**Cost:** \$24,000 per year for the first three years.

## 7. Implement *Phytophthora cinnamomi* management

Populations will be reviewed annually with regard to phosphite application and phosphite will be applied as appropriate. Management of access is required to ensure a well-drained path (Bluff Knoll) and to minimise visitor impacts (side-path formation, camping impacts) on the eastern peaks route. Community education will aim to increase awareness of the impact of the disease and improve visitor hygiene.

**Action:** Implement *Phytophthora cinnamomi* management  
**Responsibility:** CALM (Science Division and Albany Work Centre)  
**Cost:** \$7,500 per year.

## 8. Investigate the methodology for future translocation(s)

Within the 5-year time frame of the plan, the best methods for future translocations or re-stocking of *in situ* populations should be investigated and a decision made on the most appropriate translocation site and procedure.

**Action:** Investigate the methodology for future translocation(s)  
**Responsibility:** CALM (Science Division and Albany Work Centre)  
**Cost:** \$2,500 per year.

## 9. Promote awareness and encourage involvement

The importance of biodiversity conservation and the need for the long-term protection of wild populations of this species 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. Particularly, input and involvement will be sought from any Noongar groups that have an active interest in the areas that are habitat for *Darwinia collina*. A Bush-book on Stirling Range flora is currently being produced and is due for completion in 2005. The book will contain a section on the Mountain Bells.

**Action:** Promote awareness and encourage involvement  
**Responsibility:** CALM (Albany Work Centre) through the ADTFRT  
**Cost:** \$900 per year.

## 10. Map habitat critical to the survival of the species

It is a requirement of the EPBC Act (Section 207A) that spatial data relating to critical habitat be determined. Although habitat critical to the survival of the species 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, habitat critical to their survival will also be determined and mapped.

**Action:** Map habitat critical to the survival of the species  
**Responsibility:** CALM (Albany Work Centre)  
**Cost:** \$600 in the first year.

#### 11. Review the IRP and assess the need for further recovery actions

If *Darwinia collina* is still ranked as Endangered at the end of the fourth year of the five-year term of this IRP, the plan will be reviewed and the need for further recovery actions assessed.

**Action:** Review the IRP and assess the need for further recovery actions  
**Responsibility:** CALM (Species and Communities Branch and Albany Work Centre) through the ADFRT  
**Cost:** \$4,000 in the fifth year (if required).

#### 4. TERM OF PLAN

This Interim Recovery Plan will operate from April 2005 to March 2010 but will remain in force until withdrawn or replaced. If the taxon is still ranked Endangered under the Commonwealth EPBC Act after five years, this IRP will be reviewed and, if necessary, further recovery actions put in place.

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## 6. TAXONOMIC DESCRIPTION

Information derived from the Journal and Proceedings of the Royal Society of Western Australia 9:41-42 (1923)

A bushy 40-60cm. in height. Leaves 1 cm. long and 6 mm. wide crowded and imbricate on the branches, ovate-elliptical, quite flat and yellowish-green in colour the margins narrowly scarious, minutely denticulate. Involucres 2-2.5 cm. long, campanulate, the inner petal-like bracts yellow, entire, broadly elliptical-ovate, the outer ones shorter and green, the lowest passing into the stem leaves. Flowers numerous. Bracteoles about as long as the flowers, oblong-spathulate, obtuse. Calyx-tube 5 mm. long, 10-ribbed at the base, the ribs most conspicuous in the adnate part, the lobes very small, broadly ovate. Petals 3 mm. long, white, ovate-deltoid. Staminodia linear-filiform, very small. Style 1.3 cm long and more or less flattened, bearded towards the end.

The new species has affinity to *Darwinia fimbriata* and *D. macrostegia*, differing from the former in the flat leaves, entire bracts and ribbed calyx, and from the latter in the ovate bracts, smaller ovate flat ciliate leaves.

