INTERIM RECOVERY PLAN NO. 10

MOGUMBER BELL (*DARWINIA CARNEA*) INTERIM RECOVERY PLAN

1996-1999

by

Emma Holland, Kim Kershaw and Andrew Brown

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Department of Conservation and Land Management
Western Australian Threatened Species and Communities Unit
PO Box 51, Wanneroo, WA 6065

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 are designed to run for three years only and will be replaced by full Recovery Plans where required.

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 Critically Endangered taxa are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by the Minister.

This IRP was approved by the Director of Nature Conservation on 7 May 1997. Approved IRPs are subject to modification as dictated by new findings, changes in status of the taxon or ecological community and the completion of recovery actions. 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 March, 1997.

CONTENTS

Page

SUMMARY

Mogumber Bell, *Darwinia carnea* **Family:** MYRTACEAE

Flowering period: September-December

CALM Region: Wheatbelt and Midwest **CALM District:** Narrogin and Moora

Shires: Narrogin and Victoria Plains

Current status: Declared as Rare Flora in January 1980, ranked as Critically Endangered in September 1995

Recovery team: Moora District Threatened Flora Recovery Team. A Recovery team will be established for CALM's Narrogin District in 1997.

Illustrations and/or further information: J. Leigh *et al*. *Extinct and Endangered Plants of Australia*. (1984); J Leigh and J. Briggs, *Threatened Australian Plants: Overview and Case Studies* (1992); S. D. Hopper, *et al*., *Western Australia's Endangered Flora* (1990); W. E. Blackall and B. J. Grieve, *How to Known Western Australian Wildflowers* (1980); S.J. Patrick & A.P. Brown *Declared Rare and Poorly Known Flora in the Moora District* (draft 1997).

Darwinia carnea is a small shrub 20-30 cm tall with linear-lanceolate opposite leaves 6-10 mm long. The flower head is nodding and surrounded by broad, ovate bracts which are coloured yellowish-green to pinkish-red. The bracts are c. 3 cm long and conceal 10-14 flowers within.

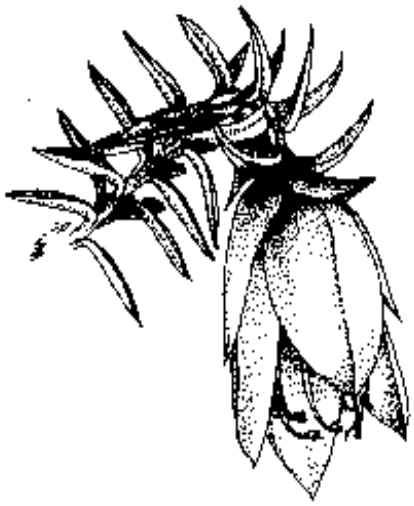
The species was first discovered near Mogumber (approximately 100 km north of Perth) by C.A. Gardner in 1922 and was described by him in 1928. The Narrogin population was first discovered in the 1950s by R. Durell. It was last seen at the type locality in 1970 and was presumed extinct in that area until 1990 when rediscovered by E. Griffin not far from the original locality. Currently, three extant populations containing about 269 plants (1995) are known over a geographical range of 245 km. All are located on private property (two at Mogumber and one at Narrogin). Plants in the Mogumber populations differ from plants in the Narrogin population in being shorter with a different habit. They also have smaller flowers with a different bract colour.

Due to agricultural development in the Mogumber and Narrogin regions, most suitable habitat has either been cleared or is badly degraded through grazing. The aim of this Interim Recovery Plan is to abate identified threats and maintain viable *in situ* populations of *Darwinia carnea* in order to conserve the wild genetic stock of the species. To achieve this aim the following essential and desirable recovery actions are prescribed:

Recovery actions:

Essential	Desirable
1. Fence subpopulation 5b	1. Conduct further surveys
2. Develop fire management plan	2. Implement weed control
3. Preserve genetic diversity of the species	3. Information dissemination
4. Implement rabbit control	4. Conduct research
5. Monitor populations	5. Land purchase
	6. Translocation

Darwinia carnea



Margaret Pieroni

Distribution of *Darwinia carnea*
Not available

1. BACKGROUND

1.1 History, taxonomy and status

Darwinia carnea Gardner is a small shrub 20-30 cm tall. The leaves are 6-10 mm long, opposite, linear lanceolate in shape and keeled. The flower head is nodding and surrounded by broad, ovate, coloured bracts which are yellowish-green to pinkish-red in colour. The bracts are *c*. 3 cm long and conceal the 10-14 flowers within. Each flower is tubular with an unribbed calyx tube and short blunt lobes *c*. 1.5 mm long. The five petals are white and 4 mm long. There are short staminodes between the ten stamens and the style is 13.5 mm long with a curved, bearded tip. The fruits are small nuts. The plants in the Mogumber populations differ from plants in the Narrogin population in being shorter, with a different habit, smaller inflorescence and a difference in bract colour.

D. carnea was first discovered in 1922 by C.A. Gardner from an area near Mogumber (approximately 100 km north of Perth). The species was described by him in 1928 in Latin. An English translation is included in Appendix 1. The species is named from the Latin *carneus*, meaning flesh coloured, in reference to the unusual colour of the bells.

The species was last seen in the type locality at Mogumber in 1970 and was presumed extinct in that area (due to grazing). However in 1990 population 3 was discovered by E. Griffin not far from the original locality. Another population (population 5) was found by consultant botanist J. Gathe in late 1990 on private property at Mogumber, *c*. 2 km from population 3.

D. carnea was found south-east of Narrogin on private property in the 1950s by R Durell. When the area was proposed to be cleared in the mid 1970s, Mr Durell negotiated with the landowner (Mr Nottle) and was successful in conserving a small area of remnant bush comprising most of the population. The existing fenced area represents the total area that was saved from clearing. The population was brought to CALM's attention in 1978 when a site inspection was undertaken by Dr N. Marchant, Mr P. Lambert, Mr F. Lullfitz and Mr R. Durell, during which cutting material was collected (G. Durell[1] pers. comm.).

Cutting material was also collected prior to 1970 from the Mogumber population. This was the source material for Kings Park and Botanic Garden (KPBG) research and was later cloned by The Wildflower and Lullfitz Nurseries.

An attempt to reintroduce the species into the type locality was made by B. Jack, a local horticulturalist. However this failed due to drought and / or grazing. In July 1985, 50+ plants were planted from 12.5 cm pots in an area of private property of about 0.5 ha, which is believed to be the type locality. In 1990 the translocation site was surveyed by J. Gathe. No plants were found and local farmer, Mr M. Roley, believed the plants had been eaten by sheep.

In September 1992 an unconfirmed sighting of a single plant of *D. carnea* (Population 4) was made by Mrs Barratt-Lennard and Mrs Scott in State Forest south west of Narrogin. Searching for this population was undertaken by L. Silvester in 1993 and 1994, in October 1993 by P. Hussey and P. Murray and in October 1995 by E. Holland, J. Gathe and R. Hindmarsh. No plants were found.

Ms Rosanna Hindmarsh is currently studying the genetic differences between populations of *D. carnea* at Mogumber and the populations at Narrogin using electrophoresis. A loss of genetic variability through genetic drift may be the cause of the morphological differences between the populations.

[1] Mr Greg Durell (CALM Narrogin District)

1.2 Distribution and habitat

At Narrogin, *Darwinia carnea* is known from a single population on private property covering an area of approximately 0.5 ha. The population grows on an exposed lateritic hilltop in heath.

At Mogumber, *D. carnea* is known from two populations on private property covering an area of approximately 1 ha each. The populations are situated on the tops of lateritic breakaways, growing in gravelly brown loamy soils, in open *Eucalyptus wandoo* woodland over heath. Narrogin and Mogumber are geographically isolated, being 245 km apart.

Associated species include *Petrophile heterophylla, Adenanthos cygnorum, Banksia sphaerocarpa, Beaufortia incana, Dryandra polycephala* and *D. nobilis*. A list of associated species is included in Appendix 2.

Table 1: Summary of population information

Pop. No & Location.	Land Status	No. of plants	Condition	Threats
1. SE of Narrogin	Private	1983, 67 1995, 69	Moderate	Inadequate fencing, inappropriate fire, rabbits
2. NNE of Mogumber	Private	1985, 50+ (transplants) 1990, 0	Failed translocation due to grazing, drought	_
3. ESE of Mogumber	Private	1990, 200 1995, 110+	Good	Grazing, inappropriate fire
4. *WSW of Highbury	State Forest	1992, 1 1995, 0	_	_
5A. ESE of Mogumber	Private	1996, 70+	Poor	Inappropriate fire
5B. ESE of Mogumber	Private	1995, **20+	Poor	Grazing, clearing, inappropriate fire

* Unconfirmed sighting 19/9/92 by Mrs Barratt-Lennard and Mrs Scott; further surveys have failed to locate this single plant

** This is an estimate only as the numbers in past surveys have combined the subpopulation numbers. The only reference to numbers is “the vast majority of plants occur on 5a”.

1.3 Biology and ecology

Endemic to south-western and south-eastern Australia, the genus *Darwinia* is closely related to *Chamelaucium* (wax plants) and *Verticordia* (feather flowers) (Keighery 1985). Many south-western species are characterised by their large inflorescences which are surrounded by coloured bracts and the common name “bells” is derived from this feature. A taxonomic study (Marchant and Keighery 1992) recognised 48 *Darwinia* species, two of which have subspecies, and an additional 15-20 unnamed species.

Darwinia carnea is the only member of the mountain bell group to occur outside of the Stirling Range. However, as is the case for the Stirling Range species, *D. carnea* is believed to be killed by fire and to later regenerate from soil-stored seed (no documentation of fire has been recorded in the known populations of *D. carnea*). *Darwinia* seeds have no specialised means of dispersal and remain stored in the soil below adult plants. Most Stirling Range *Darwinia* species flower two to four years after germination and reach maturity in seven to ten years (Keighery and Marchant 1993).

It is believed that *D. carnea* is pollinated by nectar feeding birds. Birds feed by day, have no sense of smell and locate food by sight, thus the bells flower in open areas in dense populations and are brightly coloured. The flowers are quite large (for birds to visit) and pendulous (to keep rain from the nectar) and positioned so that a bird can perch on them or probe up from the ground (Keighery and Marchant 1993).

It has been noted within the Narrogin population that several associated species, eg, *Dryandra nobilis* and *Adenanthos cygnorum,* compete with *D. carnea* and may eventually displace the species. This appears to show the disturbance opportunistic nature of *D. carnea*.

Potted species of *Darwinia* are susceptible to dieback disease caused by *Phytophthora cinnamomi*, however they appear resistant in the wild (Keighery and Marchant 1993). No specific information is available for *D. carnea.*

1.4 Threatening processes

1.4.1 Causes of the critically endangered status of this species

Despite extensive searches for the species since 1990, only three populations with a combined total of about 269 plants (1995) are known to exist. Due to agricultural development in the Mogumber and Narrogin regions, much of the species habitat has been cleared or badly degraded.

Population 1 (Narrogin) is restricted to a small area of remnant vegetation, subjected to edge effects from management of the adjacent land. Edge effects include increased wind speeds, increased fertiliser runoff, modified hydrology and altered disturbance regimes, including fire regimes (Lynch 1987; Saunders *et al.* 1987; Taylor 1987). The fragmentation of the remnant vegetation, combined with edge effects subjects the vegetation to high levels of stress together with acute disturbances. The condition of the habitat of *D. carnea* initially improved after fencing but has declined since and will continue to decline into the future unless recovery actions are applied.

1.4.2 Threats to the ongoing survival of this species in the wild

- **Grazing** by sheep is an immediate threat to Sub-population 5b, and a minor threat to Population 3. Grazing has left the adult plants at Population 5 stunted with minimal foliage. If allowed to continue, recruitment of *D. carnea* will be interfered with and extinction may result.

- **Inappropriate fire regimes** during the reproductive phase of *D. carnea* (ie. flowering, pollination, seed growth and seed dispersal) may result in low/nil seedling recruitment. High fire frequency commonly leads to the degradation of natural communities due to factors such as depletion of soil seed banks, death of juveniles before maturity and a temporary increase in the availability of nutrients for weed establishment (Panetta and Hopkins 1991). A fire within population 1 at Narrogin would probably lead to the local extinction of the species, due to the small size of the remnant vegetation and great threat of weed invasion (G. Durell[2] pers. comm.).

- **Rabbits** (*Oryctolagus cuniculus*) have caused major disturbances in the past at Population 1 (Narrogin). Warren construction, increased nutrient levels from their droppings, introduction of weeds and grazing have had impacts on the habitat.

[2] Mr Greg Durell (CALM Narrogin District)

- **Weeds** are not a serious problem, however the potential for invasion may be increased if the populations are exposed to further disturbance (fire, continued grazing pressure). The three extant *D. carnea* populations have the potential to be both directly and indirectly affected by weeds due to:

    - direct competition, inhibiting growth and displacing the species
    - a decrease in habitat diversity
    - inhibiting recruitment
    - an alteration in nutrient cycling
    - a change in soil acidity
    - an increase in fire hazard due to easy ignition, high fuel loads produced annually, and the formation of a continuous bed permitting a fire to spread quickly (Hussey and Wallace 1993)

1.5 Conservation status

Darwinia carnea is known from three extant populations at Mogumber and Narrogin, all occurring on private property. No plants are known to exist on a conservation reserve.

1.6 Strategy for recovery

A Threatened Flora Recovery Team will be established for the Narrogin District and it, along with the Moora District Threatened Flora Recovery Team, will oversee the implementation of this IRP and report annually to CALM's Corporative Executive. The following essential strategies will be implemented:

1. Control of the most threatening factors currently affecting *D. carnea* as outlined at 3.2.
2. Preserve the genetic material of *D. carnea* by including it in cryostorage and/or *ex situ* cultivation (see 3.2.3).
3. Protect *D. carnea* from possible future threats (eg weeds, further habitat degradation), by appropriate management practices (see 3.2.4, 3.2.2).

The following desirable strategies will be implemented if resources permit:

1. Enhance plant numbers (eg by removal of a limiting factor or with direct propagation and translocation techniques) (see 3.3.6, CALM Policy Statement No 29, *Translocation of Threatened Flora and Fauna*).
2. Ensure that relevant land managers and CALM personnel are aware of the presence of *D. carnea*, and the need to protect it (eg notification) and ensure that all are familiar with the threatening processes identified in these guidelines (see 3.3.3).
3. Research the biology, ecology and management of *D. carnea* (see 3.3.4).
4. Seek funds for purchase and reservation of privately owned lands containing *D. carnea.*

2. RECOVERY OBJECTIVE AND CRITERIA

2.1 Objective

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

2.2 Criteria

2.2.1 Criteria for success

Recovery will be deemed a success if threatening processes identified within this IRP have been reduced or removed within the three year period.

2.2.2 Criteria for failure

The recovery process will have been unsuccessful if identified threats have not abated within the three year period of this IRP or there has been a substantial decrease in the number of mature plants.

3. RECOVERY ACTIONS

3.1 Existing recovery actions

The owners of private property at Narrogin (Population 1) were notified of the presence of *D. carnea* in November 1992. The owners of private property at Mogumber were notified in December 1994 (Populations 5a and 5b) and in January 1995 (Population 3).

Fencing materials were delivered to the owners of Population 5a on 30 April 1996 and erection was completed in September.

The Narrogin population (Population 1) was fenced in 1978 by the landowner, Mr R. Durell and several volunteers. The fence was repaired in 1994 by CALM after rabbit and sheep damage.

A rabbit control program is undertaken by CALM's Narrogin District at Population 1 when rabbits are reported to occur within rabbit proof fenced area. Several successful rabbit trappings were undertaken by R. Durell during 1978. The owner of the private property shoots rabbits in the adjoining paddock.

Cutting material was collected by KPBG in 1989 and 1990. Plants are in the nursery and on display at Kings Park.

The Threatened Flora Seed Centre (TFSC) at CALM's West Australian Herbarium have seed in storage from collections made in 1990 and 1995.

The Moora District Threatened Flora Recovery Team (MDTFRT) oversees the implementation of this IRP for the Mogumber populations and reports annually to CALM's Corporate Executive.

3.2 Essential recovery actions

3.2.1 Fencing

It is essential that subpopulation 5b (Mogumber) be fenced from stock (subpopulation 5a was fenced in September 1996). Fences excluding stock from population 3 (Mogumber) and population 1 (Narrogin) need to be routinely monitored and maintained. Liaison with land owners is essential.

Action:	Fence supopulation 5b, maintain fences at populations 1 and 3
Responsibility:	CALM (Narrogin and Moora Districts, Western Australian Threatened Species and Communities Unit (WATSCU))
Cost:	$2450

3.2.2 Develop a fire management plan

Little is known about the effects of fire on *D. carnea* (see 1.3). It is recommended that a fire management plan for the areas of each population be developed in consultation with relevant authorities and land managers. It is likely that occasional fire is required for recruitment of this species.

Action:	Develop fire management plan
Responsibility:	CALM (Moora and Narrogin Districts, WATSCU)

Cost: $450 pa.

3.2.3 Preserve genetic diversity of the species

Germplasm collections should be given a high priority if the extinction of populations *D. carnea* is considered a high probability through disease, its limited distribution or low number of plants. If this is deemed to be the case, recovery of the species is likely to need *ex situ* conservation techniques.

Genetic diversity conservation of the species should be incorporated into the research component (see 3.3.4) and should include collection of seed from all populations, ensuring an adequate representation of genetic diversity.

If it is not possible to collect adequate quantities of viable seed, other more costly germplasm storage methodologies may need to be investigated. These can involve living collections from cutting or other source material, or storage of tissue culture material. If resources are limited these techniques will need to be carefully prioritised in relation to *in situ* conservation. This will be coordinated by the MDTFRT and the yet to be established Narrogin District threatened Flora Recovery Team (NDTFRT).

It is also important that the size and viability of the soil seed bank is determined and research undertaken to develop techniques for stimulating germination of soil stored seed. Care, however, should be taken as these processes inherently carry a significant risk of depletion of seed bank reserves.

Action:	Collect seed and/or other genetic material from all populations
Responsibility:	MDTFRT, NDTFRT to be established, CALM (Narrogin and Moora Districts, TFSC, WATSCU), KPBG
Cost:	$1600

3.2.4 Implement rabbit control

A rabbit control program is currently operating in the Narrogin District for Population 1. It is essential that this program is maintained to ensure habitat degradation does not occur.

Action:	Maintain rabbit control program at Population 1 (Narrogin)
Responsibility:	CALM (Narrogin District)
Cost:	$400 pa.

3.2.5 Monitor populations

Monitoring of factors such as weed encroachment, habitat degradation, population stability (expanding or declining), pollination activity, seed production, recruitment, and longevity is prescribed.

Populations should be inspected annually as a requirement under CALM's Policy Statements, No. 9 *Conservation of Threatened Flora in the Wild* and No 28 *Reporting Monitoring and Re-evaluation of Ecosystems and Ecosystem Management*. See also below 3.3.4, *Development of a quadrat/transect based monitoring system for threatened plant species.*

Action:	Monitor populations annually
Responsibility:	CALM (Narrogin and Moora Districts, WATSCU)
Cost:	$650 pa.

.3 Desirable recovery actions

3.3.1 Conduct further surveys

D. carnea has been extensively surveyed by CALM staff and consultant botanists in recent years, however it is recommended that further surveys are conducted on a systematic basis for the presence of the species, particularly during the flowering period (September-December) and one or two years following disturbance such as fire in both the Narrogin and Mogumber areas. Reserves with suitable habitats such as lateritic breakaways or lateritic hill tops with associated species (*Petrophile heterophylla, Adenanthos cygnorum, Banksia sphaerocarpa, Beaufortia incana, Dryandra polycephala, Dryandra nobilis)* should be considered for survey. Areas considered suitable for the species should be noted and considered for possible future translocation (see 3.3.6). Volunteers from the local community, wildflower societies and naturalist clubs should be involved in surveys supervised by CALM staff. Liaison between groups is essential.

Action:	Conduct further surveys
Responsibility:	CALM (Narrogin and Moora Districts, WATSCU)
Cost:	$900 pa.

3.3.2 Implement weed control

Although weeds are currently not a threat to *Darwinia carnea* populations, they may become so if not effectively controlled with the use of herbicides and hand pulling. The tolerance of native plant species to herbicides at *D. carnea* sites is unknown and it is recommended that weed control programs are undertaken in conjunction with research (see 3.3.4). The aim of weed control is to maintain the pre-invasion condition of the habitat (prevention), control or arrest ongoing weed invasion (intervention) and reverse the degraded condition of the habitat where applicable (rehabilitation) (Panetta and Hopkins 1991). A weed control program, if required, will involve:

1. Accurately mapping the boundaries of the populations.
2. Selection of an appropriate herbicide or other method of weed control after determining which weeds are present.
3. Controlling invasive weeds internal to the boundary by hand removal and spot spraying around individual *D. carnea* plants when weeds first emerge.
4. Scheduling to include weed spraying of other Declared Rare Flora populations requiring weed control within the Moora and Narrogin Districts.

Action:	Monitor weeds at all populations and implement a weed control program if required
Responsibility:	CALM (Narrogin and Moora Districts, WATSCU)
Cost:	$1000 pa.

3.3.3 Information dissemination

To promote an awareness of *D. carnea* among relevant CALM staff (Moora and Narrogin Districts) and Shires, the production of posters is recommended. Posters should illustrate and provide information on the species.

The importance of biodiversity conservation and the preservation of critically endangered species need to be promoted with the general public, however, it is recommended that the exact location of populations of *Darwinia carnea* remain confidential. Awareness can be encouraged throughout the community by a publicity campaign using the local print and electronic media and by setting up poster displays in venues of high exposure. Formal links with local naturalist groups and interested individuals should also be encouraged. Such activities may lead to the discovery of new populations of the species.

Action:	Produce posters, implement a publicity campaign
Responsibility:	CALM (Corporate Relations Division, Moora and Narrogin Districts, WATSCU)
Cost:	$500 first year, $1500 second year

3.3.4 Conduct research

Research designed to increase an understanding of the biology of the species will provide a scientific base for management of *D. carnea* in the wild. Research should include:

1. Pollinator activity within populations of *D. carnea*.
2. Investigation of factors determining level of flower and fruit abortion.
3. Quantification of level of invertebrate grazing of seed.
4. The size and viability of the soil seed bank.
5. Seed germination requirements.
6. The role of disturbance in regeneration.
7. The response of *D. carnea* and its habitat to fire.
8. The longevity of plants, and time taken to reach maturity.
9. The extent of genetic variation within and between populations (essential knowledge if new populations are to be established).
10. Development of a monitoring system. Specific protocols for rare flora will be outlined in a future CALM discussion paper *Development of a quadrat/transect based monitoring system for threatened plant species*, (D. Coates, A. Brown and P. Pigott, in prep).

Action:	Conduct research
Responsibility:	CALM (Science and Information Division (SID), Narrogin and Moora Districts, WATSCU)
Cost:	$3000

3.3.5 Land purchase

CALM should seek funds for purchase and reservation of privately owned land containing *D. carnea* for the purpose of conservation and vesting in the National Parks and Nature Conservation Authority (NPNCA). CALM will liaise and negotiate with the land owner at the appropriate time.

Action: Seek funds, negotiate land purchase from land owners
Responsibility: CALM (Land Administration, Moora and Narrogin Districts, WATSCU), land owners.
Cost: To be negotiated

3.3.6 Translocation

Information on the translocation of threatened animals and plants in the wild is provided in CALM Policy Statement No 29. Surveying potential habitat for possible future translocation sites is recommended within the scope of IRPs, with actual translocation addressed in full Recovery Plans where necessary. This should be coordinated by the MDTFRT and the Narrogin District Threatened Flora Recovery Team which is yet to be established. All translocation proposals require endorsement by the Director of Nature Conservation.

Action: Survey potential habitats for translocation
Responsibility: MDTFRT, NDTFRT to be established, CALM (Narrogin and Moora Districts, WATSCU)
Cost: See Section 3.3.1 (Further surveys)

Table 2: Summary of recovery actions

Recovery Actions	Priority	Responsibility	Completion date
Essential			
Fencing	High	CALM (Narrogin & Moora Districts, WATSCU)	1996
Develop a fire management plan	High	CALM (Narrogin & Moora Districts, WATSCU)	1996, ongoing
Preserve genetic diversity of the species	High	MDTFRT, CALM (TFSC, Narrogin District, WATSCU), KPBG	Ongoing
Implement rabbit control	High	CALM (Narrogin & Moora Districts, WATSCU)	Ongoing
Monitor populations	High	CALM (Narrogin & Moora Districts, WATSCU)	Annually
Desirable			
Conduct further surveys	Moderate	CALM (Narrogin & Moora Districts, WATSCU)	October-December 1996 - 1997
Implement weed control	Moderate	CALM (Narrogin & Moora Districts, WATSCU, SID)	Annually
Information dissemination	Moderate	CALM (Corporate Relations Division, Narrogin & Moora Districts, WATSCU)	1996 ongoing
Conduct research	Moderate	CALM (SID, WATSCU)	Ongoing
Land purchase	Moderate	CALM (Land Administration, Narrogin & Moora Districts, WATSCU), Land owners	Ongoing
Translocation	Low	MDTFRT, CALM (Narrogin, WATSCU)	Ongoing

3.4 Costs

Table 3: Summary of costs for each recovery action

Recovery Action	1996			1997		1998	
	CALM	EA	KPBG	CALM	EA	CALM	EA
Essential							
Fencing	2200	250					
Develop a fire management plan	200	250		200	250	200	250
Preserve genetic diversity of the species		500	1100				
Implement rabbit control	400			400		400	
Monitor populations	400	250		400	250	400	250
Sub-total	**$3200**	**$1250**	**$1100**	**$1000**	**$500**	**$1000**	**$500**
Desirable							
Conduct further surveys	400	500		400	500	400	500
Implement weed control	500	500		500	500	500	500
Information dissemination		500			1500		
Conduct research	2000			1000			
Land purchase							
Sub-total	**$2900**	**$1500**		**$1900**	**$2500**	**$900**	**$1000**
Total	**$6100**	**$2750**	**$1100**	**$2900**	**$3000**	**$1900**	**$1500**

EA Environment Australia (formerly ANCA)

Total of all costs : $19250

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Roseanna Hindmarsh	Masters student, Edith Cowan University
Janette Gathe	Botanist

REFERENCES

Bentham, G. (1863). *A Description of the Plants of the Australian Territory. Flora Australiensis*, Vol 1.

Blackall, W.E. and Grieve B.J. (1980) *How to Known Western Australian Wildflowers* Part IIIA. University of Western Australian Press, Nedlands.

CALM (1988). Policy Statement No. 28 *Reporting Monitoring and Re-evaluation of Ecosystems and Ecosystem Management*. Department of Conservation and Land Management, Perth.

CALM (1992). Policy Statement No. 9 *Conservation of Threatened Flora in the Wild.* Department of Conservation and Land Management, Perth.

CALM (1992). Policy Statement No. 44 *Wildlife Management Programs* Department of Conservation and Land Management, Perth.

CALM (1994). Policy Statement No. 50 *Setting Priorities for the Conservation of Western Australia's Threatened Flora and Fauna*. Department of Conservation and Land Management, Perth.

CALM (1995). Policy Statement No. 29 *Translocation of Threatened Flora and Fauna* Department of Conservation and Land Management, Perth.

CALM (In prep.). Discussion paper (No. to be allocated) *Development of a quadrat/transect based monitoring system for threatened plants*. Department of Conservation and Land Management, Perth.

Hussey, B.M.J. and Wallace, K.J. (1993). *Managing Your Bushland*. Department of Conservation and Land Management, Perth.

Keighery, G. (1985) *Rediscovering Mountain Bells*. *Landscope* **1** pp 3-10.

Keighery, G. and Marchant, N. (1993) *Mountain Bells*. PP. 55-59 in *Mountains of Mystery A natural History of the Stirling Range* ed. by C. Thomson, G. Hall, and G. Friend. Department of Conservation and Land Management, Perth.

Hopper, S., Van Leeuwen, S., Brown, A. and Patrick, S. (1990). *Western Australia's Endangered Flora*. Department of Conservation and Land Management, Perth.

Leigh, J. Boden, R. and Briggs, J. (1984) *Extinct and Endangered Plants of Australia*. Pp 338. The Macmillan Company of Australia Pty Ltd. Crows Nest, South Melbourne.

Leigh, J.H. and Briggs, J.D. (1992) *Threatened Australian Plants: Overview and Case Studies*. Australian National Parks and Wildlife Service on behalf of the Australian and New Zealand Environment and Conservation Council, Canberra

Lynch, J.F. (1987*). Responses of breeding bird communities to forest fragmentation*. Pp. 123-40 in Nature Conservation: The Role of Remnants of Native Vegetation ed by D.A. Saunders, G.W. Arnold, A.A Burbidge and A. J.M. Hopkins. Surrey Beatty and Sons, Chipping Norton, NSW.

Marchant, N.G. and Keighery, G.J. (1992). *Conservation of Endangered* Darwinia: Endangered Species Program. A report on the project for the Australian National Parks and Wildlife Service and the Western Australian Department of Conservation and Land Management.

Panetta, F.D. and Hopkins, A J.M. (1991) *Weeds in Corridors: Invasion and Management*. Pp 341 - 351 in *Nature Conservation 2 The Role of Corridors* ed by D.A Saunders and R.J. Hobbs. Surrey Beatty and Sons Pty Limited, Chipping Norton, NSW.

Patrick S.J. and Brown A.P. (in prep.). *Declared Rare and Poorly Known Flora in the Moora District*. Department of Conservation and Land Management, Perth.

Saunders, D.A.; Arnold, G.W.; Burbidge, A.A and Hopkins, A.J.M. (1987). *The role of remnants of native vegetation in nature conservation: future directions.* Pp 387-92 in Nature Conservation: The Role of Remnants of Native Vegetation ed by D.A. Saunders, G.W. Arnold, A.A Burbidge and A.J.M. . Surrey Beatty and Sons, Chipping Norton, NSW.

Taylor, S.G. (1987). *Conservation strategies for human dominated landscapes: the South Australian example*. Pp 313-22 in Nature Conservation: The Role of Remnants of Native Vegetation ed by D.A. Saunders, G.W. Arnold, A.A Burbidge and A.J.M. Hopkins. Surrey Beatty and Sons, Chipping Norton, NSW.

Appendix One:

Taxonomic description taken from Leigh, J. *et al*. (1984). *Extinct and Endangered Plants of Australia*. Pp 338.

Darwinia carnea C.A. Gardner
Mogumber Bell
STATUS 2E
DESCRIPTION Open spreading shrub to 40 cm high. *Leaves* are crowded, opposite with alternate pairs at right angles to each other, linear-lanceolate and pointed at the tip, keeled, 5-15 mm long and about 1 mm wide, hairless, leathery in texture. *Flowers* are small, pale pink, arranged 10-14 together at the ends of the branches in large globular bell-shaped nodding heads 3 cm long which are enclosed by several ovate, hairless greenish-pink persistent bracts. Individual flowers have ovate-lanceolate blunt-tipped petals 4 mm long and about 2 mm wide and a shortly lobed cylindrical calyx 4 mm long and 2 mm wide. Fruit is a small nut but not described in detail. *Flowering* October to December.
DERIVATION *carnea*, Latin, meaning flesh-coloured, referring to the colour of the floral bracts.

Appendix Two: Associated species

CYPERACEAE
Lepidosperma tenuis

XANTHORRHOEACEAE
Xanthorrhoea preissii

ANTHERICACEAE
Laxmannia squarrosa
Laxmannia brachyphylla

HAEMODORACEAE
Conostylis villosa

CASUARINACEAE
Allocasuarina huegeliana

PROTEACEAE
Adenanthos cygnorum
Banksia sphaerocarpa var *caesia*
Dryandra nobilis
Dryandra polycephala
Dryandra sessilis

STYLIDIACEAE
Stylidium calcaratum

PROTEACEAE
Grevillea leptobotrys
Grevillea synaphea subsp. *synaphea*
Hakea incrassata
Hakea stenocarpa
Hakea undulata
Isopogon teretifolius
Petrophile divaricata
Petrophile heterophylla

RUTACEAE
Boronia ovata

POLYGALACEAE
Comesperma calymega

STACKHOUSIACEAE
Stackhousia monogyna

RHAMNACEAE
Trymalium ledifolium var *lineare*

LOBELIACEAE
Lobelia rhytidosperma

MYRTACEAE
Baeckea crispiflora
Beaufortia incana
Calothamnus quadrifidus
Melaleuca scabra
Eucalyptus wandoo
Eucalyptus accedens
Eucalyptus calophylla

EPACRIDACEAE
Astroloma microcalyx
Conostephium drummondii

GENTIANACEAE
* *Centaurium erythraea*

DILLENIACEAE
Hibbertia acerosa
Hibbertia hypericoides
Hibbertia lasiopus

*Introduced species