FAIRALL'S LAMBERTIA

(*Lambertia fairallii*)

RECOVERY PLAN

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Australian Government

Government of Western Australia

Department of Environment and Conservation

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in WA 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.

This IRP will operate from October 2005 to September 2010 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Endangered (WA), 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 IRP is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

This IRP has been updated with information contained herein and is accurate as at January 2008.

This IRP was prepared with financial support from the Australian Government and has been adopted as a National Recovery Plan under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act).

ACKNOWLEDGMENTS

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

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

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

SUMMARY

Scientific Name:	*Lambertia fairallii*	**Common Name:**	Fairall's Lambertia
Family:	Proteaceae	**Flowering Period:**	May to September
DEC Regions:	Albany	**DEC District:**	Albany Work Centre
Shires:	Gnowangerup & Plantagenet	**Recovery Team:**	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: *Lambertia fairallii* was declared as Rare Flora under the Western Australian *Wildlife Conservation Act 1950* in September 1987 and is currently ranked as Endangered (EN) under World Conservation Union (IUCN 2001) Red List criteria A2c, B1+2c due to its restricted geographical range, a continuing population decline and a decline in quality of habitat. Three populations together consisting of approximately one thousand mature individuals are currently known. The species is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Description: *Lambertia fairallii* is an erect, very dense compact shrub up to 1.5 m high. Young branches and leaf bases are loosely covered with long white hairs. The rigid, almost stalkless leaves, crowded on short branchlets, are linear and up to 4 cm long, with an awn-like projection on the tip. Mature leaves are hairless above, with a network of veins on the upper surface, and covered with soft hairs underneath. The foliage of long plants is much less compact, and some leaves may have several lobes at the apex. The inflorescences, on the ends of the branchlets, may be solitary or clustered in groups of 2 or 3. Each inflorescence is composed of 5 to 7 tubular, golden-yellow flowers, enclosed in 17 to 27 dry brown bracts. The dark brown fruits are about 8 mm long and have 2 horns.

Habitat requirements: *Lambertia fairallii* has been found on four peaks of the Stirling Range NP, where it grows on ridgelines in dense heath on shallow soils over metamorphosed sandstone and shale, over approximately 350 metres above sea level.

Habitat critical to the survival of the species, and important populations: Habitat critical to the survival of *Lambertia fairallii* includes the area of occupancy of important populations; areas of similar habitat surrounding important populations - these areas provide potential habitat for natural range extension and/or for allowing pollinators or biota essential to the continued existence of the species to move between populations; and additional occurrences of similar habitat that may contain important populations of the species or be suitable for future translocations or other recovery actions intended to create important populations. All population are considered important for the long-term recovery and survival of the species.

Benefits to other species/ecological communities: *Lambertia fairallii* occurs within the Montane Mallee Thicket Threatened Ecological Community. The Montane Mallee Thicket TEC contains an assemblage of plants that are susceptible to *Phytophthora cinnamomi* and many of which are threatened species. Furthermore, Stirling Range National Park is habitat for seven threatened fauna species. Recovery actions put in place for *L. fairallii* will benefit these species and reciprocally, actions put in place for these species will benefit *L. fairallii.*

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. *Lambertia fairallii* is not specifically listed under any international treaty and therefore this plan does not affect Australia's obligations under any other international agreements.

Role and interests of Indigenous people: Involvement of the Indigenous community is being sought through the advice of the 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 two registered sites that occur in the vicinity of the *Lambertia fairallii* populations. 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.

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 DEC managed land.

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

Completed Recovery Actions: The following recovery actions have been implemented:

1. Land managers are aware of the location and threatened status of the species.
2. Research was undertaken on the conservation biology and management of three *Lambertia* species, including *L. fairallii* and population genetics research is continuing.
3. Seed collections have been made by staff of DEC's Threatened Flora Seed Centre (TFSC) and germination tests conducted.
4. A fire management plan for the Stirling Range National Park has been developed and implemented.

Ongoing and future recovery actions

1. A systematic and phylogenetic study of the genus *Lambertia* is underway and includes morphometric analysis of *L. fairallii*.
2. Phosphite application is underway and monitoring has been established to assess its effect.
3. Volunteers and staff from the DEC Albany Work Centre regularly monitor populations and quadrats have been established to study the plant survival and reproduction.

Objectives

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.

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. Implement disease management
4. Implement fire management
5. Ongoing seed collection
6. Obtain biological and ecological information
7. Conduct further surveys
8. Investigate the methodology for future translocation(s)
9. Map habitat critical to the survival of the species
10. Liaise with stakeholders
11. Promote awareness
12. Review the IRP and assess the need for further recovery actions

1. BACKGROUND

History

Lambertia fairallii was discovered in 1968 by the first Superintendent of Kings Park, Arthur Fairall and was formally described in 1983 by G.J. Keighery. The type location is southeast Ellen Peak (Population 1) in the Stirling Range National Park. A second population was found less than one hundred metres away, on a separate ridge and a third (though unconfirmed) population was later located north of Ellen Peak. In 1991, the majority of the Ellen Peak populations were burnt in a fire that affected a large part of the eastern Stirling Range. Regeneration was poor and population sizes were greatly reduced. In 2000, Ellen Peak was again burnt in a large fire and the population is now presumed extinct.

In September 1993, a much larger population of ten-year-old plants was found on Southwest Gog (Population 2), almost forty kilometres west of Ellen Peak. This population was burnt again in 1997 and appeared to regenerate well after the fire. In 2002, this population suffered an estimated ten percent seedling death, possibly as a result of drought.

In 1996, a population was found at Mt Success (Population 3), which is an intermediate location to the other populations. Since then, a number of subpopulations have been located on various ridges on the southern side of Mt Success. Most of this population was also burnt in the fires of 1991 and 2000, which lead to a significant decline in numbers.

Most recently, in April 2004, a new population was found on the southeast slopes of Yungermere (Population 4), approximately six kilometres west of Mt Success. This population was burnt in 1991 and like the other populations, is greatly threatened by *Phytophthora cinnamomi*.

Description

Lambertia fairallii is an erect, very dense compact shrub up to 1.5 m high. Young branches and leaf bases are loosely covered with long white hairs. The rigid, almost stalkless leaves, crowded on short branchlets, are linear and up to 4 cm long, with an awn-like projection on the tip. Mature leaves are hairless above, with a network of veins on the upper surface, and covered with soft hairs underneath. The foliage of long plants is much less compact, and some leaves may have several lobes at the apex. The inflorescences, on the ends of the branchlets, may be solitary or clustered in groups of 2 or 3. Each inflorescence is composed of 5 to 7 tubular, golden-yellow flowers, enclosed in 17 to 27 dry brown bracts. The dark brown fruits are about 8 mm long and have 2 horns.

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). *Lambertia fairallii* is endemic to the Stirling Range National Park where it is found between 350 and 600 metres above sea level. Its extent of occurrence is approximately forty kilometres and total area of occupancy is approximately ten hectares. It grows on metamorphosed sandstone and shale and tends to occur mid-slope on exposed rocky south-facing ridges where soils are residual (Obbens and Coates 1997; S. Barrett, personal observation).

Lambertia fairallii is largely endemic to the Montane Mallee Thicket Threatened Ecological Community (Mallee-heath and mallee-thicket community on mid to upper slopes of Stirling Range mountains and hills). The Montane Mallee Thicket TEC occurs on the mid to upper slopes of mountains and hills and above 400 m above sea level. The community generally extends further down-slope on the southern aspects of these hills, which may be due to the moister cooler conditions experienced on these southern aspects. It contains an assemblage of plants that are susceptible to *Phytophthora cinnamomi* and many of which are threatened species.

Biology and ecology

Lambertia fairallii is a weakly serotinous, non-sprouting shrub. Plants are killed by fire and persistence of the species is contingent on seeds stored in the canopy being released, germinating, seedlings establishing and plants growing to reproductive maturity before the next fire (Obbens and Coates 1997). Keith (1996) identified

a number of fire-driven mechanisms of plant population decline and extinction for non-sprouting shrubs. These mechanisms included death of standing plants and seeds, failure of seed release and/or germination, failure of seedling establishment, interruption of maturation or developmental growth and failure of seed production. Bradstock *et al.* (1998) used a spatially explicit model to simulate plant extinction in relation to fire frequency and scale and found that extinction probabilities in non-sprouting perennial shrubs increased with fire frequency and scale.

In the last thirty-five years, there have been three major fires in the eastern Stirling Range (February 1972, April 1991 and October 2000). These resulted in some of the eastern *Lambertia fairallii* populations being burnt, with fire return times of nineteen and nine years. The fires in 1991 and 2000 affected both the Ellen Peak and Mt Success populations. At Ellen Peak, forty plants (80% of the population) were burnt in 1991 and only ten seedlings appeared following the fire. Nine years later in 2000, 100% of the plants were burnt and no further seedlings appeared. This population is now thought to be extinct. After a nine year fire interval, species regeneration on Mt Success was extremely poor (Population 3A was reduced to half its size) and densities of *L. fairallii* fell from 7.5/m^2 to 0.1/m^2 (S. Barrett, unpublished data).

In 2003, thirty plants were tagged on Mt Success and Southwest Gog to monitor plant growth and the number of buds, inflorescences, fruit present and fruit released. In June 2003, 47% of *Lambertia fairallii* on Southwest Gog were reproductive. In June of the following year, 53% of plants had fruited. Table 1 (below) shows the fruit development observed on *L. fairallii* at various times since fire. Seven years post-fire, the level of fruiting on Southwest Gog was still low. Fruiting levels remained relatively low on Mt Success thirteen years post-fire. The species may be considered weakly serotinous as seed appears to be stored for approximately three seasons before being released (S. Barrett, unpublished data).

Table 1: Mean fruit produced and released per plant at various times since fire (n = 30)

Location	**Southwest Gog (Pop 2)**		**Mt Success (Pop 3E)**	
Time since fire (years)	**6**	**7**	**12**	**13**
Mean number of fruit	0.4	1.8	6.2	6.5
Mean number of fruit released	-	0.03	4.2	4.5

There is some suggestion from monitoring data that inter-fire recruitment of the species was occurring at seven years post-fire on Mt Success ([3]E. Hickman, personal observation). A seedling was also noted in an unburnt patch on Ellen Peak in 1994, twenty-two years post-fire (A. Cochrane, personal communication). Inter-fire recruitment has been noted in other *Lambertia* species such as *Lambertia orbifolia* subsp. *orbifolia* (S. Barrett, unpublished data)

Lambertia fairallii is a non-dormant species that requires no special treatment to achieve germination ([4]A. Crawford, personal communication). High levels of germination were obtained from seed collected from Southwest Gog, with a mean germination of 93%. The two samples of seed from Ellen Peak had a lower mean germination of 50%, however this could be attributed to problems experienced with the equipment during the trial and the seed having been collected from dead plants.

The population genetic structure and patterns of differentiation between the Ellen Peak and Southwest Gog populations have been investigated using isozyme markers (Obbens and Coates 1997). Ellen Peak was found to have a low genetic diversity, with 'no obvious explanation' (possibly sampling error), whereas Southwest Gog had a genetic diversity comparable to that found in other endemic species (Hamrick and Godt 1989). A significant genetic divergence was observed between the two populations of *Lambertia fairallii*, which was slightly higher than the divergence seen between two subspecies of *L. echinata* (*citrina* and *occidentalis*). This genetic differentiation may be the result of prolonged isolation of these populations on different peaks in the Stirling Ranges and warrants further investigation (Obbens and Coates 1997). The level of genetic divergence

[3] Ellen Hickman Botanist

[4] Andrew Crawford Senior Technical Officer, DEC Threatened Flora Seed Centre

suggests that populations on different peaks should be treated as separate conservation units and further research is currently being done (Obbens and Coates 1997).

The pollination biology of *Lambertia fairallii* is largely unknown, however New Holland Honeyeaters (*Phylidronyris novaehollandiae*) and White-Cheeked Honeyeaters (*Phylidronyris nigra)* have been found to be major pollen vectors for four other *Lambertia* species (Burbidge *et al*. 1979, Hopper 1980, Pyke and O'Connor 1993, Collins *et al*. 1990 and 1994, Whittaker and Collins 1997).

Threats

Lambertia fairallii was declared as Rare Flora under the Western Australian *Wildlife Conservation Act 1950* in September 1987 and is currently ranked as Endangered (EN) under World Conservation Union (IUCN 2001) Red List criteria A2c, B1+2c due to its restricted geographical range, a continuing population decline and a decline in quality of habitat. Three populations together consisting of approximately one thousand mature individuals are currently known. The species is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

Phytophthora cinnamomi and fire have resulted in the decline of the species and all populations continue to be threatened by both of these threats. Moreover, as population size decreases and isolation increases, populations may become more vulnerable to extinction for three main reasons. Firstly, loss of genetic variation and increased inbreeding are considered to be associated with a reduction in the ability of a population to adapt to short-term environmental change. Secondly, small populations are more susceptible to chance events associated with demographic and environmental stochasticity. Finally, Allee effects may occur, whereby at some density or population size, reproductive capacity drops below a threshold and the organism can no longer replace itself (Hobbs and Yates 2003).

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

- **Disease:** *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).

  The impact of *Phytophthora cinnamomi* is considered to be a critical issue in the management of all *Lambertia* species and *P. cinnamomi* is a primary concern within the Stirling Range National Park, due to the large number of threatened species that are at risk from the disease (Obbens and Coates 1997). The pathogen has been spread to many of the peaks in the Stirling Range through the transport of infected soil. Infestations at higher altitudes have led to substantial down-slope spread in broad fronts (Barrett 2004). Broadscale mapping of *P. cinnamomi* from 1986 to 1995 indicated that over 60% of the Stirling Range National Park was infested by the pathogen and a further 10% was exposed to future uncontrolled spread of the pathogen (Grant and Barrett 2003).

  All *Lambertia fairallii* populations are currently infested with or threatened by *Phytophthora cinnamomi*. Field observations indicate that *L. fairallii* is highly susceptible to *P. cinnamomi* (Barrett, personal observation). Susceptibility investigations in the laboratory by DEC also rate *L. fairallii* as Highly Susceptible (highest ranking) corresponding to a death of over 80% of plants, however the sample size was not of sufficient size to be conclusive and further testing is underway ([5]B. Shearer, unpublished data). The pathogen is of particular concern in the case of this species due to the high proportion of juveniles, which are likely to be more susceptible than adults (Obbens and Coates 1997). Combined with fire, *P. cinnamomi* infestation has caused the significant decline of the Ellen Peak and Mt Success populations. On Yungermere, a large infestation within the population has already caused significant plant death, while the Southwest Gog population is threatened by currently small infestations. There is evidence that a large part

[5] Bryan Shearer Principal Research Scientist, DEC Science Division

of the Southwest Gog population (the eastern end) is now extinct and the remainder of the population is vulnerable to similar effects.

Phytophthora cinnamomi may increase the chance of fire by increasing the fuel load (dry plant matter). The relationship between *P. cinnamomi* and fire regimes and their impact on population densities requires further clarification. An Honours project on the interactions between fire and *Phytophthora* is currently underway and while there has been no formal study previously, field observations indicate that the impact of the pathogen may be exacerbated post-fire as a result of altered hydrology and increased surface run-off (Barrett 1996; [6]M. Grant, personal communication). In addition, the non-suberised root tissue of seedlings may be more vulnerable to the pathogen and phosphite may be less effective in the seedling stage (B. Shearer, personal communication).

The rate at which *Phytophthora cinnamomi* spreads can vary and may be related to site characteristics including soils, topography, hydrology, fire history and species composition. On sites with significant gradients in the Stirling Range, the rate of spread can range from several metres to more than a hundred metres per annum (Grant and Barrett 2003). On Yungermere, the down-slope rate of spread in a small circular infestation averaged 15 to 25 cm per annum from 2000 to 2002 but by 2003 the infestation had extended several metres downhill (Barrett 2004). The rate of spread from infested to healthy habitat has not yet been determined for any of the *Lambertia fairallii* populations.

Spot infestations of *Phytophthora cinnamomi* on Yungermere are indicative of the possible role of native animal vectors in the spread of *P. cinnamomi*. Yungermere occurs within a "Special Conservation" zone, which has access by permit only. Recent observations of spotting were associated with large numbers of quokka (*Setonix brachyurus*) and/or bandicoot (*Isoodon obesulus fusciventer*) diggings (S. Barrett and [7]G. Freebury, personal observation).

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 in the form of thick ground cover and increased predation risk (Wilson, *et al.* 1994; Nichols 1998).

- **Recreation:** The Southwest Gog population occurs near Stirling Range Drive, which is a popular scenic drive and a main road within the park. It is at considerable risk of *Phytophthora cinnamomi* introduction to currently healthy areas from infested gravel on the Drive or Lookout area. Management of the carpark area to prevent ponding of water is important as areas where water pools on tracks or where soils are muddy loams provide ideal conditions for soil and disease transfer (Watson and Passmore 1993). The opportunity for vectoring of the pathogen by vehicle or foot traffic is considerable.

- **Inappropriate fire regime:** The extensive, intense wildfire that occurred in 1991 affected all populations other than Southwest Gog, which was burnt in 1997. In 2000, another large scale fire burnt the majority of the Mt Success and Ellen Peak populations. Seedling recruitment was poor or absent for these populations that had a fire interval of only nine years, as discussed in Section 1.

  Age specific fecundity is of central importance for the demography of species like *Lambertia fairallii* that are killed by fire. Poorly timed, intense and too frequent fire may be detrimental, as plants need to reach reproductive maturity to build up a seed bank. It is therefore necessary to know how much seed needs to be held on parent plants to enable the replacement of the population after fire. An estimation of the minimum desirable fire interval may be determined by doubling the primary juvenile period (time to first flower from germination in 50% of the population) (Gill and Nichols 1989), although 2.5 times the juvenile period may be a more conservative approach ([8]R. Hearn, personal communication). The primary juvenile period for *Lambertia fairallii* is 7 years, making the minimum desirable fire interval 14 to 17.5 years. However, a longer fire-free interval may be required for other members of the plant community, particularly within the Montane Mallee Thicket TEC (S. Barrett, unpublished data).

[6] Malcolm Grant Senior Operations Officer, Nature Conservation, DEC Albany Work Centre, Ravensthorpe Office
[7] Greg Freebury Operations Officer, Nature Conservation, DEC Albany Work Centre
[8] Roger Hearn Regional Ecologist, Nature Conservation, DEC Warren Region

- **Drought:** Field observations have identified that drought may pose a threat to plant survival. In Population 2, 10 of the 30 tagged individuals died due to what appeared to be drought stress over summer 2004/05 (S. Barrett, personal observation).

- **Climate Change:** The Stirling Range lies between the moist, mild areas of the southwest Plains, where annual rainfall can exceed 1400 mm, and the drier north where annual rainfall averages around 400 mm. 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 have 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 Range to become refugia for several specialised flora and fauna species. It is thought that the onset of drier conditions in the Holocene has caused the contraction of some species 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 *Lambertia fairallii*.

- **Granivory:** Seed predation was noted on 57% of the tagged plants on Mt Success. Similarly, heavy seed predation was noted in the Yungermere population in 2004 and it is thought to be the likely result of birds, small mammals or insects (A. Cochrane, personal communication; S. Barrett, personal observation). Seed predation can reduce the number of viable seeds available for dispersal and therefore limit the species reproductive potential.

Table 2: Summary of population land vesting, purpose and tenure

Population	Vesting	Purpose	Tenure
1.	WA Conservation Commission	National Park	National Park
2.	WA Conservation Commission	National Park	National Park
3A.	WA Conservation Commission	National Park	National Park
3B.	WA Conservation Commission	National Park	National Park
3C.	WA Conservation Commission	National Park	National Park
3D.	WA Conservation Commission	National Park	National Park
3E.	WA Conservation Commission	National Park	National Park
3F.	WA Conservation Commission	National Park	National Park
4.	WA Conservation Commission	National Park	National Park

Table 3: Summary of population information and threats

Pop. No. & Location	Year	No. plants Mature (Juveniles)	Habitat Condition	Threats
1. Ellen Peak	1987	50		*Phytophthora cinnamomi*, fire
	1993	Not found post-fire		
	1994	9 (2)		
	1995	10 (10)	Healthy	
	1996	10 (10)	Healthy	
	1998	4 (1)		
	1999	1 (2)	Poor	
	2002	0 (0)		
	2003	0 (0)		
	2004	0 (0)	Probably extinct	

Pop. No. & Location	Year	No. plants Mature (Juveniles)	Habitat Condition	Threats
2. Southwest Gog	1993	300+	Healthy	*Phytophthora cinnamomi*, fire, drought
	1996	5000+ (population extended)	Healthy-Moderate	
	2000	0 (5000+)	Healthy	
	2001	0 (2000+)	Healthy	
	2002	100+/- (850+/-)*	Moderate	
	2003	200+/- (800+/-)*	Healthy	
	2004	750+/- (250)*	Moderate	
	2005	3500+ (1000+)	Moderate	
3A. Mt Success	1996	1 (400+/-)	Moderate	*Phytophthora cinnamomi*, fire, drought
	1997	2500+/- (incl. 3B)	Moderate	
	1999	2500- (incl. 3B&C)	Poor	
	2000	2000+	Moderate	
	2002	0 (200+/-)	Poor	
	2003	0 (200+/-)	Moderate	
	2004	0 (200+/-)	Poor	
3B.	2004	0 (0)		
3C.	2004	0 (0)		
3D.	1999	0 (300+/-)	Moderate	
3E.	2002	250+/- (200+/-)	Poor	
	2003	300+/- (300+/-)	Poor	
	2004	300+/- (300+/-)	Poor	
3F.	2004	0 (4+)	Healthy	
4. Yungermere	2004	500+ (0)	Poor	*Phytophthora cinnamomi*

*Partial survey

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

Habitat critical to the survival of *Lambertia fairallii* includes the area of occupancy of important populations; areas of similar habitat surrounding important populations - these areas provide potential habitat for natural range extension and/or for allowing pollinators or biota essential to the continued existence of the species to move between populations; and additional occurrences of similar habitat that may contain important populations of the species or be suitable for future translocations or other recovery actions intended to create important populations. All population are considered important for the long-term recovery and survival of the species.

Benefits to other species/ecological communities

Lambertia fairallii occurs within the Montane Mallee Thicket Threatened Ecological Community (Mallee-heath and mallee-thicket community on mid to upper slopes of Stirling Range mountains and hills), which is recommended for listing as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and is currently awaiting endorsement. The Montane Mallee Thicket TEC contains an assemblage of plants that are susceptible to *Phytophthora cinnamomi* and many of which are threatened species. Threatened species associated with *L. fairallii* include *Banksia brownii* (CR), *Dryandra anatona* (CR), *Darwinia wittwerorum* (En), *Davieisa obovata* (En), *D. mesophylla* (P2), *Andersonia echinocephala* (P3), *Isopogon latifolius* (P3), *Hibbertia argentea* (P3), *Dryandra concinna* (P4), *Banksia solandri* (P4).

Furthermore, seven threatened fauna species occur within Stirling Range National Park. These include three endangered 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 species; Quokka (*Setonix brachyurus*), Numbat (*Myrmecobius fasciatus*), Malleefowl (*Leipoa ocellata*) and Baudin's Cockatoo (*Calyptorhynchus baudinii*).

Recovery actions put in place for *L. fairallii* will benefit these species and reciprocally, actions put in place for these species will benefit *L. fairallii.*

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. However, as *Lambertia fairallii* is not listed under any international agreement, the implementation of other international environmental responsibilities is not affected by this plan.

Role and interests of Indigenous people

According to the Department of Indigenous Affairs Aboriginal Heritage Sites Register, the registered sites Kojaneerup and Moingup Springs occur in the vicinity of *Lambertia fairallii*. Input and involvement will be sought from Noongar groups that have an active interest in the areas that are habitat for *D. montana.* 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 DEC managed land.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the population or within the defined habitat critical to the survival of *Lambertia fairallii* require assessment for the potential for a significant level of impact.

Evaluation of the Plan's Performance

The Department of Environment and Conservation, in conjunction with the Albany District Threatened Flora Recovery Team will evaluate the performance of this IRP. 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

Objectives

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.

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

Completed recovery actions

DEC (Albany Work Centre) and the Ranger in Charge (Stirling Range National Park) are aware of the location and threatened status of the species.

Obbens and Coates (1997) conducted a study into the conservation biology and management of three endangered *Lambertia* species, including *Lambertia fairallii*. Research included population genetic structure, seed biology, disease susceptibility and control and recommendations for conservation and management were made (as discussed in Section 1).

DEC's Threatened Flora Seed Centre have made a number of seed collections from each of the *Lambertia fairallii* populations since 1993. From the Southwest Gog population, 1564 seed has been collected; 294 seed has been collected from Ellen Peak; 411 seed from Mt Success; and seed have been collected from Yungermere and Southwest Gog that is still to be processed. Germination tests have also been carried out, as discussed in Section 1.

Kings Park and Botanic Gardens (KPBG) have records of material from four *Lambertia fairallii* clones. Currently, 0.41g of seed is stored and six plants are recorded as being planted in the Botanic Garden (cannot be verified). KPBG has no propagation data for this species ([9]A. Shade, personal communication).

Phosphite control is currently carried out on the *Lambertia fairallii* population at Mt Success under the spraying program for the Montane Heath and Thicket TEC. Phosphite has been applied by aerial application at a rate of 24 kg/ha every two years since 1997. After the Ellen Peak and Mt Success populations were burnt in 2000, phosphite was applied at 12 kg/ha annually; however in 2003 spraying ceased at Ellen Peak as the population was not relocated. Aerial application of phosphite will commence on Southwest Gog and Yungermere in 2005.

Ongoing and future recovery actions

A Masters project involving a systematic and phylogenetic study of the genus *Lambertia* is currently underway. The study aims to resolve the phylogeny of *Lambertia* and clarify species limits with particular attention given to threatened taxa. A morphometric analysis of *L. fairallii* is presently being undertaken using material gathered from three different sites ([10]A. Spooner).

All populations are monitored regularly by staff at the DEC Albany Work Centre. Close monitoring is being conducted on Mt Success and Southwest Gog to study plant survival and reproduction, as discussed in Section 1. Quadrats were established on Mt Success to monitor the effects of phosphite, which 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 in infested populations or along *Phytophthora* fronts to protect *Phytophthora*-free vegetation (Komorek, *et al*. 1997). Aerial spraying trials in the Stirling Range NP (Bluff Knoll and East Stirling Range Montane Community) found that in *Phytophthora* infested vegetation, percentage survival of plants from the Epacridaceae, eighteen months to three years after spraying, was significantly higher in the sprayed quadrats compared with unsprayed (Barrett 2003).

Although phosphite has been shown to be effective in controlling *Phytophthora cinnamomi* in a number of native plant species, recent tests provide no evidence to suggest that phosphite is effective in controlling stem

[9] Amanda Shade Kings Park and Botanic Garden
[10] Amanda Spooner Technical Officer, DEC Herbarium

lesions in *Lambertia* species and further testing is required (B. Shearer, personal communication; Shearer and Fairman 1991; 1997a; 1997b; Komorek, *et al*. 1997).

Long-term monitoring is necessary to determine the effectiveness of phosphite application, as control of *Phytophthora cinnamomi* with phosphite has been more effective at some sites than at others. While phosphite may be relatively effective in reducing root to root spread of *Phytophthora*, zoospores may be readily transmitted down slopes after rainfall events and consequently the pathogen may spread more rapidly (Barrett 2004). There is also a need to further refine phosphite application techniques and determine reasons for loss of disease control. Annual application may be required to improve its effectiveness (Barrett 2004).

Table 4: History of phosphite application on *Lambertia fairallii* populations

	1994	**1995**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Ellen Peak (Population 1)	Mister	Mister		6 kg/ha	12 kg/ha			2 x 6 kg/ha		
Southwest Gog (Population 2)										
Mt Success (Population 3)			24 kg/ha		12 kg/ha	24 kg/ha		2 x 6 kg/ha	2 x 6 kg/ha	2 x 6 kg/ha
Yungermere (Population 4)										

In 1997, eight quadrats were set up on Mt Success with the aim of assessing the survival of plants under the current phosphite spraying regime. Four of the quadrats were treated with phosphite and four were left untreated. By March 2000, there was no significant difference in percentage survival between sprayed (66%) and non-sprayed (75%) quadrats, however only one control and one treated quadrat were near active *Phytophthora* fronts. There were insufficient seedlings in quadrats after the 2000 fire to continue this monitoring.

Sprayed juvenile plants on Mt Success were tagged to monitor plant health and survival in 2003. Results showed that between June 2003 and December 2004, 47.8% and 60% of *Lambertia fairallii* plants survived in Populations 3A and 3E, respectively. By 2007, approximately 5% survived in both sub-populations. Significant declines over the summer of 2006 may have been associated with summer drought. While there has been a significant attrition of juvenile plants since 2001, survey in autumn 2008 revealed that some 70 plants had commenced flowering and some 250 juveniles had survived in sub-population 3e.

High resolution (1:5000) aerial photography of Southwest Gog and Yungermere was obtained in 2004 to enable accurate interpretation of *Phytophthora* infestations at these sites as well as providing an opportunity to monitor disease spread over time. On Yungermere in particular, the inaccessibility of the population makes it difficult to undertake regular ground interpretation. This photography will be completed in 2005.

Fire management objectives and strategies for the Stirling Range are outlined in the Stirling Range and Porongurup National Parks Management Plan 1999-2009 (CALM 1999). More recently, a refined Draft 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 (vital attributes) be used to identify fire sensitive threatened species and ecological communities within each cell to determine the minimal tolerable fire frequency for these species and communities.

Where populations occur on lands other than those managed by DEC, permission has been or will be sought from appropriate land managers prior to recovery actions being undertaken.

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 and other opportunities arise.

1. Coordinate recovery actions

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

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

2. Monitor populations

Continue regular monitoring of all *Lambertia fairallii* populations and establish additional monitoring for the rate of spread of *Phytophthora cinnamomi* on Southwest Gog, Yungermere and Mt Success. Aerial photography used for monitoring will be completed in 2005.

Action: Monitor populations
Responsibility: DEC (Albany Work Centre)
Cost: $5,080 in the first year and $4,080 each year following

3. Implement disease management

All populations will receive phosphite application annually at a rate of 12kg/ha. Access to all populations will be restricted to dry soil conditions and appropriate hygiene ensured. Suitable drainage in the recreational area adjacent to the Southwest Gog population needs to be ensured.

Action: Implement disease management
Responsibility: DEC (Science Division and Albany Work Centre)
Cost: $4,160 per year

4. Implement fire management

A fire interval of at least 12 to 15 years is recommended for *Lambertia fairallii*, however a longer fire-free interval may be required for other members of the Montane Mallee TEC (S. Barrett, unpublished data). Under the current strategy, fire will be excluded from *L. fairallii* populations for at least the term of this Interim Recovery Plan (five years).

Action: Implement fire management
Responsibility: DEC (Albany Work Centre)
Cost: $1,000 per year

5. Ongoing seed collection

Seed collection will be ongoing to obtain seed from as wide a range of individuals as possible. Currently 21 seed collections are held at DEC's Threatened Flora Seed Centre.

Action: Ongoing seed collection
Responsibility: DEC (Threatened Flora Seed Centre and Albany Work Centre)
Cost: $3,930 per year

6. Obtain biological and ecological information

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

1. Reproductive biology and pollination.
2. Seed bank dynamics, germination and recruitment, including the role of various disturbances (particularly the interaction of fire and *P. cinnamomi*), competition and rainfall.
3. The phenology and seasonal growth of the species.
4. The population genetic structure, levels of genetic diversity and minimum viable population size.

Monitoring plots have been established to assess seasonal growth and reproductive biology.

Action: Obtain biological and ecological information
Responsibility: DEC (Science Division and Albany Work Centre)
Cost: $24,000 per year for the final three years

7. Conduct further surveys

Surveys supervised by DEC staff and with assistance from local naturalists and wildflower society members to be conducted during the species flowering period (May to September).

Action: Conduct further surveys
Responsibility: DEC (Albany Work Centre)
Cost: $5,100 per year

8. Investigate the methodology for future translocation(s)

The best methods for future translocations are being investigated and a decision made on the most appropriate translocation site and procedure. A translocation proposal was approved in July 2007.

Action: Investigate the methodology for future translocation(s)
Responsibility: DEC (Science Division and Albany Work Centre)
Cost: $5,100 per year

9. Map habitat critical to the survival of the species

Although habitat critical to the survival of the species is identified 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: DEC (Albany Work Centre)
Cost: $600 in the first year.

10. Liaise with stakeholders

Input and involvement will also be sought from managers and any Indigenous groups that have an active interest in areas that are habitat for *Lambertia fairallii*.

Action: Liaise with stakeholders
Responsibility: DEC (Albany Work Centre)
Cost: $1,200 per year

11. Promote awareness

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. A Bush-book on Stirling Range flora, with references to *Lambertia fairallii* has been produced.

Action: Promote awareness
Responsibility: DEC (Albany Work Centre)
Cost: $1,400 in first year and $1,100 in remaining years

12. Review the IRP and assess the need for further recovery actions

If *Lambertia fairallii* is still ranked as Endangered (WA) at the end 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: DEC (Species and Communities Branch and Albany Work Centre) through the ADTFRT
Cost: $4,000 in the fifth year (if required)

4. TERM OF PLAN

Western Australia

This Interim Recovery Plan will operate from October 2005 to September 2010 but will remain in force until withdrawn or replaced. If the taxon is still ranked Endangered (WA) after five years, this IRP will be reviewed and if necessary, further recovery actions put in place.

Commonwealth

In accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) this adopted recovery plan will remain in force until revoked.

The recovery plan must be reviewed at intervals of not longer than 5 years.

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6. TAXONOMIC DESCRIPTION

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Erect spreading shrubs, 0.5-1.5 m tall, with dense branches, single stemmed at base. Leaves crowded around short branchlets, very shortly petiolate to almost sessile, linear, reticulate when mature on upper surface, rigid, upper surface covered by indumentum of long soft simple hairs when young, underneath a dense wool of simple hairs, margins entire, incurved, 2-4 cm long, apex mucronate. Inflorescence terminal, 5-7 flowered, solitary or clustered 2-3 together. Bracts 17-27 per inflorescence, scarious, brown, apex acute with a tuft of hairs; basal bracts ovate, 3-5 mm long, upper bracts narrowly ovate to lanceolate, 4 to 25 mm long. Perianth yellow, recurved at end of tube, lobes surmounted by a tuft of hairs, ± 34 mm in total, lobes ± 3 mm, tube 31 mm, tube ± 3 mm wide in the middle. Stamens 4, 2-3 mm long; gland small, basifixed. Style linear 34 mm long, with fine sparse hairs. Fruit 2 horned, 6-7 mm long. Seeds 2 per fruit (fruit opening on death of branch), circular, flat on one side, domed on the other with tuberculate pattern on surface.