WESTERN AUSTRALIAN WILDLIFE MANAGEMENT PROGRAM NO. 14

ROSE MALLEE RECOVERY PLAN

by

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FOREWORD

The Western Australian Department of Conservation and Land Management (CALM) publishes Wildlife Management Programs to provide detailed information and management actions for the protection of certain exploited or threatened species of flora and fauna. A Wildlife Management Program has been published for *Eucalyptus rhodantha* (Sampson *et al*. 1990) and much of the information and recovery actions in this Plan are taken from that document.

Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of an endangered or vulnerable species or ecological community. The attainment of objectives and the provision of funds is subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery Plans do not necessarily represent the views nor the official positions of any individuals or agencies represented on the Recovery Team. This Recovery Plan has been approved by the Executive Director, Department of Conservation and Land Management, the National Parks and Nature Conservation Authority and the Minister for the Environment.

Approved Recovery Plans are subject to modification as directed by new findings, changes in species' status and completion of recovery actions.

Information in the Plan is accurate at December 1992, although where it seemed important modifications have been made to provide updated information up to the end of 1993.

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SUMMARY

CURRENT SPECIES STATUS:

Gazetted as Declared Rare Flora under Section 23F of the Western Australian Wildlife Conservation Act (1950). *Eucalyptus rhodantha* occurs in a few remnant populations in established farmland of the northern wheatbelt. Less than 500 plants are recorded, most of these occurring on uncleared private land. The remaining plants occur as scattered individuals in cleared or cropped paddocks and narrow degraded road verges. No natural seedling recruitment has been observed at any sites and inbreeding has increased significantly in the small isolated stands. Careful management of the populations is essential to ensure the species' continued survival in the wild.

HABITAT REQUIREMENTS AND LIMITING FACTORS:

Most of the range of *E. rhodantha* has been cleared so additional populations are unlikely. Its habitat is in poor condition due to grazing and heavy weed and rabbit infestation. Some of the existing stands can be rehabilitated by introduction of seedlings, revegetation and elimination of threats (weeds, rabbits, stock).

RECOVERY OBJECTIVE:

Ensure the species' survival in the wild by protecting existing populations in conservation reserves and promoting rehabilitation through population and habitat enhancement.

RECOVERY CRITERIA:

2 years - acquisition of land containing stands 4 and 5 at Watheroo as a conservation reserve. Protection of stands 4 and 5 from grazing and potential uncontrolled fires.

5 years - rehabilitation of stands 2, 4 and 5 by introduction of seedlings and associated species.

10 years - self-maintaining populations protected in conservation reserves. Control perceived threats to populations. Collection of seed from all populations in long-term storage. Representative sample of plants from each population maintained in cultivation.

ACTIONS NEEDED

1. Establish recovery team.
2. Acquisition of land for a conservation reserve.
3. Protection of habitat (fencing, rabbit control, fire protection).
4. Population enhancement.
5. Habitat enhancement.
6. Research.
7. *Ex situ* conservation.
8. Liaison and public education.
9. Population monitoring and reporting.

TOTAL ESTIMATED COSTS OF RECOVERY: 1991 prices in $000s/year

TC - Total Cost ESP - Endangered Species Program funds required (= TC - CALM contribution)

Actions	1		2		3		4		5		6		7		8		9		Total	
	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP
1992	2.5	-	32	2	31.5	29	3	3	21.9	21	17	10	-	-	1.8	1	7.5	6	117.2	72
1993	2.5	-	-	-	2.7	2	-	-	9.3	7.6	5	-	-	-	1.8	1	7.5	6	28.8	16.6
1994	2.5	-	-	-	2.7	2	17.2	14.2	-	-	5	-	7.4	6	1.8	1	7.5	6	44.1	29.2
1995	2.5	-	-	-	2.7	2	16.2	13.2	-	-	-	-	7.2	6	1.8	1	7.5	6	37.9	28.2
1996	2.5	-	-	-	4.2	3	16.2	13.2	-	-	-	-	5.9	4.7	1.8	1	7.5	6	38.1	27.9
1997	1.5	-	-	-	5	4	-	-	-	-	-	-	2.2	1	1.8	1	5.5	4	16	10
1998	1.5	-	-	-	2.7	2	-	-	-	-	-	-	2.2	1	1.8	1	5.5	4	13.7	8
1999	1.5	-	-	-	2.7	2	-	-	7.8	7.5	-	-	2.2	1	1.8	1	5.5	4	21.5	15.5
2000	1.5	-	-	-	2.7	2	-	-	7.8	7.5	-	-	2.7	1.5	1.8	1	5.5	4	22	16
2001	1.5	-	-	-	6.5	5	-	-	-	-	-	-	2.2	1	1.8	1	5.5	4	17.5	11
Total	20	-	32	2	63.4	53	52.6	43.6	46.8	43.6	27	10	32	22.2	18	10	65	50	356.8	234.4

BIODIVERSITY BENEFITS

Acquisition of the site at Watheroo will conserve habitat that is poorly represented in conservation reserves. Rehabilitation of the populations and associated vegetation will provide increased habitat and food resources for animal species (eg. honeyeaters and honey possums). Conservation of other Declared Rare Flora and priority species can be incorporated into the rehabilitation and enhancement of *E. rhodantha* populations.

INTRODUCTION

1.1 Description and taxonomy

The Rose Mallee, *Eucalyptus rhodantha* Blakely & Steedman, was described from material collected near Gunyidi by Henry Steedman in 1934 (Blakely *et al.* 1938). It is a low spreading mallee up to 4m high, with smooth greyish brown stems and glaucous branchlets. It has distinctive silvery grey leaves that are opposite, sessile and often clasping the stems (Cover illustration). The leaves are orbicular to cordate, to 8 cm x 8 cm, with the apex ending in a short point. The buds are glaucous, to 5.5 cm long x 4 cm wide, with a beaked, conical budcap. They are pendulous and usually solitary, on long, thick pedicels and peduncles. The flowers are large, to 7.5 cm across, bright red to pink, or rarely creamy yellow. The fruits are woody, hemispherical to top-shaped, to 3 cm long x 5.5 cm wide, and containing dark brown, winged seeds. There is some variation within the species, with plants in the Three Springs area having greener, less glaucous leaves. Plants at the Watheroo sites are most distinctive and possess the typical characteristics.

A variety, *E. rhodantha* var. *petiolaris* Blakely & Steedman, has been described (Blakely 1941) and is distinguished by its sometimes alternate, shortly petiolate leaves that tend to be yellowish green and cordate to lanceolate in shape. The buds have a rounder, unbeaked budcap and longer calyx tube.

E. rhodantha is related to and closely resembles *Eucalyptus macrocarpa*, differing in its smaller, pendulous buds and fruits, more compact habit and less elongated leaves. Both species are included together in the series *Curviptera* (Chippendale 1988). The two species are not associated in the field.

There has been some confusion in the past about the taxonomic status of *E. rhodantha*, owing to the misidentification of *E. macrocarpa* x *E. pyriformis* hybrids. It was not included in Pryor and Johnson's (1971) classification of the eucalypts for this reason. Subsequent research established that it is not a hybrid and it is now regarded as a highly restricted species, distinct from other eucalypts but having some relationship with *E. macrocarpa* and *E. pyriformis* (Pryor 1981).

1.2 Distribution

E. rhodantha is known from only a few remnant stands in the northern wheatbelt of Western Australia (Figure 1). The two northern stands occur south-west of Three Springs within one kilometre of each other, while the five southern stands are distributed over several kilometres near Watheroo. Both var. *rhodantha* and var. *petiolaris* occur at these localities, sometimes in association. Numerous references (Chippendale 1973, Gardner 1979, Lucas & Synge 1978, Pryor 1981) have reported *E. rhodantha* as occurring south to New Norcia and Bolgart, but this was owing to confusion with specimens of the hybrid *E. macrocarpa* x *E. pyriformis*. Apart from a 1953 collection from Eneabba Creek, all the specimens are from the Three Springs and Watheroo sites. Eneabba Creek and surrounding areas were surveyed during August 1991 but no other populations were located. The region has been largely cleared of native vegetation for agriculture.

There are only two relatively undisturbed populations of *E. rhodantha*. They occur on uncleared private land in the Watheroo area. The remainder occur on cleared and grazed farmland and degraded road verges. The locations, estimated size and condition of the stands are summarised below (stand numbers follow Sampson *et al.* 1990). Precise locality details are contained on the departmental rare flora database and files.

Stand 1 - south-west of Three Springs. 14 plants of var. *rhodantha* on narrow, degraded road verge. 1 plant of var. *petiolaris* has been recorded on adjacent cleared private property.

Stand 2 - south-west of Three Springs. 8 plants of var. *rhodantha* and 1 var. *petiolaris* on road verge. A gravel pit to 3 m deep is situated in the middle of the population. Some of the plants are suffering heavy predation by leaf-eating insects.

Figure 1 Distribution of *Eucalyptus rhodantha*

Stand 3 - north-east of Watheroo. A total of 37 plants of var. *rhodantha* and 1 of var. *petiolaris* on private property and road reserve. A subpopulation of 14 plants (stand 3a) are grouped together on partially cleared land along a creekline. The remaining 23 plants are scattered over about 25ha in a paddock which has been cleared except for a small stand of *Eucalyptus todtiana*.

N.B. Isolated plants occur along the road verge between stands 3, 4 and 5.

Stand 4 - north-east of Watheroo. An estimated 180 plants of var. *rhodantha* on uncleared private land. Approximately 8ha is completely fenced-off from the surrounding agricultural land. Stock have grazed outside the fenced area.

Stand 5 - north-east of Watheroo. An estimated 150 plants of var. *rhodantha* and 1 plant of var. *petiolaris* on uncleared private property, east of stand 4. A dense stand of *E. loxophleba* occurs at the east end of the population.

N.B. Stands 4 and 5 occur on uncleared land set aside by the landowner for the conservation of E. rhodantha*. The area is heavily weed and rabbit infested. A few plants occur due north of these stands in a cleared paddock.*

Stand 6 - north-east of Watheroo. 9 plants of var. *rhodantha* on weed infested road verge bordered by paddocks.

Stand 7 - east of Watheroo. 1 plant of var. *rhodantha* on cleared private land. Some 40 plants occurred in a nearby paddock but are now dead.

1.3 Habitat and associated species

E. rhodantha grows on sandy soils, often with some gravel, in flat or gently undulating country. The populations on uncleared land occur as almost pure mallee communities over low heath including *Dryandra ashbyi*, *Calothamnus quadrifidus*, *Gastrolobium spinosum*, *Hakea trifurcata*, *Hakea sulcata*, *Grevillea eriostachya* and *Acacia* sp. Where *E. rhodantha* is absent, *Callitris* thickets and stands of *Banksia prionotes* and *Allocasuarina* sp. occur. Eucalypt species found in the vicinity of *E. rhodantha* populations include *E. loxophleba, E. eudesmioides, E. tetragona* and *E. todtiana.*

The climate of the area is 'extra-dry Mediterranean' (Beard 1984), with the majority of rainfall during the winter months (May-August). Average annual rainfall is 388 mm at Three Springs and 425 mm at Watheroo (Western Australian Bureau of Meteorology). The summers are hot and the winters cool with only occasional frosts.

1.4 Life history and ecology

1.4.1 Flowering phenology

E. rhodantha flowers between March and November, with peak flowering in the winter months of June to August (McNee 1986; Sampson 1988). It produces few flowers per plant in comparison to other eucalypt species, with individual plants differing in the number of flowers and in the time and duration of flowering. The flowers are long-lived (20-30 days) and yield copious quantities of nectar, mainly during the day. They are protandrous, most of the pollen being shed from the anthers within six or seven days after anthesis. The stigma becomes receptive after about twelve days (McNee 1986).

Vegetative growth and bud development occur during the summer months. Predation by the bud weevil, *Haplonyx maximus*, and the Port Lincoln Parrot, *Barnardius zonarius*, reduces the number of buds which will eventually flower (McNee 1986).

1.4.2 Pollination biology

The flowers are pollinated by several species of birds and possibly small mammals. Birds observed feeding at the flowers include *Lichmera indistincta* (Brown Honeyeater), *Lichenostomus virescens*

(Singing Honeyeater), *Manorina flavigula* (Yellow-throated Miner), *Anthochaera carunculata* (Red Wattlebird) and *Barnardius zonarius* (Port Lincoln Ringneck). *E. rhodantha* pollen has been found in pollen smears from *Philydonyris albifrons* (White-fronted Honeyeater), although it has not been observed foraging. The Honey Possum, *Tarsipes rostratus*, may also harvest pollen from the flowers (McNee 1986). *L. virescens* and *M. flavigula* are thought to be the main pollinators.

The birds do not forage exclusively on *E. rhodantha*; they use a variety of locally occurring species including *Banksia prionotes, Dryandra ashbyi, Grevillea eriostachya* and *Calothamnus quadrifidus.* They may travel over long distances, with some species observed feeding on flowers and then flying up to 60 m to the next flower. Other species establish territories and move between a few plants (McNee 1989). Opportunity for pollen exchange between populations is provided by birds travelling over uncleared bush between stands.

The abundance and behaviour of bird species varies between years, and is closely related to the number of flowers and availability of nectar resources.

1.4.3 Breeding system

Detailed investigations of the mating system of *E. rhodantha* indicate that it has a mixed mating system with predominant outcrossing but a significant proportion of self-pollination (Sampson 1988; Sampson *et al*. 1989). Protandry does not prevent self-pollination in *E. rhodantha* as several flowers at different stages may be present on a plant at any one time. Seed-set of single plants in isolated locations is evidence that self-pollination occurs in *E. rhodantha*. Some inbreeding other than self-pollination also occurs, probably as a result of matings between related plants within relatively small family neighbourhoods (Sampson 1988).

Selection favouring heterozygous progeny, which are more likely to be produced by outcrossing, probably contributes to the maintenance of a mixed mating system in *E. rhodantha*. In mature plants the level of heterozygosity was significantly higher than those detected in seeds or newly germinated seedlings (Sampson 1988). This suggests that selection is operating during the life cycle and that heterozygotes are more likely to survive at all stages.

1.4.4 Genetic diversity

Despite the range in size of the remnant stands of *E. rhodantha* the average levels of genetic diversity found in all of them were high. The effects of fragmentation and small population size were apparent however, as there were weak correlations between some measures of genetic diversity and population size (Sampson 1988). A significant increase in inbreeding was found in a small stand of isolated plants (see section 1.4.5).

Differentiation between the distribution of genetic diversity in the remnant stands of *E. rhodantha* was significant but relatively low. The mean genetic distance increased with geographical distance, with separation of stands one and two from the southern stands (see Figure 2). A significant but low differentiation was observed on a local scale between two arbitrary subpopulations in stand 4 (Sampson 1988). It appears that gene flow within populations is restricted so that local neighbourhoods form and become genetically different.

1.4.5 Inbreeding in small stands

A substantial increase in inbreeding was reported in a small remnant of 14 plants isolated in land cleared for agriculture (subpopulation 3a). The level of outcrossing in this stand was significantly lower than that determined for a population on uncleared land (stand 4). This was attributed to a substantial increase in self-pollination, probably as a result of reduced plant and pollinator numbers resulting from clearing (Sampson 1988). While limited investigations found that the increase in inbreeding was not associated with a decrease in reproductive output, as determined by the number of capsules produced per plant, observations suggest that the small remnants of *E. rhodantha* are less fecund and less vigorous than the larger populations. This may simply be the result of environmental

degradation (Sampson *et al*. 1990). Inbreeding in the other small stands (stands 1, 2, 6) is also probably significant.

Figure 2 Dendrogram based on UPGMA cluster analysis of genetic distance (Nei's *D*) showing the relationships between remnant stands of *E. rhodantha*. After Sampson (1988)

1.4.6 Recruitment and vegetative regeneration after fire

Plants in both the disturbed and relatively undisturbed stands of *E. rhodantha* maintain moderate levels of fruit and seed production (Sampson 1988). The fruits open and release seed in the absence of fire, and more than half the fruit on a plant can open during a single year (McNee 1989). Despite this supply of seed no natural seedling recruitment has been observed in any of the stands.

The effect of fire on seedling recruitment and vegetative regeneration was investigated by Sampson (1988). A moderate burn was conducted on a subpopulation of 30 plants in stand 4 in April 1986. An estimated 27 000 seeds held in the canopy were released following the fire but only six seedlings were observed. None of these seedlings survived through to August 1987. It was suggested that the depletion of seed after fire by predators and wind was probably the major factor limiting germination in the small burnt stand (Sampson 1988).

In the burnt stand of 30 plants, 29 began coppicing at the onset of the first growing season (November 1986) after the fire. Some of the plants flowered during the 1988 season, two years after the fire (McNee, pers. comm.). Exclusion of stock prevented damage to the new vegetative growth, which in grazed stands are usually stripped of leaves.

Planted seedling trials in fenced and unfenced plots showed that large vertebrates (kangaroos, rabbits) had no significant effect on the mortality of planted seedlings. Water and/or nutrient stress probably contributed to the mortality of seedlings, although there was no increase in deaths over the summer months when conditions are extreme.

The experimental burn demonstrated that fire may have an important role in the reproductive biology of *E. rhodantha* by stimulating the release of large quantities of seed from the canopy. Recruitment after fire probably occurs only when environmental conditions are suitable for seedling establishment. Because establishment is likely only after a small percentage of fires it is not recommended as a management tool for promoting seedling recruitment in *E. rhodantha.*

1.5 Threats and impacts

The long-term survival of *E. rhodantha* in the wild is not guaranteed given its distribution as small isolated remnants in largely cleared agricultural land. Only two populations remain relatively undisturbed on uncleared private property, the others occurring in cleared paddocks or degraded, weed infested road verge. No natural recruitment has been recorded in any of the populations. Increased inbreeding reported in small remnants may result in reduced fecundity and loss of vigour.

Some of the roadside populations have been subject to commercial seed collection in the past, although this has not been reported in recent years. The populations adjoining crops may be subject to drift from herbicide and pesticide spraying. The effect of salination and fungal pathogens (*Phytophthora* spp) on *E. rhodantha* is not known but may have an increasing impact in the future.

1.6 Existing conservation measures

E. rhodantha has been gazetted as Declared Rare Flora under the Western Australian Wildlife Conservation Act (1950-1985) since 1980, and so is afforded special legal protection from damage or destruction. Its survival in the wild has been due to the foresight, goodwill and assistance of private landowners, shire councils and other authorities. Close liaison with the owner of the land supporting the large populations at Watheroo has been maintained and negotiations to acquire the land as a conservation reserve are underway. Detailed research on the genetic systems and reproductive biology of *E. rhodantha* has been conducted by the University of Western Australia and Curtin University in cooperation with the Department of CALM. A management program outlining detailed management actions has been prepared by CALM (Sampson *et al*. 1990). Some degree of protection is provided by its wide *ex situ* cultivation in parks and gardens throughout Australia.

1.7 Strategy for recovery

To recover this species it will be necessary to conserve populations at both Three Springs and Watheroo. Research has found that the range of variation within the species could be adequately conserved by preserving stands 1, 2, 4 and 5 (Sampson *et al*. 1990). Enhancement of the populations and surrounding habitat would provide a suitable environment for natural recruitment and recovery of the stands.

At Watheroo, stands 4 and 5 will be protected through acquisition of the land as a conservation reserve, eliminating grazing and undertaking fire protection measures. The populations and surrounding habitat will be rehabilitated by planting seedlings of *E. rhodantha,* control of rabbits and weeds, and by introducing plant species that support pollinators.

At Three Springs, stand 2 will be rehabilitated by landscaping the gravel pit, reducing weeds and introducing plant species supporting pollinators. The number of *E. rhodantha* at the site will be increased by introducing seedlings from both stands 1 and 2. Protection from potential uncontrolled fires and road maintenance operations will be undertaken.

Seed will be collected from all sites and maintained in long-term storage. A representative sample of plants from all populations will be maintained in cultivation. Research on seed production and viability in the very rare var. *petiolaris* will be conducted. The populations will be monitored annually to assess recovery.

The recovery plan will run for a ten year period from 1992 to 2001 inclusive.

RECOVERY

2.1 Objective and criteria

The objective of this Recovery Plan is to ensure this species' survival in the wild by protecting existing populations at both localities through reserve acquisition, rehabilitation and control of threats.

Recovery will be achieved when:

- stands 4 and 5 are protected by acquisition of the land as a conservation reserve;
- stands 2, 3, 4 and 5 are protected from existing and potential threats (eg. grazing, fire, road maintenance operations);
- stands 2, 4 and 5 are rehabilitated through enhancement of population numbers, removal of rabbits and weeds and introduction of species supporting pollinators;
- a collection of seed from all populations is maintained in long-term storage;
- a collection of plants from all localities is maintained in cultivation.

2.2 Recovery actions

Recovery actions for *Eucalyptus rhodantha* are detailed below. All costs are calculated in 1991 dollars and no allowance has been made for inflation.

The Plan requires a contract botanist to be employed on a quarter-year basis to undertake the research and monitoring phases outlined in some sections.

2.2.1 Appointing the Recovery Team

A recovery team will be appointed to coordinate the implementation of this Recovery Plan. The team will comprise representatives from CALM's Science and Information Division, Nature Conservation Division and Greenough Region, Australian Nature Conservation Agency (ANCA) and others who may be involved in implementing this plan. The recovery team will report annually to CALM's Corporate Executive on implementation of the plan.

2.2.2 Acquisition of Conservation Reserve

Acquisition of land supporting the large stands 4 and 5 at Watheroo is essential. These stands are the only ones on uncleared land and represent a significant proportion of the total known plants. The area, of approximately 50 ha, meets the minimum reserve size requirements as recommended by Sampson *et al*. (1990).

Acquiring the site as a conservation reserve will enable management and rehabilitation of the populations and surrounding habitat to be undertaken. Certain measures will be required to protect the area from threats such as grazing and potential uncontrolled fires. None of the other sites are suitable for acquisition as conservation reserves.

Land acquisition is the responsibility of CALM's Land Administration Branch.

2.2.3 Protection of Habitat

2.2.3.1 Fencing

The proposed reserve at Watheroo (stands 4 and 5) has been considerably degraded by rabbit infestation and sheep grazing. While rabbits and kangaroos do not have a significant effect on the mortality of seedlings of *E. rhodantha* (Sampson *et al.* 1990) they may affect seedlings of species which support pollinators. Sheep have been reported to strip *E. rhodantha* of new growth and are likely to graze young plants.

As rabbits contribute to the overall degradation of the area, complete rabbit-proof fencing of stands 4 and 5 and the associated habitat is required. The road verge stands 1, 2 and 6 and the degraded private property stand 3 do not require fencing.

Rabbit-proof fencing will be installed by contract under the supervision of CALM District staff. Regular inspections and maintenance of the fence will be required.

ESP funds are required for materials, construction and maintenance of 5 km of rabbit-proof fencing. CALM will contribute salaries of District staff coordinating fence construction and conducting routine inspections.

2.2.3.2 Rabbit control

Rabbit eradication is required after construction of rabbit-proof fencing around the proposed reserve (stands 4 and 5) at Watheroo. Baiting will be required three times in the ten year period and will be undertaken by the Agriculture Protection Board (APB).

2.2.3.3 Protection from fire

Fire is not recommended as a management tool for promoting seedling recruitment or vegetative regeneration in *E. rhodantha* (Sampson *et al.* 1990). All populations will be excluded from prescribed burning programs and protected from potential uncontrolled fires. Ploughed firebreaks will be installed and maintained annually around stands 4 and 5. The rehabilitated stand 2 will be protected by controlling weed species in adjacent habitat. Fire protection will be undertaken by local contractors under the supervision of District staff.

ESP funds are required for contract labour and machinery hire. CALM will contribute salaries of supervising District staff.

2.2.3.4 Roadside markers

Stands 1, 2 and 6 and isolated plants near stands 3, 4 and 5 occur along road verges where they are vulnerable to damage or destruction from road maintenance operations. Permanent but discrete marker pegs have been installed at stand 1. Marker pegs are required at sites 2 and 6 and between stands 3 and 5.

ESP funds are required for purchase of marker pegs. District operations staff will provide installation labour.

2.2.3.5 Protection from dieback disease (*Phytophthora* spp.)

The impact of *Phytophthora* species on *E. rhodantha* is not known, however they are known to kill other plant species which support pollinators. Several *Phytophthora* species have been isolated from sites in the northern sandplains region, and while no populations of *E. rhodantha* are known from dieback affected habitat, they may be threatened in the future. It is essential that *Phytophthora* species be excluded from the immediate habitat and surrounding communities. All operations in the vicinity of *E. rhodantha* populations are to be conducted under strict dieback hygiene conditions.

Monitoring of the sites will be undertaken by a contract botanist.

2.2.4 Population Enhancement

Natural recruitment has not been observed at any of the sites and it is desirable to enhance the populations by introducing seedlings of *E. rhodantha.* The large stands 4 and 5 are genetically viable but new individuals are required to vary the age structure. Stand 2 does not meet the estimated minimum viable population size of 25 plants (Sampson 1988) so additional individuals are required. After rehabilitation and protection of these sites, introduction of new individuals should be maintained through natural recruitment.

2.2.4.1 Seed collection and propagation

Seed collection will be undertaken in summer 1992/1993 for propagating and planting out in 1994-1996. At Watheroo seed will be collected from up to 60 randomly-chosen individuals in each of stands 4 and 5. At Three Springs seed will be collected from all plants (where possible) in stands 1 and 2. Seed will be collected from all individuals of var. *petiolaris* in the source populations for planting out in their respective stands. Seed collection will be undertaken by a contract botanist.

Seedlings will be propagated and raised to at least 8-weeks-old before planting out so that a deep root system has developed. Excess seed will be stored at the Threatened Flora Seed Centre at the WA Herbarium until required for propagation.

ESP funds are required for seed collection, storage and propagation. CALM will contribute salaries of nursery staff.

2.2.4.2 Re-introduction and monitoring

Seedlings of *E. rhodantha* will be planted out in Autumn 1994 after the first winter rains and completion of the weed control program. For both stands 4 and 5 250 seedlings will be planted out in the first year, with supplementary plantings in the following two years. At Three Springs 50 seedlings will be introduced to stand 2 in the first year, with supplementary plantings in the following two years. It is important to ensure that individuals of the extremely rare var *petiolaris* present in the source populations are propagated and introduced into the stands.

Seedling introduction will be undertaken by local and/or contract staff depending on resources. Volunteers from local interest groups and schools may provide assistance.

Monthly monitoring of the introduced plants is required in the first year after each planting (ie. for a total of three years) and will be undertaken by a contract botanist. Quarterly monitoring is required thereafter and is costed under routine population monitoring (see section 2.2.9).

ESP funds are required for planting out and monitoring seedlings over the three years. CALM will contribute salaries of supervising staff.

2.2.5 Habitat enhancement

To enhance the long-term survival of stands 2, 4 and 5, rehabilitation of the degraded habitat is required. Fencing of the proposed reserve at Watheroo (stands 4 and 5) and eradication of rabbits is addressed in section 2.2.3.2.

2.2.5.1 Weed Control

Removal of weeds at stands 2, 4 and 5 will enhance the habitat and promote natural regeneration of both *E. rhodantha* and the associated species. Weed control is essential to reduce competition with young seedlings. A contact, non-residual herbicide (eg. Roundup®) will be used to eliminate both

grass and broad-leaved weeds at the sites. The herbicide will be applied using a hand-sprayer to prevent contacting native species.

At stands 4 and 5 the weed control program will commence after fencing and removal of rabbits. Two applications of herbicide in the first year (May and September) and one in the second year (May) will be required. Follow-up control after five years is desirable. Weed control will be undertaken by the Agriculture Protection Board (APB) under the supervision of CALM District staff.

ESP funds are required for chemicals and APB staff labour. CALM will contribute salaries of supervising staff.

2.2.5.2 Associated species

The vegetation of the proposed reserve (stands 4 and 5) and stand 2 will be enhanced to promote pollinator activity by providing greater nectar resources. Pollinators of *E. rhodantha* forage on a variety of species throughout the year so introduction of a diverse range of species is required. Species to be introduced should occur, or have occurred, at the particular sites or be found in similar habitats nearby. Appendix 1 lists species suitable for introduction to the Watheroo stands 4 and 5.

Seedlings for introduction should be raised from seed obtained at the site, or if not available there, from nearby localities. Seed collection will be undertaken by a licensed seed collector in 1992-93 and seedlings propagated for planting out in 1994.

Introduction of associated species will be undertaken by district staff or local contractors, depending on resources. A volunteer program involving local interest groups may be organised to assist with the rehabilitation program.

ESP funds are required for seed collection, propagation and planting of seedlings. CALM will contribute salaries of nursery and supervising staff.

2.2.5.3 Site rehabilitation

The gravel pit adjacent to stand 2 will be landscaped and revegetated by the introduction of *E. rhodantha* seedlings and other plant species exploited by pollinators. Gravel pit revegetation costs are included under section 2.2.5.2. The gravel pit will be landscaped by local contractors under the supervision of District staff. No site rehabilitation is required at stands 4 and 5.

ESP funds are required for contract labour and machinery. CALM will contribute salaries of supervising staff.

2.2.5.4 Reserve buffers

A buffer will be planted inside the proposed reserve boundary (stands 4 and 5) to provide protection against soil erosion, desiccation, fertiliser drift and weed encroachment. It should consist of locally collected *Acacia* species and species likely to promote pollinator activity (see Appendix 1). Seed will be collected by a licensed seed collector and the buffer installed by local contractors using direct seeding methods.

ESP funds are required for seed collection, contract machinery and labour. CALM will contribute salaries of supervising District staff.

2.2.6 Research

Research on seed production and viability is required for the very rare var. *petiolaris* which occurs as single isolated individuals in stands of var. *rhodantha*. It has been observed to set occasional fruit but seed production and viability is not known. It is proposed that this research be conducted as an Honours project.

ESP funds are required to support the Honours project. CALM contributions will include salaries of an Honours supervisor.

2.2.7 *Ex situ* conservation

Ex situ conservation is advisable for *E. rhodantha* to reduce the possibility of sudden extinctions of wild populations through catastrophes (eg. fire or disease). Representative genotypes will be conserved by maintaining seed in storage and plants in cultivation.

2.2.7.1 Seed collection and long-term storage

Seed will be collected from all stands so that the range of genetic and morphological diversity is represented. In the smaller stands 1, 2, 3, 6 and 7 seed will be harvested from up to five randomly-chosen fruits from all individuals in the stands. In the large stands 4 and 5 seed will be harvested from one fruit per plant from approximately 50 randomly-chosen plants within each stand. Seed will be collected from all recorded individuals of the var. *petiolaris* where possible.

Seed collection will be undertaken in 1993/1994 and 2000/2001 by a contract botanist. The seed will be maintained in long-term storage at the CALM Threatened Flora Seed Centre at the WA Herbarium. Seed from individuals in each stand will be maintained separately and not bulked. Viability of the stored seed will be tested regularly and the seed collection enhanced if required. Seed will be made available, as required, for cultivation (see 2.2.8.2). Methods of collecting and storing seed are outlined in CALM Information Sheet 5-87 and Edmiston (1984).

ESP funds are required to collect and maintain seed. CALM will contribute salaries of supervising staff.

2.2.7.2 Maintenance in cultivation

There is currently no facility in Western Australia for maintaining an *ex situ* collection of plants in a botanic garden so stock plants, representing the range of morphological and genetic diversity, will be maintained in nursery cultivation. Seedlings propagated from the local stands will be made available to the Three Springs Shire for planting in the town gardens. Through the landcare committees, local farmers may be encouraged to plant *E. rhodantha* on their properties.

E. rhodantha is a highly ornamental plant and should be more widely cultivated in parks and gardens. This will reduce any pressure on natural populations from illegal seed harvesters. Seed should be collected from a range of plants within the northern and southern stands and made available to commercial nurseries. Cost of collecting seed for commercial purposes can be paid for by the nurseries.

ESP funds are required for materials to maintain stock plants in cultivation. CALM will contribute salaries of nursery staff.

2.2.8 Liaison and public education

Survival of *E. rhodantha* has largely depended on the goodwill and assistance of landowners, shires and authorities. It is essential that this be maintained and all management actions will be undertaken with their approval and cooperation. Liaison with local shires and authorities is particularly important in the protection of populations occurring along road verges. Protection of the main stands 4 and 5 at Watheroo will require close cooperation with the landowners, especially where their farming practices may require modification (eg. use of herbicides and fertilisers). Local shires, landowners, schools and interest groups (eg. wildflower societies, naturalist clubs) will be encouraged to participate in aspects of the Recovery Plan. All relevant parties will be kept informed of recovery progress. A public education program will be conducted to increase the awareness of the significance of rare flora, and in particular *E. rhodantha*. Interpretive display boards will be installed at the proposed reserve at Watheroo (stands 4 and 5). General publicity and education programs will be coordinated by CALM Wildlife Branch and District staff. Public information material will be prepared by the Corporate Relations Division.

ESP funds are required for liaison administrative costs and to prepare displays and information material for the education program. CALM will contribute salaries of the coordinating staff.

2.2.9 Population monitoring and reporting

All populations will be monitored quarterly to assess their condition and potential threats. More intensive monitoring as part of the population enhancement phase is costed under the relevant section (see 2.2.4.2). Monitoring will be undertaken by a contract botanist under the supervision of Wildlife Branch and Science and Information staff.

ESP funds are required for a contract botanist, travel and administrative costs. CALM will provide salaries for staff supervisors.

3. IMPLEMENTATION SCHEDULE

Task Description	Priority	Feasibility	Responsibility		Cost Estimates ($000s/Year) 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	TOTAL
1. APPOINTING RECOVERY TEAM															
	1	100%	CALM (W)	a	-	-	-	-	-	-	-	-	-	-	-
				b	2.5	2.5	2.5	2.5	2.5	1.5	1.5	1.5	1.5	1.5	20
2. LAND ACQUISITION															
	1	95%	CALM (L)	a	2	-	-	-	-	-	-	-	-	-	2
				b	30	-	-	-	-	-	-	-	-	-	30
3. PROTECTION OF HABITAT															
3.1. Fencing	1	100%	Local contract,	a	25	1	1	1	1	1	1	1	1	1	34
			CALM (D)	b	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.5
3.2. Rabbit control	1	95%	APB,	a	1	-	-	-	1	-	-	-	-	1	3
			CALM (D)	b	0.5	-	-	-	0.5	-	-	-	-	0.5	1.5
3.3. Fire Protection	1	99%	CALM (D),	a	2.4	0.5	0.5	0.5	0.5	2.5	0.5	0.5	0.5	2.5	10.9
			Local contract	b	0.5	0.2	0.2	0.2	0.2	0.5	0.2	0.2	0.2	0.5	2.9
3.4. Roadside markers	3	100%	CALM (D)	a	0.1	-	-	-	-	-	-	-	-	-	0.1
				b	0.5	-	-	-	-	-	-	-	-	-	0.5
3.5. Dieback protection	1	90%	CALM (D)	a	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5
				b	-	-	-	-	-	-	-	-	-	-	-
4. POPULATION ENHANCEMENT															
4.1. Seed collection & propagation	2	100%	Consult. botanist,	a	3	-	1	1	1	-	-	-	-	-	6
			CALM (S)	b	-	-	1	1	1	-	-	-	-	-	3
4.2. Re-introduction & monitoring	2	95%	Consult. botanist,	a	-	-	13.2	12.2	12.2	-	-	-	-	-	37.6
			CALM (W, D, S&I)	b	-	-	2	2	2	-	-	-	-	-	6

Task Description	Priority	Feasibility	Responsibility		Cost Estimates ($000s/Year) 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	TOTAL
5. HABITAT ENHANCEMENT															
5.1. Weed control	2	85%	APB, CALM (D)	a	14	5	-	-	-	-	-	7.5	7.5	-	34
				b	0.6	0.3	-	-	-	-	-	0.3	0.3	-	1.5
5.2. Associated species	2	80%	CALM (D),	a	3	2	-	-	-	-	-	-	-	-	5
			Seed collector	b	-	1	-	-	-	-	-	-	-	-	1
5.3. Site Rehabilitation	3	90%	CALM (D),	a	2	-	-	-	-	-	-	-	-	-	2
			Local contract	b	0.3	-	-	-	-	-	-	-	-	-	0.3
5.4. Buffer	3	95%	CALM (D),	a	2	0.6	-	-	-	-	-	-	-	-	2.6
			Seed collector, Local contract	b	-	0.4	-	-	-	-	-	-	-	-	0.4
6. RESEARCH															
	3	80%	Honours student,	a	10	-	-	-	-	-	-	-	-	-	10
			CALM (S&I)	b	7	5	5	-	-	-	-	-	-	-	17
7. *EX SITU* CONSERVATION															
7.1. Seed collection & long-term	3	100%	Consult. botanist,	a	-	-	3	3	2.7	0.5	0.5	0.5	1	0.5	11.7
storage			CALM (S&I)	b	-	-	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8
7.2. Maintenance in cultivation	3	85%	CALM (S)	a	-	-	3	3	2	0.5	0.5	0.5	0.5	0.5	10.5
				b	-	-	1	1	1	1	1	1	1	1	8
8. LIAISON & PUBLIC EDUCATION															
	3	100%	CALM (W, D)	a	1	1	1	1	1	1	1	1	1	1	10
				b	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	8
9. POPULATION MONITORING & REPORTING															
	1	100%	Consult. botanist,	a	6	6	6	6	6	4	4	4	4	4	50
			CALM (W, S&I)	b	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	15
TOTAL				**a**	**72**	**16.6**	**29.2**	**28.2**	**27.9**	**10**	**8**	**15.5**	**16**	**11**	**234.4**
				b	**45.2**	**12.2**	**14.9**	**9.7**	**10.2**	**6**	**5.7**	**6**	**6**	**6.5**	**122.4**
															356.8

a - ESP Funds Required

b - CALM Contributions (W) = Wildlife Branch (S&I) = Science & Information Division (D) = District (L) = Land Administration Branch (S) Silviculture Branch

APB = Agriculture Protection Board

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APPENDIX 1

The following species have been recorded at the main site or in nearby habitat to stands 4 and 5. They would be suitable for introduction to existing sites to promote pollinator activity. McNee (1986) found that *B. prionotes, D. ashbyi* and the *Calothamnus* spp. were most preferred by the pollinator species.

Anigozanthus humilis

Banksia prionotes

Calothamnus quadrifidus

Calothamnus sanguineus

Dryandra ashbyi

Eucalyptus todtiana

Grevillea eriostachya

Grevillea integrifolia

Hakea obliqua

Hakea scoparia

Hakea sulcata

Hakea trifurcata