Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Interim Recovery Plan No. **387**

Mallee Box (*Eucalyptus cuprea*)

Interim Recovery Plan

Department of Biodiversity, Conservation and Attractions, Western Australia

December 2018

List of Acronyms

The following acronyms are used in this plan:

BGPA	Botanic Gardens and Parks Authority
CALM	Department of Conservation and Land Management
CITES	Convention on International Trade in Endangered Species
CPC	Conservation and Parks Commission
CR	Critically Endangered
DEC	Department of Environment and Conservation
DPLH	Department of Planning, Lands and Heritage
DBCA	Department of Biodiversity, Conservation and Attractions
DPaW	Department of Parks and Wildlife
DRF	Declared Rare Flora
EN	Endangered
EPBC	Environment Protection and Biodiversity Conservation
GDTFCRT	Geraldton District Threatened Flora and Communities Recovery Team
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
IRP	Interim Recovery Plan
IUCN	International Union for Conservation of Nature
LGA	Local Government Authority
MRWA	Main Roads Western Australia
NACC	Northern Agricultural Catchment Council
NRM	Natural Resource Management
PEC	Priority Ecological Community
PICA	Public Information and Corporate Affairs
SCP	Species and Communities Program
TFSC	Threatened Flora Seed Centre
TPFL	Threatened and Priority Flora database
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
VU	Vulnerable
WA	Western Australia

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Biodiversity, Conservation and Attractions (DBCA) Corporate Policy Statement No. 35 (DPaW 2015*a*) and DBCA Corporate Guideline No. 35 (DPaW 2015*b*). Plans 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.

DBCA are committed to ensuring that Threatened Flora (also known as Declared Rare Flora (DRF)) are conserved through the preparation and implementation of Recovery Plans (RPs) or Interim Recovery Plans (IRPs), and by ensuring that conservation actions commence as soon as possible.

This plan, which results from a review of IRP No. 43 *Eucalyptus cuprea* (Evans, Brown and English 1999), will operate from December 2018 to December 2023 but will remain in force until withdrawn or replaced. It is intended that, if *Eucalyptus cuprea* is still listed as Threatened Flora in Western Australia following five years of implementation, this plan will be reviewed and the need for further recovery actions assessed.

This plan was given regional approval on 12 December 2018 and was approved by the Executive Director of Biodiversity and Conservation Science on 14 December 2018. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting DBCA, as well as the need to address other priorities.

Information in this plan was accurate at November 2018.

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Summary

Scientific name:	*Eucalyptus cuprea*	**IBRA region:**	Geraldton Sandplains
Common name:	Mallee Box	**IBRA subregion:**	Geraldton Hills GES01
Family:	Myrtaceae	**NRM region:**	Northern Agricultural
Flowering period:	August–November	**Recovery team:**	Geraldton District Threatened Flora and Communities Recovery Team (GDTFCRT)
DBCA region:	Midwest		
DBCA district:	Geraldton		
Shires:	Shark Bay, Northampton		

Distribution and habitat: *Eucalyptus cuprea* is found from north of Ajana to east of Howatharra, growing in brown sandy-loam with sandstone or with granite, and more rarely in red-brown clayey-loam with laterite (Brown *et al*. 1998).

Habitat important for the survival of the species, and important subpopulations: *Eucalyptus cuprea* is listed as Threatened Flora (Critically Endangered) in Western Australia and it is considered that all known habitat for wild subpopulations is important for the survival of the species, and that all wild subpopulations are important subpopulations. Habitat important for the survival of *E. cuprea* includes the area of occupancy of subpopulations, areas of similar habitat surrounding and linking subpopulations (these providing potential habitat for subpopulation expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered subpopulations of the species or be suitable for future translocations, and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Conservation status: *Eucalyptus cuprea* was listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 17 May 1991. It is ranked as Endangered (EN) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii)+B2ab(iii) due to the extent of occurrence being less than 5,000 km^2; severely fragmented subpopulations; continuing decline in area, extent and/or quality of habitat; and area of occupancy less than 500 km^2. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Threats: The main threats to the species are habitat loss, clearing, farming activities, fire, insect infestation, poor recruitment, grazing, lack of genetic diversity, road, track and firebreak maintenance, weeds, feral pigs and competition.

Existing recovery actions: The following recovery actions have been or are currently being implemented and have been considered in the preparation of this plan:

1. All relevant landholders have been notified of the location and Threatened status of the species.
2. Threatened Flora markers have been installed at Subpopulations 1a, 11a, 12c, 12d and 13a.
3. Fencing has been installed at Subpopulations 2a, 2b, 2c (funded by Northern Agricultural Catchment Council (NACC)), 5, 7c, 10, and 12b.
4. Genetic analysis of *Eucalyptus cuprea* was undertaken by Sampson and Byrne (2016). Other research includes an ongoing study and revision of the genus *Eucalyptus* by D. Nicolle of Adelaide.
5. *Eucalyptus cuprea* has been extensively and opportunistically surveyed for in areas of suitable habitat near Galena, on private properties and in nature reserves.
6. Monitoring has been carried out opportunistically with plant numbers and current threats recorded.
7. Approximately 23,160 *Eucalyptus cuprea* seeds have been collected from seven subpopulations and is currently being stored at –20°C at the Threatened Flora Seed Centre (TFSC).
8. The Botanic Gardens and Parks Authority (BGPA) has six collections of seed from *Eucalyptus cuprea*.
9. A translocation introduction was undertaken for *Eucalyptus cuprea* in 2015 and 2017.

10. Rehabilitation of approximately 40 hectares of surrounding habitat was undertaken at the translocated subpopulation.
11. An information sheet on *Eucalyptus cuprea* has been jointly produced by the Natural Heritage Trust and DBCA.
12. Dashboard stickers and posters describing the significance of Threatened Flora markers have been produced and distributed to relevant Shires and other organisations.

Plan objective: The objective of this plan is to abate identified threats and maintain or enhance extant subpopulations to ensure the long-term conservation of the species in the wild.

Recovery criteria

Criteria for recovery success: The plan will be deemed a success if one or more of the following take place over the term of the plan.

- There is no reduction in the extent of occurrence, and the number of mature plants within the known subpopulations has remained within a 5% range or has increased by >5%; or
- New subpopulations have been found, increasing the number of extant subpopulations from 12 to 13 or more with no net loss of mature plants; or
- The area of occupancy has increased by >10%.

Criteria for recovery failure: The plan will be deemed a failure if one or more of the following take place over the term of the plan.

- Subpopulations have been lost which result in a reduction in the extent of occurrence; or
- The number of mature plants has decreased by >5%; or
- The area of occupancy has decreased by >10%.

Recovery actions

1. Coordinate recovery actions
2. Monitor subpopulations
3. Implement translocations
4. Rehabilitate habitat
5. Undertake weed control
6. Control insect infestation
7. Obtain additional biological and ecological information
8. Undertake surveys
9. Collect and store seed
10. Liaise with land managers and Aboriginal communities
11. Develop and implement a fire management strategy
12. Control pigs and rabbits
13. Fence subpopulations, where required
14. Map habitat important for the survival of *Eucalyptus cuprea*
15. Promote awareness
16. Ensure long-term protection of habitat
17. Review this plan and assess the need for further recovery actions

1. Background

Review of Mallee Box (*Eucalyptus cuprea*) Interim Recovery Plan 1999–2000 (Evans, Brown and English 1999)

A review of outputs and effectiveness of IRP 43 (1999–2002) by R. Evans, A. Brown and V. English follows. This plan replaces IRP No. 43.

The criterion for success in the previous plan (the number of individuals within subpopulations and/or the number of subpopulations have increased) was met with an additional eight subpopulations located since the commencement of the previous plan. The total number of known mature individuals rose from approximately 70 in 1998 to approximately 394. This increase in numbers and hence the success of the plan is solely the result of the location of new subpopulations from survey. A translocation has also established a new subpopulation. The main recovery actions from the previous plan and their outcomes, taken from a review of the IRP undertaken by Fairs (2008) and more recent actions, are listed in Table 1.

Table 1: Status of the implementation of recovery actions from the previous Interim Recovery Plan

Recovery action	Status	Result
Coordinate recovery actions	Started and ongoing	Recovery actions conducted by the Geraldton District Flora Conservation Officer are coordinated through DBCA's Geraldton District with assistance from the Geraldton District Threatened Flora and Communities Recovery Team.
Conduct further surveys	Ongoing	The species has been extensively and opportunistically surveyed for in areas of suitable habitat near Galena, on private properties and in Nature Reserves. Eight new subpopulations have been discovered since 1998.
Collect seed and cutting material	Started and ongoing	DBCA's TFSC has seed collections from seven subpopulations and BGPA has six seed collections in storage.
Install fencing	Mostly complete	Subpopulation 5 was fenced in 2000. Subpopulation 3 was destroyed and fencing is no longer required. Fencing materials were provided to property owners of Subpopulation 2 in the 1990's, however the landowner did not carry out the required fencing. The property has since changed hands and the pursuit of fencing discontinued. DBCA's Geraldton District applied for Northern Agricultural Catchment Council (NACC) project funding to fence Subpopulation 11b. The landholder withdrew consent after the funds had been granted. The funds were then used to fence Subpopulations 2a, 2b and 2c in 2017. Subpopulation 11b is not being impacted by grazing and pressure to fence may cause relations to deteriorate with this landholder.
Notify and liaise with relevant land managers	100% complete and ongoing	All managers of land where new occurrences were discovered during the term of the plan have been sent official notification letters.
Undertake weed control	Started and ongoing	Weed control was undertaken in 2000 at Subpopulations 1, 2, 4 and 5; and at the translocated subpopulation in 2016 and 2017.
Develop and implement a fire management strategy	Started and ongoing	Locations of subpopulations and descriptions were added to DBCA's Fire Incident Controllers Grab Kit in 2000. No Fire Response Strategies have been prepared for the species.
Control insect infestation	Started and ongoing	Insect activity has been monitored at Subpopulations 1, 2, 7 (processional caterpillar nests) and 8 (caterpillars and termites). Samples of insect nests have been collected for identification. Nests have partially been removed from Subpopulation 2.
Obtain biological and ecological information	Started and ongoing	Genetic analysis of *Eucalyptus cuprea* was undertaken by Sampson and Byrne (2016). Other research includes an ongoing study and revision of the

		genus *Eucalyptus* by D. Nicolle of Adelaide. This work includes germination, seedling and cultivation trials to determine the genetic relationships between species.
Monitor subpopulations	Started and ongoing	DBCA's Geraldton District Flora Conservation Officer regularly monitors subpopulations. Extant plants have not been seen at Subpopulation 3 since 1989. All information collected during monitoring is stored at DBCA Geraldton District and Species and Communities Program (SCP).
Negotiate to acquire land at Subpopulation 4 (Howatharra)	0% complete	No attempt was made to acquire land at Subpopulation 4 as it is currently being managed for conservation by private landowners and has been fenced, including good supporting habitat.
Promote awareness	Started and ongoing	Several presentations have been conducted in schools and the species has been displayed at regional agricultural and wildflower shows. Information on the species has been included in the book 'Threatened Wildflowers of the Midwest' (Chant 2002) and the Western Australian Newspaper. A colour information flyer was produced and distributed to local landowners.
Write full Recovery Plan	No longer relevant	DBCA no longer produces full recovery plans for flora. The previous IRP has been reviewed as part of the preparation of this replacement IRP.

The majority of the recovery actions included in the previous plan have been fully or partially implemented. *Action 13* Write a full Recovery Plan is redundant as DBCA does not generally produce full recovery plans for flora and current interim recovery plans have been extended to five-year terms. *Action 11* Negotiate to acquire land at Subpopulation 4 is no longer deemed practical due to the small area of habitat. Ongoing recovery actions included in the previous plan are included in this revised plan. New recovery actions included in this plan are to implement translocations, rehabilitate habitat, control feral pigs and rabbits, map habitat important for the survival of *Eucalyptus cuprea* and review this plan and assess the need for further recovery actions.

History

The first collection of *Eucalyptus cuprea* was made between Northampton and Lynton by G.E. Brockway in 1952. The second collection was made near Hutt River by C.A. Gardner in 1959. Neither of these subpopulations has since been relocated. The type specimen was collected alongside the North Western Coastal Highway by I. Brooker in 1984. For some years the species was known as *E*. sp. Northampton until S. Hopper and I. Brooker named it *E. cuprea* in 1993.

Eucalyptus cuprea is found from north of Ajana, south to east of Howatharra. Most vegetation within the species' range was removed during the 20th Century and replaced with crops and pasture, resulting in a highly fragmented distribution. When the previous recovery plan was written, five subpopulations over a range of approximately 80 km were known. Only three of these still contain extant plants. Subpopulation 3 was destroyed in 1990 or 1991 and a plant was removed from Subpopulation 1a in the early 1990s. Since then, although a further nine subpopulations have been found, many subpopulations growing either on road reserves or in otherwise cleared paddocks have been impacted by clearing. Several 'paddock' trees at Subpopulation 6 have been deliberately cleared, including subsequent reshoots, and this population may now be extinct. Road widening has also removed associated vegetation. No recruitment has been observed from seed. A feature of the species is its similarity to York gum (*E. loxophleba*) and difficulties associated with identification may be the reason that it has not been located elsewhere.

Eucalyptus cuprea is currently known from 13 natural subpopulations (12 extant), comprising around 394 clumps.

Description

Eucalyptus cuprea is an erect mallee, rarely a tree, 4 to 6 m tall with a stocking of thin, flaky and fibrous grey bark. Above this stocking, the bark is smooth and grey or coppery. The juvenile leaves are light green and oval-shaped. The adult leaves are narrow, 11 cm long and approximately 2 cm wide, and a glossy dark green. The juvenile buds are club-shaped, with a distinct scar from the early loss of the outer operculum. The inflorescence is terminal and has small white flowers, 6 mm long and 4 mm wide, with inner stamens that are inflected, and with outer stamens that lack anthers. This lack of anthers distinguishes the species from other similar eucalypts. The valves of the stalked cup-shaped fruits, up to 5 mm long and 4 mm wide, are positioned below the rim, and hold greyish-brown seeds (Brown *et al*. 1998). The Latin name *cupreus* means coppery and refers to the seasonal colour of the smooth bark (Brooker and Hopper 1993).

The species can be confused with York Gum, which has heart-shaped, smoky-grey juvenile leaves, as distinct from the light green oval- or egg-shaped leaves of *Eucalyptus cuprea*. The venation of *E. loxophleba* is sparse compared to the dense venation of *E. cuprea*. York Gum also has an outer ring of stamens with anthers. The seed of *E. loxophleba* is paler in colour than *E. cuprea,* which is described as greyish-brown.

Eucalyptus cuprea is distinguished from Badgingarra Box (*E. absita*) in having light green, oval-shaped juvenile leaves and a less prominent disc. Granite Rock Box (*E. petraea*) is also distinguished from *E. cuprea* by having larger buds and fruits (Brown *et al*. 1998).

Illustrations and/or further information

Brooker, M.I.H. and Hopper, S.D. (1993) New series, subseries and subspecies of *Eucalyptus* (Myrtaceae) from Western Australia and from South Australia. *Nuytsia* 9(1): 1–68.

Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) Western Australia's Threatened Flora. Department of Conservation and Land Management, Western Australia.

Chant, A. (2002) Threatened flowers of the mid-west. Bush Books, Department of Conservation and Land Management, Kensington, WA.

Western Australian Herbarium (1998–) FloraBase- the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/.

Distribution and habitat

Eucalyptus cuprea is endemic to Western Australia where it is confined to three main areas some 80 km apart from north of Ajana, south to east of Howatharra. It grows on rises in brown sandy loam with sandstone or granite, and more rarely in red-brown clayey loam with laterite. It has also been recorded on a clay flat. *Eucalyptus cuprea* grows in low heath with other emergent trees such as *Nuytsia floribunda*, or in tall shrubland with *E. loxophleba*, *Acacia acuminata*, *Dodonaea inaequifolia* and *Allocasuarina* spp. (Brown *et al*. 1998). The extent of occurrence is 1,149 km^2 and the area of occupancy is estimated to be 40 km^2 using the IUCN 2 km x 2 km grid method.

Table 2. Summary of subpopulation land vesting, purpose and manager

TPFL subpopulation number & location	DBCA District	Shire	Vesting	Purpose	Manager
1a. N of Galena Bridge	Geraldton	Northampton	Main Roads Western Australia (MRWA)	Road reserve	MRWA
1b. N of Galena Bridge	Geraldton	Northampton	Private property		Landowners
1c. N of Galena Bridge	Geraldton	Northampton	Private property		Landowners
2a. W of Ogilvie	Geraldton	Northampton	Private property		Landowners
2b. W of Ogilvie	Geraldton	Northampton	Private property		Landowners
2c. NW of Ogilvie	Geraldton	Northampton	Private property		Landowners
4. E of Howatharra	Geraldton	Chapman Valley	Private property		Landowners
5. W of Ogilvie	Geraldton	Northampton	Private property		Landowners
6. W of Ogilvie	Geraldton	Northampton	Private property		Landowners
7a. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7b. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7c. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7d. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7e. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7f. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7g. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7h. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
7i. SW of Ogilvie	Geraldton	Northampton	Private property		Landowners
8. NW of Ogilvie	Geraldton	Northampton	Conservation and Parks Commission (CPC)	Nature reserve	DBCA
9. E of Howatharra	Geraldton	Chapman Valley	CPC	Nature reserve	DBCA
10. NW of Northampton	Geraldton	Northampton	Private property		Landowners
11a. E of Ogilvie	Geraldton	Northampton	LGA	Road reserve	Shire of Northampton
11b. E of Ogilvie	Geraldton	Northampton	Private property		Landowners
12a. E of Ogilvie	Geraldton	Northampton	Private property		Landowners
12b. E of Ogilvie	Geraldton	Northampton	Private property		Landowners
12c. E of Ogilvie	Geraldton	Northampton	LGA	Road reserve	Shire of Northampton
12d. E of Ogilvie	Geraldton	Northampton	LGA	Road reserve	Shire of Northampton
13a. E of Ogilvie	Geraldton	Northampton	LGA	Road reserve	Shire of Northampton
13b. E of Ogilvie	Geraldton	Northampton	Private property		Landowners

Biology and ecology

In many *Eucalyptus* species including *E. cuprea*, the development of a persistent lignotuber is an adaptation to fire and other disturbance that allows the regeneration of vegetative growth after the above-ground parts of the plant have been destroyed. *Eucalyptus cuprea* plants that have been burnt in stubble fires have been observed to reshoot from the base and remain healthy for years. Field and anecdotal evidence also suggest that *E. cuprea* plants are not easily killed during clearing due to the presence of their lignotuber. Subpopulations 2, 4 and 5 have survived repeated 'stumping' and have subsequently regenerated, resulting in several subpopulations that exist as single stands in the middle of paddocks. As these stands continued to regenerate, property owners left them as shade for

stock. Several subpopulations are or were isolated stands within paddocks that are otherwise cropped.

Eucalyptus cuprea appears to display a near obligate sprouter strategy, with long-lived individuals and low rates of sexual recruitment. Multi-stemmed eucalypt mallees may eventually lose the physical connection between stems and become separate clumps of ramets (individuals) that are genetically identical and may live for thousands of years (Nicolle 2006). The longevity of *E. cuprea* individuals is unknown, but is expected to be great in the absence of other pressures; some clones extend up to 35 m in diameter (Sampson and Byrne 2016). Genetic analysis has confirmed that many *E. cuprea* plants are clonal, although the degree of clonality varies among subpopulations (Sampson and Byrne 2016). The number of genetically different individuals within remnants is less than the number of stems, and only one genotype is represented in each of the two small remnants in nature reserves, indicating that only two genotypes are within secure tenure. Some single genotypes are represented by quite large multi-stemmed individuals that may or may not be distinguishable as such. As it is often not possible to identify genetically distinct individuals in the field, this may result in inconsistent subpopulation size estimates (Sampson and Byrne 2016) and complicate conservation management of the species.

Although clonal reproduction allows long-term population persistence, it is likely that *E. cuprea* relies on occasional sexual reproduction to maintain adaptive potential (Sampson and Byrne 2016). Outcrossing is a part of the species' genetic system, and only one of three subpopulations tested showed past inbreeding to have significantly contributed to the genetic composition of adult plants (Sampson and Byrne 2016). *Eucalyptus cuprea* appears to have a mixed but flexible breeding system (Sampson and Byrne 2009). However, population fragmentation and related disturbance may prevent or severely limit outbreeding and recruitment of sexually-generated individuals in *E. cuprea* subpopulations. Despite abundant flower production, field evidence shows very low fruit production by *E. cuprea* plants and an apparent lack of regeneration through seedling generation.

Opportunities for outcrossing and seed set are likely to be limited by the low numbers of genetically distinct individuals within subpopulations, scattered distribution of subpopulations, and the absence of one band of anthers in the flowers. In many cases, lack of supporting habitat may contribute to low fecundity, as there is less opportunity to support the pollinators of *E. cuprea*. Like the related *E. absita* (Department of Conservation and Land Management 2006), pollinators of *E. cuprea* are likely to include native beetles, bees and possibly small birds such as honeyeaters, as all have been observed at the flowers. Many seeds produced by *E. cuprea* plants are unviable, and viable seeds were collected from only 13% of genets sampled by Sampson and Byrne (2016). Among the viable seeds produced, outcrossing rates vary between plants and populations and is not directly related to subpopulation size; plants in larger subpopulations may produce significant proportions of inbred seed (Sampson and Byrne 2009). Correlated paternity, a form of inbreeding where seeds have few male parents, was found to be prevalent and needs to be considered in any seed collection (Sampson and Byrne 2009). Increased rates of inbreeding are likely to lead to reduced genetic diversity among viable seeds; in turn, reduced genetic variation among future recruits may compromise the long-term survival of the species through a lack of evolutionary potential.

The absence of sexual recruitment and lack of regenerative material is increasingly becoming a threat as individuals within these subpopulations age or succumb to land use pressures. The lack of appropriate disturbance or grazing of seedlings by vertebrates (rabbits, kangaroos) had been thought to influence the species' recruitment (Llorens *et al*. 2015). However, landowners routinely burn paddock stubble and at times also burn *E. cuprea* plants. Although plants reshoot from a lignotuber

following fire, no seedlings have been observed (pers. comm. A. Chant). In a study of the effect of regeneration of *Eucalyptus salmonophloia*, Yates *et al.* (1995) found that both predation of seeds by ants and the short-term viability of seeds in the soil (unlikely to persist longer than 12 months) contribute to the inability of *E. salmonophloia* to form a persistent soil seed reserve. Although these factors are also likely to affect *E. cuprea*, seed availability in this species appears to be mainly limited by very low seed set.

Remnant subpopulations of *E. cuprea* can be grouped into four geographic clusters: (1) Subpopulation 1; (2) Subpopulations 2, 7, 8 and 9; (3) Subpopulations 2a, 2b and c and (4) Subpopulations 4, 5 and 6. Genetic analysis revealed only moderate differentiation among subpopulations (F_{ST} = 0.100), and the most northern and geographically isolated occurrence (Subpopulation 1) was the only subpopulation to be genetically distinct (Sampson and Byrne 2016). Southern and central populations did not show any significant genetic structure, with most diversity occurring within populations (Sampson and Byrne 2016). This was supported by evidence for contemporary pollen transfer among the central, less isolated subpopulations (Sampson and Byrne 2009). Genetic diversity for adult plants was low to moderate, and was generally lower in populations with smaller effective population sizes (Sampson and Byrne 2016); this further illustrates that declining population sizes may have implications for both demographic and evolutionary viability.

Conservation status

Eucalyptus cuprea was listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 17 May 1991. It was ranked as Endangered (EN) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii)+B2ab(iii) due to the extent of occurrence being less than 5,000 km^2; severely fragmented subpopulations; continuing decline in area, extent and/or quality of habitat; and area of occupancy less than 500 km^2. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Government of Australia 1999).

Threats

- **Habitat loss**. Some subpopulations of *Eucalyptus cuprea* contain no or very little natural vegetation to provide a buffer for the species from the impacts of farming or other activities.
- **Clearing** is a threat to the majority of subpopulations, particularly those on private property and road reserves. Most subpopulations on private property are solitary stands surrounded by cleared paddocks.
- **Road, track and firebreak maintenance**. Threats include grading, chemical spraying, construction of drainage channels and the slashing of roadside vegetation. Several of these actions also encourage weed invasion.
- **Farming activities**. Threats include the deliberate removal of paddock trees, fertiliser and chemical drift, damage to roots during cropping, weed encroachment and lack of protection.
- **Altered fire regimes.** Mature plants of *Eucalyptus cuprea* appear to resprout from lignotubers following fire. Frequent burning of crops and/or weeds on a short rotation would deplete the soil seed store and may deplete lignotuber reserves. Most subpopulations on private property have been burnt in "stubble fires" in the past. Fire appears to also facilitate weed invasion and when it occurs should be followed up with appropriate weed control.
- **Insect infestation** has affected the majority of subpopulations and is thought to be due to the plants being weakened by farming activities. An unidentified leaf mite has been present in high

numbers at Subpopulations 1a and 1b, covering up to 70% of the leaf surface on up to 80% of mature trees. In 2007 extensive processionary caterpillar damage occurred with a loss of foliage on plants in Subpopulation 1 and 2, and lesser damage at Subpopulation 8. The caterpillar has also been observed at many other subpopulations. Galls were noted at Subpopulation 1b in 1998. One clump at Subpopulation 8 was also affected by termites.

- **Poor recruitment** is a threat to the species. Despite many disturbance events having occurred, such as plants being ploughed, dug up and burnt, no recruitment after a disturbance event has been observed, other than reshooting from lignotubers.
- **Grazing**. In the past, stands of *Eucalyptus cuprea* have acted as shelters for sheep where there is often no other vegetation. This has resulted in increased soil nutrient content from droppings, continued root and branch pruning and soil compaction.
- **Lack of genetic diversity.** Genetic analysis has revealed that the species is clonal and has low genetic diversity, which can restrict a species' ability to adapt to environmental change. Genetic diversity will probably continue to decline due to severe fragmentation and small population sizes that limit mate availability and promote inbreeding.
- Habitat degradation by **weed invasion** is a threat to most subpopulations of *Eucalyptus cuprea*. Weeds suppress early plant growth by competing for soil moisture, nutrients and light. They also increase the fire hazard due to the easy ignition of high fuel loads, which are produced annually by many grass weed species.
- **Feral animals**. Pigs and rabbits can damage the trees and their habitat by digging through areas of soil in search of food, thereby damaging the understorey vegetation. They also have the potential to introduce weed seeds and nutrients, and the soil disturbance they create encourages establishment of weeds. Although grazing does not kill the plants, it reduces their reproductive output.
- **Competition** from a native vine (*Marianthus bicolor*) is a minor threat to plants at Subpopulation 9 where it has been found growing on two trees.
- **Infrastructure maintenance**, including maintenance to powerlines at Subpopulation 9, is a potential threat to *Eucalyptus cuprea*. Disturbance during maintenance may encourage weed invasion and also directly damage plants. The relevant authorities will be notified of the subpopulations that are potentially threatened by infrastructure maintenance activity.

The intent of this plan is to identify actions that will mitigate immediate threats to *Eucalyptus cuprea*. Although climate change and drought may have a long-term effect on the species, actions taken directly to prevent their impact are beyond the scope of this plan.

Table 3. Summary of subpopulation information and threats

TPFL subpopulation number & location	Land status	Year/no. mature plants		Condition		Threats
				Plants	Habitat	
1a. N of Galena Bridge	MRWA road reserve	1989 2011 2018	6 8 11	Moderate	Degraded	Weeds, road and firebreak maintenance, gravel pit access, insects (leaf mite, caterpillars), fire, habitat loss, poor recruitment
1b. N of Galena Bridge	Private property	1991 2011 2018	39 34 34	Healthy	Very good	Weeds, firebreak maintenance, insects (galls, caterpillars), fire, habitat loss, gravel pit access, poor recruitment
1c. N of Galena Bridge	Private property	2008 2011 2018	14 14 13	Healthy	Degraded	Insects (caterpillars), grazing (kangaroos), weeds, fire, habitat loss, poor recruitment

2a. W of Ogilvie	Private property	1994 2011 2013 2014 2018	3 15 15 15 15	Healthy	Completely degraded	Insects (caterpillars), fire, habitat loss, poor recruitment
2b. W of Ogilvie	Private property	2007 2011 2013 2014 2018	8 9 9 9 9	Healthy	Good/ degraded	Insects (caterpillars), weeds, habitat loss, poor recruitment
2c. NW of Ogilvie	Private property	2000 2011 2013 2014 2018	1 1 1 1 1	Healthy	Completely degraded	Habitat loss, fire, grazing (sheep), weeds, firebreak maintenance, poor recruitment
4. E of Howatharra	Private property	1989 2011 2013 2018	3 3 3 3	Healthy	Excellent	Insects (caterpillars), weeds, poor recruitment, rabbits (digging)
5. W of Ogilvie	Private property	2000 2011 2014 2018	9 9 9 9	Moderate	Completely degraded	Weeds, firebreak maintenance, fire, habitat loss, poor recruitment
6. W of Ogilvie	Private property	2000 2011 2014 2018	20+*s* 2 1 [1] 0		Completely degraded	Likely exinct
7a. SW of Ogilvie	Private property	2006 2011 2014 2018	80*s* 30 [54] 37 30	Poor (partly cleared)	Completely degraded	Grazing (sheep), fire, habitat loss, poor recruitment
7b. SW of Ogilvie	Private property	2004 2011 2018	6 5 5	Moderate	Completely degraded	Grazing (sheep), habitat loss, insects (caterpillars), fire
7c. SW of Ogilvie	Private property	2004 2011 2018	8 5 5	Healthy	Very good	Insects (caterpillars), fire, poor recruitment
7d. SW of Ogilvie	Private property	2004 2011 2018	20+*s* 16 16	Moderate	Good	Grazing (sheep), habitat loss, insects (caterpillars), fire, weeds, poor recruitment
7e. SW of Ogilvie	Private property	2008 2011 2018	4 9 9	Healthy	Very good	Grazing (sheep), habitat loss, insects (caterpillars), fire, poor recruitment
7f. SW of Ogilvie	Private property	2008 2011	7 6	Moderate	Good	Grazing (sheep), habitat loss, insects (caterpillars), fire, poor recruitment
7g. SW of Ogilvie	Private property	2008 2011	10 10	Healthy	Degraded	Insects (caterpillars), fire, poor recruitment
7h. SW of Ogilvie	Private property	2008 2011 2018	1 1 1	Healthy	Degraded	Grazing (sheep), habitat loss, fire, poor recruitment
7i. SW of Ogilvie	Private property	2008 2011 2018	1 1 2	Healthy	Degraded	Grazing (sheep), habitat loss, fire, poor recruitment
8. NW of Ogilvie	Nature reserve	2002 2011 2018	9 9 9	Healthy	Very good	Weeds, poor recruitment, insects (termites, caterpillars), fire
9. E of Howatharra	Nature reserve	2008 2011 2013	3 3 6?	Healthy		Pigs, insects (caterpillars), poor recruitment, competition, utilities maintenance

		2018	6			
10. NW of Northampton	Private property	2008 2011	17 17	Healthy	Excellent	Insects (caterpillars), fire, poor recruitment
11a. E of Ogilvie	Shire road reserve	2008 2011 2015	*28+ 2 2	Healthy	Completely degraded	Road maintenance
11b. E of Ogilvie	Private property	2008 2011 2015	*28+ 100+ 115	Healthy	Very good/good	Habitat loss, fire, farming activities
12a. E of Ogilvie	Private property	2008 2011	*65+ 35+	Healthy	Good	Habitat loss, fire
12b. E of Ogilvie	Private property	2008 2011 2015	*65+ 6+ 22	Healthy	Excellent/ very good	Poor recruitment, fire
12c. E of Ogilvie	Shire road reserve	2008	2			Road maintenance, weeds
12d. E of Ogilvie	Shire road reserve	2008	2			Road maintenance, weeds
13a. E of Ogilvie	Shire road reserve	2008 2015	2 2	Healthy	Good	Road maintenance, weeds
13b. E of Ogilvie	Private property	2008 2015	3 3	Healthy		Weeds

Note: Plants have been counted in either clumps or stems; *s* = number of stems; * = total for subpopulations combined; []= number of dead; Subpopulation 3 has been destroyed.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions that result in any of the following may potentially have a significant impact on the species:

- damage or destruction of occupied or potential habitat
- alteration of the local surface hydrology or drainage
- reduction in subpopulation size
- a major increase in disturbance in the vicinity of a subpopulation.

Habitat important for the survival of the species, and important subpopulations

Eucalyptus cuprea is listed as Threatened Flora (Critically Endangered) in Western Australia and it is considered that all known habitat for wild subpopulations is important for the survival of the species, and that all wild subpopulations are important subpopulations. Habitat important for the survival of *E. cuprea* includes the area of occupancy of subpopulations, areas of similar habitat surrounding and linking subpopulations (these providing potential habitat for subpopulation expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered subpopulations of the species or be suitable for future translocations, and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Benefits to other species or ecological communities

Recovery actions implemented to improve the quality or security of the habitat of *Eucalyptus cuprea* will also improve the status of associated native vegetation. Two Threatened Flora species and 12 Priority Flora taxa also occur within 500 m of *E. cuprea* populations (see Table 4).

Table 4. Conservation-listed flora species occurring within 500 m of *Eucalyptus cuprea*

Species name	Conservation status (WA)	Conservation status (EPBC Act 1999)
Grevillea bracteosa subsp. *howatharra*	Threatened (CR)	CR
Grevillea christineae	Threatened (EN)	EN
Baeckea sp. Nolba (M.E. Trudgen MET21632)	Priority 1	-
Grevillea pinifolia	Priority 1	-
Xanthoparmelia sargentii	Priority 1	-
Homalocalyx chapmanii	Priority 2	-
Leucopogon borealis	Priority 2	-
Xanthoparmelia kondininensis	Priority 2	-
Blackallia nudiflora	Priority 3	-
Cryptandra nola	Priority 3	-
Thryptomene stapfii	Priority 3	-
Eucalyptus blaxellii	Priority 4	-
Stachystemon nematophorus	Priority 4	VU
Verticordia penicillaris	Priority 4	-

For a description of conservation codes for Western Australian flora see: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf.

Eucalyptus cuprea occurs within 1 km of a Priority Ecological Community (PEC) "Plant assemblages of the Moresby Range system" which is currently listed as Priority 1[3].

International obligations

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

Aboriginal consultation

A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Sites Register revealed no sites of Aboriginal significance adjacent to subpopulations of *Eucalyptus cuprea*. Input and involvement has been sought through the DPLH to determine if there are any issues or interests with respect to management for this species in the vicinity of these sites. Indigenous opportunity for future involvement in the implementation of the plan is included as an action in the plan. Aboriginal involvement in management of land covered by an agreement under the *Conservation and Land*

[3] For a description of TEC and PEC categories see https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf.

Management Act 1984 is also provided for under the joint management arrangements in that Act, and will apply if an agreement is established over any reserved lands on which this species occurs.

Social and economic impacts

Implementation of this plan is likely to have some societal and/or economic implications. Management practices on private land containing subpopulations of *Eucalyptus cuprea* may need to be modified, and it may be necessary to maintain fences and other infrastructure, and control weeds. It may also impact on road maintenance and other activities in the vicinity of subpopulations situated on Shire and MRWA managed road reserves. Recovery actions refer to continued negotiations between stakeholders with regard to these areas.

Affected interests

Affected interests include private landholders, the Shire of Northampton and MRWA, particularly where subpopulations occur on lands not specifically managed for conservation.

Evaluation of the plan's performance

DBCA, with assistance from the Geraldton District Threatened Flora and Communities Recovery Team (GDTFCRT), will evaluate the performance of this plan. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan will be reviewed following five years of implementation.

2. Recovery objective and criteria

Plan objective

The objective of this plan is to abate identified threats and maintain or enhance extant subpopulations to ensure the long-term conservation of the species in the wild.

Recovery criteria

Criteria for recovery success: The plan will be deemed a success if one or more of the following take place over the term of the plan.

- There is no reduction in the extent of occurrence, and the number of mature plants within the known subpopulations has remained within a 5% range or has increased by >5%; or
- New subpopulations have been found, increasing the number of extant subpopulations from 12 to 13 or more with no net loss of mature plants; or
- The area of occupancy has increased by >10%.

Criteria for recovery failure: The plan will be deemed a failure if one or more of the following take place over the term of the plan.

- Subpopulations have been lost which result in a reduction in the extent of occurrence; or
- The number of mature plants has decreased by >5%; or
- The area of occupancy has decreased by >10%.

3. Recovery actions

Existing recovery actions

DBCA, with assistance from the MDTFRT and GDTFCRT, is overseeing the implementation of recovery actions for *Eucalyptus cuprea*. The following recovery actions have been or are being implemented.

All relevant landholders have been notified of the location and threatened status of the species. The notification contains details of the Declared Rare Flora (DRF) status of *E. cuprea* and the legal responsibility to protect it.

Threatened Flora markers have been installed at Subpopulations 1a, 11a, 12c, 12d and 13a to alert people working in the vicinity to the presence of DRF.

Fencing has been installed at Subpopulations 2a, 2b, 2c (a NACC funded project in 2017) 5 (fenced in 2000), 7c, 10, and 12b.

Genetic analysis of *E. cuprea* was undertaken by Sampson and Byrne (2016). Other research includes an ongoing study and revision of the genus *Eucalyptus* by D. Nicolle of Adelaide. This work includes germination, seedling and cultivation trials to determine the genetic relationships between species.

Eucalyptus cuprea has been extensively and opportunistically surveyed for in areas of suitable habitat near Galena, on private properties and in nature reserves. A number of new subpopulations have been located as a result.

Collections of *E. cuprea* seeds are stored at both the Threatened Flora Seed Centre (TFSC) and Botanic Gardens and Parks Authority (BGPA). Of the fruits that have been processed so far, approximately 23,160 *E. cuprea* seeds from seven subpopulations are stored at the TFSC at –20°C (see Table 5).

Table 5. TFSC seed collection details for *Eucalyptus cuprea*

Accession number	Date collected	TPFL subpopulation number	Plants in storage	Total seed	Estimated germinable seed
01241-1	6/08/2003	7a	I/2	523	455
01242-1	6/08/2003	5	I/1	293	268
01243-1	6/08/2003	1	I/2	750	750
02756-1	31/01/2008	2b	I/18	2,682	2,501
02763-1	31/01/2008	2a	I/2	203	203
02767-1	31/01/2008	5	I/1	216	205
02869-1	10/09/2008	12	I/1	57	47
04505-1	23/07/2008	12	I/1	not yet processed	
04506-1	23/07/2008	1	I/2	64	41
05749-1	13/10/2015	9	I/3	not yet processed	
05750-1	13/10/2015	11	I/19	18,372	

Note: 'I' = a collection of individuals and the number of plants collected; germination tests are still ongoing so the results may change.

BGPA has six collections totalling 3.77 g of seed from *E. cuprea*. These include 0.26 g of seed collected in January 1992, 0.44 g of seed collected in October 1997, 1.7 g of seed collected in August 1998 and 1.37 g of seed collected in June 1998.

Two translocations were undertaken for *E. cuprea* in 2015. The aim of the translocations was to assist the long-term persistence of the species by (1) establishing a new, viable subpopulation of *E. cuprea* secured on a conservation reserve, and (2) restocking Subpopulation 8, which consisted of only nine individuals, at least some of which are genetically identical (Llorens *et al*. 2015). Seedlings sourced from Subpopulations 2, 5, 7 and 12 were planted at the new site in 2015, and further seedlings sourced from Subpopulations 1 and 2 were planted in 2017 (Table 6).

Table 6. Translocation introduction results for *Eucalyptus cuprea*.

Year planted	Material used	Number planted	Treatments	Number alive (May 2017)
11/6/2015	Seedlings	197	Watering over summer	156 (137 juveniles, 19 mature)
30/5/2017	Seedlings	28	Watering over summer	28 seedlings
28/3/2018				152 (25 juveniles)

A Commonwealth funded 20 Million Trees project is in progress to rehabilitate habitat surrounding the translocated subpopulation. This project has included planting 80,000 seedlings of local native species across approximately 40 hectares.

An information sheet on *E. cuprea* has been jointly produced by the Natural Heritage Trust and DBCA. The sheet contains photographs, a description of the plant, its habitat type, threats and management actions and has been distributed to owners of land that contains this species, to landowners who live in close proximity to known subpopulations and to local Shires.

Monitoring has been carried out opportunistically with plant numbers and current threats recorded. Global Positioning System (GPS) locations of all subpopulations have been recorded in Geographic Information System databases at Geraldton District, and at Species and Communities Program (SCP).

Future recovery actions

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

1. Coordinate recovery actions

DBCA, with the assistance of the GDTFCRT, will coordinate recovery actions for *Eucalyptus cuprea* and will include information on progress in annual reports.

Action: Coordinate recovery actions
Responsibility: DBCA (Geraldton District), with assistance from the GDTFCRT
Cost: $8,000 per year

2. Monitor subpopulations

Monitoring of grazing, disease, weed invasion, habitat degradation, hydrology (including salinity), subpopulation stability (expansion or decline), pollinator activity, seed production, recruitment, and longevity will be undertaken. It is preferable that the subpopulations are at least inspected annually, and that areas where recruitment has been stimulated are inspected more frequently. For consistency it is desirable that both the number of clumps and the number of stems per clump are recorded.

Action: Monitor subpopulations
Responsibility: DBCA (Geraldton District), with assistance from the GDTFCRT
Cost: $8,000 per year

3. Implement translocations

Further translocations may be required for the long term conservation of *Eucalyptus cuprea*, if natural subpopulations continue to decline.

Information on the translocation of Threatened plants and animals in the wild is provided in DBCA Corporate Policy Statement No. 35 (DPaW 2015*a*), DBCA Corporate Guideline No. 36 (DPaW 2015*c*) and the Australian Network for Plant Conservation (ANPC) Translocation Guidelines (Commander *et al.* 2018). A translocation may decrease the risk of extinction when a species is represented by few

subpopulations and the creation of additional self-sustaining, secure subpopulations may decrease its susceptibility to catastrophic events and environmental stochasticity (Commander *et al*. 2018). For small subpopulations which may be declining in size or subject to high levels of inbreeding, successful subpopulation enhancement may increase subpopulation stability and hence long-term viability (Commander *et al*. 2018).

Depending on the characteristics of the species, a minimum viable subpopulation size of 200 to 250 mature individuals is a useful initial target (Commander *et al*. 2018), but 1,000 or more plants may be required to maintain evolutionary potential (Frankham *et al*. 2014). Suitable translocation sites may include where the taxon currently occurs, where it was known to have occurred historically, and other areas that contain similar habitat (soil, associated vegetation type and structure, aspect, mutualisms *etc*.), preferably within the known range of the taxon (Commander *et al*. 2018). Other factors that should be considered when selecting recipient sites include the security of land tenure for conservation, the ability to effectively mitigate threats to the taxon, and potential negative consequences to existing biodiversity and cultural values at the site (Commander *et al*. 2018).

All Translocation Proposals require endorsement by the department's Executive Director of Biodiversity and Conservation Science. Monitoring of translocations is essential and will be included in the timetable developed for the Translocation Proposal.

Action: Implement translocations
Responsibility: DBCA (Biodiversity and Conservation Science, Geraldton District)
Cost: $42,000 in years 1 and 2; and $26,500 in subsequent years as required

4. Rehabilitate habitat

Rehabilitation will continue at the translocated subpopulation, by further planting of local species.

Action: Rehabilitate habitat
Responsibility: DBCA (Geraldton District), land managers
Cost: $30,000 per year

5. Undertake weed control

Weeds are a threat to most subpopulations and control is required. The following actions will be implemented:

1. Determine which weeds are present, map them and determine priority for treatment.
2. Select appropriate control techniques: herbicide, mowing or hand weeding.
3. Control invasive weeds by hand removal and/or spot spraying around the *Eucalyptus cuprea* plants when weeds first emerge.
4. Monitor the success of the treatment for eradicating weeds, and the tolerance of *E. cuprea* and associated native plant species to the weed control treatment.
5. Report on the method and success of the treatment, and effect on *E. cuprea* plants and associated species.
6. Revegetation with site-specific species is required (in autumn) to maintain low weed levels.

In addition, a native vine (*Marianthus bicolor*) may be competing with *E. cuprea* trees at Subpopulation 9. If deemed a threat, hand removal may be required.

Action: Undertake weed control
Responsibility: DBCA (Geraldton District)
Cost: $10,000 per year, as required

6. Control insect infestation

Leaf mite, termites and caterpillars are a threat to the species. Insect control measures will be investigated in conjunction with research on the infestations.

Action: Control insect infestation
Responsibility: DBCA (Biodiversity and Conservation Science, Geraldton District)
Cost: $5,000 per year

7. Obtain additional biological and ecological information

Increased knowledge of the biology and ecology of the species will provide a scientific basis for management of *Eucalyptus cuprea* in the wild. Overall investigations will ideally include:

1. Soil seed bank dynamics and the role of various factors including disturbance, competition, drought, inundation and grazing in recruitment and seedling survival.
2. Reproductive strategies, phenology and seasonal growth.
3. Reproductive success and pollination biology.
4. Minimum viable population size.
5. The impact of changes in hydrology to habitat condition.

Action: Obtain additional biological and ecological information
Responsibility: DBCA (Biodiversity and Conservation Science, Geraldton District)
Cost: $50,000 in years 1–3

8. Undertake surveys

It is recommended that areas of potential suitable habitat be surveyed for the presence of *Eucalyptus cuprea* during its flowering period between August and November. All surveyed areas will be recorded and the presence or absence of the species documented to increase survey efficiency and reduce unnecessary duplicate surveys. Where possible, volunteers from the local community, landcare groups, wildflower societies and naturalists' clubs will be encouraged to become involved.

Action: Undertake surveys
Responsibility: DBCA (Geraldton District), with assistance from the GDTFCRT and volunteers
Cost: $10,000 per year

9. Collect and store seed

To guard against the extinction of natural subpopulations of *Eucalyptus cuprea* it is recommended that additional seeds are collected and stored at the TFSC. Collections should aim to sample and preserve the maximum range of genetic diversity possible by collecting from the widest range of reproductive plants.

Action: Collect and store seed
Responsibility: DBCA (Geraldton District, TFSC)
Cost: $10,000 per year

10. Liaise with land managers and Aboriginal communities

Staff from DBCA's Geraldton District will liaise with appropriate land managers to ensure that subpopulations of *Eucalyptus cuprea* are not accidentally damaged or destroyed, and the habitat is maintained in a suitable condition for the conservation of the species. Consultation with Aboriginal communities will take place to determine if there are any issues or interests in areas that provide habitat for the species.

Action: Liaise with land managers and Aboriginal communities
Responsibility: DBCA (Geraldton District)
Cost: $4,000 per year

11. Develop and implement a fire management strategy

Eucalyptus cuprea is known to regenerate from lignotubers and may also recruit from seed following fire. A fire management strategy will be developed in consultation with land managers which recommends fire frequency, intensity, season, and control measures.

Action: Develop and implement a fire management strategy
Responsibility: DBCA (Geraldton District)
Cost: $10,000 in year 1, and $6,000 in years 2–5

12. Control pigs and rabbits

Feral pigs are a threat to Subpopulation 4 and control will be undertaken. When monitoring ascertains the threat from rabbits is high, control measures including additional fencing and baiting for rabbits using 1080 oats may be required.

Action: Control pigs and rabbits
Responsibility: DBCA (Geraldton District), land managers
Cost: $9,000 per year

13. Fence subpopulations where required

At present stock do not have access to any subpopulations located on private property, however this may change in the future. Where deemed necessary, agreement will be sought to fence subpopulations to protect *Eucalyptus cuprea* from grazing by stock and other farming practices.

Action: Fence subpopulations
Responsibility: DBCA (Geraldton District), land managers
Cost: To be determined

14. Map habitat important for the survival of *Eucalyptus cuprea*

Although habitat that is important to the survival of *Eucalyptus cuprea* has been previously identified, it has not been mapped. If additional subpopulations are located, habitat important for their survival will also be determined and mapped.

Action: Map habitat important for the survival of *Eucalyptus cuprea*
Responsibility: DBCA (SCP, Geraldton District)
Cost: $6,000 in year 2

15. Promote awareness

The importance of biodiversity conservation and the protection of *Eucalyptus cuprea* will be promoted to the public through poster displays and the development of an information sheet which includes a description of the plant, its habitat type, threats, management actions and photos. This has already been produced but may need to be updated, reprinted and redistributed. Formal links with local naturalist groups and interested individuals will also be encouraged.

Action: Promote awareness
Responsibility: DBCA (Geraldton District, SCP, Public Information and Corporate affairs (PICA)), with assistance from the GDTFCRT
Cost: $7,000 in years 1 and 2; $5,000 in years 3–5

16. Ensure long-term protection of habitat

Strategies for achieving protection of private land on which subpopulations occur will be investigated. Possible methods of achieving future conservation management include developing a Management Plan in consultation with the land manager, covenanting, and acquisition of land.

Action: Ensure long-term protection of habitat
Responsibility: DBCA (Geraldton District, SCP), land managers
Cost: $4,000 per year

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

If *Eucalyptus cuprea* is still listed as Threatened at the end of the five-year term of this plan, the need for further recovery actions or a review of this plan will be assessed and a revised plan prepared if necessary.

Action: Review this plan and assess the need for further recovery actions
Responsibility: DBCA (SCP, Geraldton District)
Cost: $6,000 at the end of year 5

Table 7. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Coordinate recovery actions	High	DBCA (Geraldton District), with assistance from the GDTFCRT	Ongoing
Monitor subpopulations	High	DBCA (Geraldton District), with assistance from the GDTFCRT	Ongoing
Implement translocations	High	DBCA (Biodiversity and Conservation Science, Geraldton District)	2023
Rehabilitate habitat	High	DBCA (Geraldton District), land managers	2021
Undertake weed control	High	DBCA (Geraldton District)	Ongoing
Control insect infestation	High	DBCA (Biodiversity and Conservation Science, Geraldton District)	Ongoing
Obtain biological and ecological information	High	DBCA (Biodiversity and Conservation Science, Geraldton District)	2021
Undertake surveys	High	DBCA (Geraldton District), with assistance from the GDTFCRT and volunteers	Ongoing
Collect and store seed	High	DBCA (Geraldton District, TFSC)	2023
Liaise with land managers and Aboriginal communities	High	DBCA (Geraldton District)	Ongoing
Develop and implement a fire management strategy	High	DBCA (Geraldton District)	Developed initially, implementation ongoing
Control pigs and rabbits	Medium	DBCA (Geraldton District), land managers	Ongoing
Fence subpopulations where required	Low	DBCA (Geraldton District), land managers	2023
Map habitat important for the survival of *Eucalyptus cuprea*	Medium	DBCA (SCP, Geraldton District)	2020
Promote awareness	Medium	DBCA (Geraldton District, SCP, PICA), with assistance from the GDTFCRT	2023
Ensure long-term protection of habitat	Low	DBCA (Geraldton District, SCP)	2023
Review this plan and assess the need for further recovery actions	Medium	DBCA (SCP, Geraldton District)	2023

4. Term of plan

This plan will operate from December 2018 to December 2023 but will remain in force until withdrawn or replaced. If the species is still listed as Threatened after five years, a review of this plan will be completed, the need for further recovery actions determined, and a revised plan prepared if necessary.

5. References

Brooker, M.I.H. and Hopper, S.D. (1993) New series, subseries and subspecies of *Eucalyptus* (Myrtaceae) from Western Australia and from South Australia. *Nuytsia* 9(1): 1–68.

Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia.

Chant, A. (2002) *Threatened flowers of the mid-west*. Bush Books, Department of Conservation and Land Management, Kensington, WA.

Commander, L.E., Coates, D., Broadhurst, L., Offord, C.A., Makinson, R.O. and Matthes, M. (2018) Guidelines for the translocation of threatened plants in Australia. Third Edition. Australian Network for Plant Conservation, Canberra.

Department of Conservation and Land Management (2006) Badgingarra Box (*Eucalyptus absita*) Interim Recovery Plan 2006–2011. Interim Recovery Plan No. 226. Department of Conservation and Land Management, Perth, Western Australia.

Department of Parks and Wildlife (2015*a*) Corporate Policy Statement No. 35 *Conserving Threatened Species and Ecological Communities*. Perth, Western Australia.

Department of Parks and Wildlife (2015*b*) Corporate Guideline No. 35 *Listing and Recovery of Threatened Species and Ecological Communities*. Perth, Western Australia.

Department of Parks and Wildlife (2015*c*) Corporate Guideline No. 36 *Recovery of Threatened Species through Translocation and Captive Breeding or Propagation*. Perth, Western Australia.

Evans, R., Brown, A. and English, V. (1999) *Mallee Box (*Eucalyptus cuprea*) Interim Recovery Plan No. 43, 1999–2002*. Department of Conservation and Land Management, Perth, Western Australia.

Fairs, A. (2008) *Review of approved Western Australian Recovery Plans adopted as National Recovery Plans under the EPBC Act*. NHT Project ID 61821.

Frankham, R., Bradshaw, C.J.A. and Brook, B.W. (2014) Genetics in conservation management: Revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. *Biological Conservation* 170: 56 – 63.

Government of Australia (1999) *Environment Protection and Biodiversity Conservation Act*. International Union for Conservation of Nature (2001) *IUCN Red List Categories: Version 3.1*. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Llorens, T., Monks, L., Chant, Al., Newell, J. and Dillon, R. (2015) *Translocation Proposal* Eucalyptus cuprea *Mallee Box (Myrtaceae)*. Department of Parks and Wildlife, Western Australia.

Nicolle, D. (2006) A classification and census of regenerative strategies in the eucalypts (*Angophora*, *Corymbia* and *Eucalyptus*-Myrtaceae), with special reference to obligate seeders. *Australian Journal of Botany* 54: 391 – 407.

Sampson, J. and Byrne, M. (2009) *Genetic analysis to inform management of mallee box,* Eucalyptus cuprea. Unpublished Report. Department of Environment and Conservation, Kensington, WA.

Sampson, J.F. and Byrne, M. (2016) Assessing genetic structure in a rare clonal eucalypt as a basis for augmentation and introduction translocations. *Conservation Genetics* 17: 293 – 304.

Western Australian Herbarium (1998–) *FloraBase– the Western Australian Flora*. Department of Parks and Wildlife. http://florabase.dpaw.wa.gov.au/.

Yates, C.J., Taplin, R., Hobbs, R.J. and Bell, R.W. (1995) Factors limiting the recruitment of *Eucalyptus salmonophloia* in remnant woodlands. II. Post-dispersal seed predation and soil seed reserves. *Australian Journal of Botany* 43: 145–155.

6. Taxonomic description

Eucalyptus cuprea

Brooker, M.I.H. and Hopper, S.D. (1993) New series, subseries and subspecies of *Eucalyptus* (Myrtaceae) from Western Australia and from South Australia. *Nuytsia* 9(1): 1–68.

Mallee to 4 m tall with rough flaky or fibrous grey bark on lower half of stems, smooth coppery or grey above. Forming *lignotubers*. *Seeding leaves* decussate, remaining opposite for 3–4 pairs, petiolate, ovate, to 6 x 3 cm, blue-green, dull. *Juvenile leaves* alternating, petiolate, ovate, to 10 x 6 cm. *Adult leaves* alternating, petiolate, lanceolate, to 14 x 2 cm, concolorous, glossy, green; reticulation dense, incomplete, with scattered to very sparse intersectional or island oil glands. *Inflorescences* apparently terminal. *Peduncles* slender, to 1 cm long. *Immature buds* apparently sessile, cylindrical, with prominent scar caused by very early loss of outer operculum; mature buds distinctly pedicellate, clavate, to 0.6 x 0.4 cm; inner operculum conical to hemispherical. *Stamens* strongly inflexed, outer ones without anthers. Fertile *anthers* sub-versatile to adnate, cuboid to irregular in shape, opening by lateral pores; *flowers* white. *Ovary* (4) 5-locular; ovules in 4 vertical rows. *Fruits* distinctly pedicellate, cupular, to 0.5 x 0.4 cm; valves below rim level. *Seed* compressed-ovoid, grey-brown, with distinct shallow reticulum.