

Interim Recovery Plan No. 355

Woodman's wattle (*Acacia woodmaniorum*)

Interim Recovery Plan
2015–2020



**Karara Mining Ltd and the Department of Parks and Wildlife, Western
Australia**

December 2015

List of Acronyms

The following acronyms are used in this plan:

BGPA	Botanic Gardens and Parks Authority
BIF	Banded ironstone formations
CALM	Department of Conservation and Land Management
CITES	Convention on International Trade in Endangered Species
CR	Critically Endangered
DEC	Department of Environment and Conservation
DAA	Department of Aboriginal Affairs
DMP	Department of Mines and Petroleum
DOP	Department of Planning
DPaW	Department of Parks and Wildlife
DRF	Declared Rare Flora, now known as Threatened
EN	Endangered
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
GDTFRT	Geraldton District Threatened Flora Recovery Team
IBRA	Interim Biogeographic Regionalisation for Australia
IRP	Interim Recovery Plan
IUCN	International Union for Conservation of Nature
KML	Karara Mining Ltd
LGA	Local Government Authority
MEC	Maia Environmental Consultancy
NRM	Natural Resource Management
PEC	Priority Ecological Community
SCB	Species and Communities Branch
SMC	Sinosteel Midwest Corporation
TEC	Threatened Ecological Community
TFSC	Threatened Flora Seed Centre
TPFL	Threatened Priority Flora database
TSSC	Threatened Species Scientific Committee
UCL	Unallocated Crown Land
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
VU	Vulnerable
WA	Western Australia
WEC	Woodman Environmental Consulting Pty Ltd

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in the Department of Parks and Wildlife Policy Statement No. 35 and Corporate Guideline No. 36 (DPaW 2015). Plans outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened flora or ecological communities, and begin the recovery process.

Parks and Wildlife is committed to ensuring that threatened taxa are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible and, in the case of Critically Endangered (CR) taxa, always within one year of endorsement of that rank by the Minister.

This plan will operate from December 2015 to November 2020 but will remain in force until withdrawn or replaced. It is intended that, if the species is still ranked as Vulnerable (VU), this plan will be reviewed after five years and the need for further recovery actions assessed.

This plan was given regional approval on 5 October 2015 and was approved by the Director of Science and Conservation on 6 December 2015. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting Karara Mining Ltd and Parks and Wildlife, as well as the need to address other priorities.

Information in this plan was accurate at December 2015. The plan was prepared using funds from Karara Mining Ltd. Karara Mining Ltd is a subsidiary of Gindalbie Metals.

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Cover photograph by Adrienne Markey.

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Summary

Scientific name:	<i>Acacia woodmaniorum</i>	Common name:	Woodman's wattle
Family:	Fabaceae	Flowering period:	late June–August
DPaW region:	Midwest	DPaW district:	Geraldton
Shire:	Perenjori	NRM region:	Northern Agricultural Catchment Council
IBRA region:	Yalgoo	Recovery team:	GDTFRT
IBRA subregion:	Tallering (YAL02)		

Distribution and habitat: *Acacia woodmaniorum* is endemic to Western Australia's Midwest region where it is known from three extant populations in the Blue Hills Range approximately 80km east of Morawa. The species is restricted to massive outcrops of banded ironstone on skeletal soils (<50cm), acidic, red-brown loam, sandy loam or silt. It is usually found relatively high in the landscape (over 400m), often growing in rock crevices on exposed, steep slopes in tall shrubland or thickets dominated by *Acacia* species, *Allocasuarina acutivalvis* and/or *Eucalyptus petraea* (Markey and Dillon 2008; Maslin and Buscumb 2007).

Habitat critical to the survival of the species, and important populations: *Acacia woodmaniorum* is known from just three extant locations and it is considered that all known habitat for wild populations is critical to the survival of the species and that all wild populations are important populations. Habitat critical to the survival of *A. woodmaniorum* includes the area of occupancy of populations, areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations.

Conservation status: *Acacia woodmaniorum* is specially protected under the Western Australian *Wildlife Conservation Act 1950* and is ranked as Vulnerable (VU) in Western Australia under International Union for Conservation of Nature (2001) Red List criterion D2 due to a very restricted area of occupancy or number of locations such that it is prone to the effects of human activities or stochastic events. The species is not currently listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Threats: The main threats to the species are clearing, habitat disturbance, grazing, reduced connectivity among populations and insecure land tenure.

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. Surveys for *Acacia woodmaniorum* have been undertaken by Parks and Wildlife and environmental consultants.
2. An assessment of population genetic variation and structure of *Acacia woodmaniorum* and its phylogenetic relationship to other *Acacia* species was undertaken by Parks and Wildlife for Karara Mining Ltd (KML) (Millar and Coates 2012).
3. A quadrat-based survey of the flora and floristic communities of several ironstone ranges and outcrops in the Yalgoo bioregion was undertaken by Parks and Wildlife in 2005 (Markey and Dillon 2008).
4. Habitat critical to the survival of known populations of *Acacia woodmaniorum* has been mapped by KML.
5. A leaflet was produced by KML to highlight the value of *Acacia woodmaniorum*. The brochure included a description of the species, threats and recovery.
6. *Acacia woodmaniorum* propagation material, including 2,736 cuttings from Mungada East and West, have been taken by KML for a future translocation.
7. Approximately 1,229 *Acacia woodmaniorum* seed was collected from the Mungada Ridge by Greening Australia in 2012.

8. A Rehabilitation Strategy, which is yet to be finalised and approved by Parks and Wildlife, was developed for Mungada Ridge by KML in 2012 (Giltay *et al.* 2012).
9. A translocation proposal, which aims to establish viable populations of *Acacia woodmaniorum* at three sites previously disturbed by mining operations has been drafted (KML 2013).

Plan objective: The objective of this plan is to abate identified threats and maintain or enhance *in situ* populations 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 occur.

- No important populations have been lost and the number of mature plants within those populations has remained within a 2% range or has increased by >2% over the term of the plan from 33,166 to 33,830 or more; or
- New populations have been found, increasing the number of known populations from three to four or more over the term of the plan with no net loss of mature plants; or
- The area of occupancy has increased by >10% over the term of the plan with no net loss of mature plants.

Criteria for recovery failure: The plan will be deemed a failure if one or more of the following occur.

- Important populations have been lost; or
- The number of mature plants has decreased by >2% from 33,166 to 32,502 or less; or
- The area of occupancy has decreased by >10% over the term of the plan with a net loss of mature plants.

Note: all populations are considered important populations.

Recovery actions

1. Coordinate recovery actions
2. Monitor populations
3. Ensure long-term protection of habitat
4. Protect plants from herbivory
5. Develop and implement a fire management strategy
6. Collect and store seed
7. Obtain additional biological and ecological information
8. Undertake regeneration trials

9. Develop and implement translocations
10. Liaise with mining companies and Aboriginal communities
11. Undertake surveys
12. If further populations of *Acacia woodmaniorum* are found map habitat critical to their survival
13. Review this plan and assess the need for further recovery actions

History

Acacia woodmaniorum was first collected in the Blue Hills Range east of Morawa in 1992 by Western Australian Herbarium staff. At that time it was identified as *Acacia alata* var. *biglandulosa* but was subsequently recognised as a distinct species and was provided the phrase name *A. sp.* Blue Hills Range (R.J. Cranfield 8582). The species was formally described by Maslin and Buscomb in 2007. Additional collections were made by Markey and Dillon in 2005 and Woodman Environmental Consulting Pty Ltd (WEC) in 2007.

The species is restricted to banded ironstone formations (BIF) and is associated with the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF), Minjar and Chulaar Hills vegetation complexes (BIF) and Yalgoo (Gnows Nest/WollaWolla) (BIF) Priority Ecological Communities (PECs). These BIF landforms are highly prospective for minerals, and mining presents the greatest immediate threat to the unique and endemic floristic communities and flora found on them (Markey and Dillon 2008).

The pastoral lease in which *Acacia woodmaniorum* occurs was acquired for conservation by the Department of Conservation and Land Management (CALM) (now the Department of Parks and Wildlife) in 2002. The area contains three extant populations of *A. woodmaniorum* that together comprise 33,166 mature plants. All populations occur within mining and exploration leases.

Population 1 (referred in WEC 2007 as Population 2) is the largest population and extends over Mungada Ridge. Part of the population is also located within an old mining pit at Mungada East (WEC 2007). SMC intend to re-mine the Mungada East pit and acquired a permit on 19 June 2013 from the Minister for Environment to take at least 2,777 mature plants from populations 1 and 2 combined.

Karara Mining Ltd (KML) (a subsidiary of Gindalbie Metals) has undertaken mineral exploration along the south eastern part of Mungada Ridge in the past, with disturbed areas requiring rehabilitation within six months of exploration activities being completed (see Giltay *et al.* 2012 for Scope of Works). As part of the revised Mungada Iron Ore Project (MIOP), KML will relinquish a number of mining tenements, totalling approximately 8,592 hectares, subject to the government progressing the creation of a 'Class A' Nature Reserve over the Mungada Ridge. The relinquishment of these tenements by KML is being undertaken in consultation with Parks and Wildlife as the surrendered areas are proposed to become Class A nature reserves.

Population 2 (referred in WEC 2007 as Population 1) is located within mining tenement M59/595-1, held by SMC and is the site of the original collection by R. Cranfield. The population partially covers the Blue Hills (known as Mungada West pit area) which was mined by Western Mining in the 1960's. *Acacia woodmaniorum* was recorded on both undisturbed ground and also within the old pit area, on the waste dump, on old tracks and in a sump. None of these areas were rehabilitated after mining (WEC 2007). As stated previously, SMC intend to re-mine the area of this Blue Hills population (also including Mungada East pit) and have been granted a permit to take a total of 2,777 mature plants from populations 1 and 2 combined. Current exploration and geotechnical works involving excavation of small sumps and creation of level drill pads occurred in 2012 but did not result in the loss of any *A. woodmaniorum* plants.

Population 3 (Terapod) (referred in WEC 2007 as Population 2I) was located within mining tenement 59/649 held by Gindalbie Metals (parent company of KML) and consisted of 12 plants in 2012. A permit to take the population was issued to KML on 5 April 2012 by the Western Australian Minister for the Environment for the purpose of open pit iron ore mining and top soil stockpiling for future use in rehabilitation. Seed collected prior to mining will be used for future rehabilitation at the site.

Population 4 (referred in WEC 2007 as Population 3) at Jasper Hill was recorded in 2006 by WEC. Survey plots were established in September 2005 (Markey and Dillon 2008), however these were not established within the *Acacia woodmaniorum* population (WEC 2007). This population occurs within an exploration tenement E59/1569, held by McMahon Mining Title Services.

Description

Acacia woodmaniorum is an intricately branched, sprawling, harsh, prickly shrub 1 to 2m tall and up to 2m across. The senescent phyllodes persist on lower branches below the living crown. New shoots are red. The phyllodes are continuous and arranged in two rows, one on each side of an axis, and curve down at the edges to form opposite wings along branchlets. The wings are 2 to 10mm broad, glaucous to sub-glaucous and dull but aging green and shiny. The free portion of phyllodes bear two or three very prominent, rigid, straight, sharp, brown spines 3 to 6(–8)mm long. The marginal nerve is yellow (except red when young). The heads are globular, sepals free and half the length of the petals. The pods are narrowly oblong and straight to variously curved. The seeds are somewhat irregularly shaped, 3 to 4mm long, raised at centre and narrowed toward the margins (Maslin and Buscumb 2007).

Distinguishing features include its phyllodes, which are continuous and decurrent along the branchlets to form bifarious wings and the free portion of the phyllodes bearing three prominent spines. The species was reported to be most closely related to *Acacia alata* in particular its var. *biglandulosa* (Maslin and Buscumb 2007).

Acacia woodmaniorum was named by Maslin and Buscumb in 2007 in honour of the Woodman brothers, Simon, Richard and Greg for their technical and professional help to the first author.

Illustrations and/or further information

Maslin, B.R. and Buscumb, C. (2007) Two new *Acacia* species (Leguminosae: Mimosoideae) from banded ironstone ranges in the Midwest region of south-west Western Australia. *Nuytsia* 17: 263–272; Western Australian Herbarium (1998–) *FloraBase* – *The Western Australian Flora*. Department of Parks and Wildlife. <http://florabase.dpaw.wa.gov.au/>.

Distribution and habitat

Acacia woodmaniorum occurs in the Midwest region where it is known from three extant populations in the Blue Hills Range approximately 80km east of Morawa. The area has mild winters, hot, dry summers and low, moderately variable rainfall averaging 250–300mm annually, most of which falls during winter (Markey and Dillon 2008).

Acacia woodmaniorum is a narrow range endemic restricted to steep, massive outcrops of BIF, elongated belts of metamorphic sedimentary rocks (Markey and Dillon 2008). The soils are skeletal (<50cm), acidic, red-brown loam, sandy loam or silt. The species is usually found relatively high in the landscape (over 400m), often growing in rock crevices on exposed, steep slopes in tall shrubland or thickets dominated by *Acacia* species, *Allocasuarina acutivalvis* and/or *Eucalyptus petraea* (Maslin and Buscumb 2007).

In a quadrat-based survey of flora and floristic communities of several ironstone ranges and outcrops in the Yalgoo bioregion by Markey and Dillon (2008), *Acacia woodmaniorum* was found to occur in Community Types 2 and 4a, a description of these is provided below.

Community type 2: Found relatively high in the landscape, on moderate to very steep, rocky inclines. Restricted in distribution, located only on the slopes of Mt Karara and the far western slopes on Windaning Ridge (Population 1). Most typical of upper slopes but also repeated low in the landscape on low ridges of exposed ironstone on lower slopes and foothills. Moderately species rich (average total 50.9 ± 7.3 taxa per quadrat), consisting of a range of shrublands and thickets over an understorey rich in shrubs. Abundant in annuals. Indicator species include tall shrubs *Allocasuarina acutivalvis*, *Melaleuca nematophylla*, *Grevillea paradoxa* and *Gastrolobium laytonii*, and low shrubs *Aluta aspera* subsp. *hesperia*, *Xanthosia bungei*, and *Lepidosperma* sp. Blue Hills (A. Markey and S. Dillon 3468) (Priority 1) (Markey and Dillon 2008). This community type was listed as Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF) PEC (Priority 1).

Community type 4a: Located at the highest points in the landscape on steep, rocky or boulder-strewn ridges, cliffs and tors with shallow, loamy soils. Found on the east-facing steep cliffs of Windaning Ridge (Population 1) and consists of open stands of *Callitris columellaris* and sparse shrublands. A very species rich community (54.8 ± 9.4 taxa per quadrat), with much of this richness being contributed by annuals. Indicator species include those characteristic of rocky terrain, such as the shrubs *Calycopeplus paucifolius*, *Dodonaea petiolaris* and *D. viscosa*, rockferns *Cheilanthes sieberi* subsp. *sieberi*, *C. lasiophylla* and *Pleurosorus rutifolius* and herbaceous *Isotoma petraea* (Markey and Dillon 2008). This community type was listed as Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF) PEC (Priority 1).

Table 1. Summary of *Acacia woodmaniorum* populations, land vesting, purpose and manager

TPFL population number & location	DPaW district	LGA	Vesting	Purpose of land tenure	Tenement holder
1. Mungada/Windaning Ridge	Geraldton	Shire of Perenjori	UCL	Purchased for Conservation	SMC, KML
2. Blue Hill	Geraldton	Shire of Perenjori	UCL	Purchased for Conservation	SMC
*3. Terapod	Geraldton	Shire of Perenjori	UCL	Purchased for Conservation	KML
4. Jasper Hill	Geraldton	Shire of Perenjori	UCL	Purchased for Conservation	McMahon Mining Title Services

*Population extinct. Note: all extant populations are considered important populations.

Biology and ecology

Acacia woodmaniorum is most closely related taxonomically to members of the *A. alata* species complex (Maslin and Buscumb 2007). Results from the phylogenetic analysis of this complex are unclear and further investigations are required (Millar and Coates 2012).

An assessment of genetic variation and structure in *Acacia woodmaniorum* by Millar and Coates (2012) found that overall genetic diversity within the taxon was relatively high and, as expected, the larger populations maintained greater levels of genetic diversity, concentrated in the main population at Mungada Ridge, followed by Jasper Hills, Blue Hills and then the Terapod population. Increasing genetic difference was found with increasing geographic separation among populations over the species range suggesting that the populations have been stable for a long period of time. Isolation by distance was found within the Jasper Hills region, most likely due to a restricted level of gene flow associated with smaller, more disjunct populations. No isolation by distance occurred among the main Mungada Ridge population indicating significant pollen movement and gene flow between individuals. Genetic differences between populations and regions were low and overall gene flow via pollen dispersal was relatively high. Mating within populations appeared to be random with little evidence of inbreeding (Millar and Coates 2012).

An assessment of habitat removal on genetic diversity by Millar and Coates (2012) indicates that populations potentially affected by mining operations contain a high degree of genetic diversity and private allele richness that may be important for the maintenance of gene flow and genetic continuity, particularly those on Mungada Ridge. The removal of plants at Terapod, Blue Hills and the most western populations would result in a drop of 13% in total species genetic diversity and 45% drop in overall unique genetic variation. The latter is of particular concern for the Blue Hills population.

A study of mating systems, gene flow and pollination by Millar and Coates (2012) found that seed set in *Acacia woodmaniorum* was low compared to other *Acacia* species in the area with an average 68% of initially fertilised embryos developing into viable seed. The number of ovules within mature pods ranged from one to 12 (average 6.48). Seed was predated by birds or mammals and a significant amount by beetles (*Coleoptera* sp.), with the greatest amount of predation occurring at Mungada Ridge and Terapod. Seed (24%) was also lost to abortion, the reasons for which are unknown but could be due to environmental pressures such as lack of water.

Correlated paternity within pods suggests that an average of two different fathers sire all seed within a pod. The taxon is predominantly outcrossing and appears to have strong selection mechanisms against selfed or inbred seed. Small population size and degree of population isolation have no impact on mating system parameters (Millar and Coates 2012).

The levels of pollen immigration into populations found by Millar and Coates (2012) varied from 13 to 61% (average 40%) for eight small groups of plants of *Acacia woodmaniorum*. The high levels of pollen immigration confirm the capacity of the pollen dispersal system to affect a high degree of dispersal into small and isolated populations. Therefore small population size and degree of isolation appeared to have no impact on the amount of pollen immigration into populations. The high levels of pollen immigration also indicate that either insect pollinator visitation occurs frequently or wind pollination is effective across the species range.

Like most *Acacia* species, *A. woodmaniorum* is most likely an obligate re-seeder that is killed by fire and regenerates from soil stored seed. Germination is thought to be triggered by natural disturbance events (physical or fire), which may explain why the taxon has been observed growing on sites following mechanical disturbance (such as disturbed drill pads, road clearings, waste dumps).

Flowering of *Acacia woodmaniorum* commences in late June with some flowers persisting until August. The main flowering flush is in July. Pods with mature seeds have been collected between late November and late March (Maslin and Buscumb 2007).

Conservation status

Acacia woodmaniorum is specially protected under the Western Australian *Wildlife Conservation Act 1950* and is ranked as Vulnerable (VU) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criterion D2, due to a very restricted area of occupancy (typically less than 20km²) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events. The species is not currently listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Threats

- **Clearing.** *Acacia woodmaniorum* occurs on BIF which are highly prospective for iron ore. A number of mining leases exist over its habitat and mining has occurred in the Blue Hills Range and at Terapod, at the north-western end of the Mungada Ridge. Exploration has also occurred over the majority of the Mungada Ridge. The habitat of Population 3 at Terapod (12 plants) was cleared in 2012 by KML during mining operations. A permit to take was granted on 19 June 2013 for SMC to take at least 2,777 mature plants from Blue Hills (Population 2) and Mungada Ridge (Population 1). Exploration drilling on hillsides can cause significant disturbance and vegetation removal via digging of flat benches into the hillside using bulldozers or rock breakers, as well as clearing for roads and drill pads.
- **Habitat disturbance.** Habitat disturbance during mining operations may produce secondary threats such as dust, cracking of rock faces and impacts on reproductive biology. Negative effects on pollinator activity may lead to a decline in recruitment.
- **Grazing.** Feral animals including goats and rabbits may be a threat to the species and its habitat. Significant predation of seed by beetle larvae was also observed, the majority occurring at Mungada Ridge and Terapod populations (Millar and Coates 2012).
- **Reduced connectivity among populations.** Knowledge of the genetics of this species is well advanced and the initial conclusions from this work (Millar et al 2013, Millar and Coates 2012) indicate that the maintenance of connectivity between populations through pollen movement is likely to be critical for the persistence of this species. That is, small isolated populations on BIF outliers and large BIF populations are characterised by a level of connectivity that prevents inbreeding effects and reduced seed production in small populations through pollen movement. Any major disruption to this connectivity will significantly impact on the small outliers and potentially on the larger BIF populations if they become severely fragmented through habitat removal. The loss of the Mungada West and Terapod populations may have already impacted on this pattern of connectivity.

- **Insecure land tenure.** Although all known populations of *Acacia woodmaniorum* are found on UCL managed by Parks and Wildlife for the purpose of conservation there are mining tenements over the land and no populations are found in conservation reserves.

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

Table 2. Summary of population information and threats

TPFL population number & location	Land status	Year / no. of plants	Current condition	Threats
1. Mungada/Windaning Ridge	UCL	2008 25,483 2011 30,061	Healthy / Poor (partly mined)	Clearing, habitat disturbance, grazing, insecure land tenure
2. Blue Hills (Mungada West)	UCL	2008 125 2011 32	Healthy/poor (partly mined)	Clearing, habitat disturbance, grazing, insecure land tenure
*3. Terapod	UCL	2006 8 2008 9 2012 12 2012 0	Mined	
4. Jasper Hill	UCL	2008 3,073	Healthy	Clearing, habitat disturbance, grazing, insecure land tenure

Note: 2008 population counts are from WEC. 2011 population counts are based on 2008 counts from WEC with additional plants counted by Maia Environmental Consultancy (2012). *Population is now extinct.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions for development and/or land clearing in the immediate vicinity of *Acacia woodmaniorum* may require assessment.

Actions that could result in any of the following may potentially result in a significant impact on the species:

- Damage or destruction of occupied or potential habitat;
- Alteration of the local surface hydrology or drainage;
- Reduction in population size; and
- Reduced connectivity between populations limiting pollen flow (gene flow).

Habitat critical to the survival of the species and important populations

As *Acacia woodmaniorum* is ranked as VU in Western Australia and is known from just three locations, it is considered that all known habitat for wild populations is critical to the survival of the species and that all wild populations are important populations. Habitat critical to the survival of *A. woodmaniorum* includes the area of occupancy of populations, areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered populations of

the species or be suitable for future translocations, and the local catchment for the surface water 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 *Acacia woodmaniorum* will also improve the status of associated native vegetation. One rare and 11 priority flora taxa occur within 500m of *A. woodmaniorum* populations. These taxa are listed in the table below.

Table 3. Conservation-listed flora species occurring within 500m of *Acacia woodmaniorum*

Species name	Conservation status (WA)	Conservation status (EPBC Act)
<i>Stylidium scintillans</i>	Threatened (VU)	-
<i>Lepidosperma</i> sp. Blue Hills (A. Markey and S. Dillon 3468)	Priority 1	-
<i>Rhodanthe collina</i>	Priority 1	-
<i>Acacia karina</i>	Priority 2	-
<i>Calotis</i> sp. Perrinvale Station (R.J. Cranfield 7096)	Priority 3	-
<i>Drummondita fulva</i>	Priority 3	-
<i>Micromyrtus acuta</i>	Priority 3	-
<i>Micromyrtus trudgenii</i>	Priority 3	-
<i>Persoonia pentasticha</i>	Priority 3	-
<i>Polianthion collinum</i>	Priority 3	-
<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155–109)	Priority 3	-
<i>Stenanthemum poicilum</i>	Priority 3	-

For a description of the Priority categories see <http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities>

Two threatened (VU) fauna species, *Idiosoma nigrum* (Shield-backed Trapdoor spider) and *Leipoa ocellata* (Malleefowl), occur within the range of populations and will also benefit from management of the *Acacia woodmaniorum*.

Acacia woodmaniorum occurs within the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF) (29 occurrences, 24,944.9 hectares total), Minjar and Chulaar Hills vegetation complexes (BIF) (one occurrence, 28,914.4 hectares total) and Yalgoo (Gnows Nest/Wolla Wolla) (BIF) (four occurrences, 37,966.6 hectares total) PECs. All three communities are listed as Priority 1. For a description of Threatened and Priority Ecological Community categories see DEC (2010).

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 Aboriginal Affairs (DAA) Aboriginal Heritage Sites Register revealed four sites of significance adjacent to populations of *Acacia woodmaniorum*. These are listed in the table below. Input and involvement has been sought through the DAA to determine if there are any issues or interests with respect to management for this species at these sites. Aboriginal involvement in management of land covered by an agreement under the Western Australian *Conservation and Land Management Act 1984* is also provided for under the joint resting and joint management arrangements in that Act, and will apply if an agreement is established over any lands reserved under the Act on which this species occurs.

Table 4. Sites registered with Department of Aboriginal Affairs that occur adjacent to *Acacia woodmaniorum*

Site identification	Access	Restriction	Site name	Site type
5934	open	none	Karara Ochre Quarry	Quarry/artefacts/scatter
26485	open	none	MIOP08 (Terapod Artefacts 01)	Artefacts/scatter
31402	open	none	BH11-09	Man-made structure
31403	open	none	BH11-10	Artefacts/scatter

Social and economic impacts

Populations of *Acacia woodmaniorum* occur on UCL that is a proposed conservation reserve. However active mining is currently taking place by KML and SMC and mineral exploration leases cover all areas containing populations of *A. woodmaniorum*. There is potential for economic impact if restrictions are applied to mining operations. Recovery actions refer to continued liaison between relevant stakeholders.

Affected interests

The implementation of this plan has some implications for mining tenement holders (KML, SMC and McMahon) which may be affected by actions referred to in this plan. Recovery actions refer to continued liaison between affected stakeholders.

Evaluation of the plan's performance

Parks and Wildlife, with assistance from the Geraldton District Threatened Flora Recovery Team (GDTFRT), 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 *in situ* populations 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 occur.

- No important populations have been lost and the number of mature plants within those populations has remained within a 2% range or has increased by >2% over the term of the plan from 33,166 to 33,830 or more; or
- New populations have been found, increasing the number of known populations from three to four or more over the term of the plan with no net loss of mature plants; or
- 1. The area of occupancy has increased by >10% over the term of the plan with no net loss of mature plants.

Criteria for recovery failure: The plan will be deemed a failure if one or more of the following occur.

- Important populations have been lost; or
- The number of mature plants has decreased by >2% from 33,166 to 32,502 or less; or
- 1. The area of occupancy has decreased by >10% over the term of the plan with a loss of mature plants.

Note: all populations are considered important populations.

3. Recovery actions

Existing recovery actions

Surveys for *Acacia woodmaniorum* have been undertaken by Bennett Environmental Consultants, WEC and Maia Environmental Consultancy. WEC, in particular undertook surveys in 2004, 2005 and 2006 in areas required for drilling and exploration. The main surveys for *A. woodmaniorum* include:

- Regional survey for *Acacia woodmaniorum* in December 2007 (WEC 2008a);
- Karara - Mungada project survey area flora and vegetation survey from June to September 2006 (WEC 2008b); and
- Population census by WEC from January to March in 2008.
- Targeted flora surveys in June, July and September 2011 (Maia Environmental Consultancy 2012).

An assessment of population genetic variation and structure of *Acacia woodmaniorum* and its phylogenetic relationship to other *Acacia* species was undertaken by the Department for KML (Millar and Coates 2012).

A quadrat-based survey of the flora and floristic communities of several ironstone ranges and outcrops in the Yalgoo bioregion was undertaken by Parks and Wildlife. The survey consisted of 103 20x20m plots established in September and October, 2005 (Markey and Dillon 2008).

Habitat critical to the survival of known populations of *Acacia woodmaniorum* has been mapped by KML.

A leaflet was produced by KML as part of a wider environmental education program to highlight the value of *Acacia woodmaniorum*. The leaflet included a description of the plant, threats and recovery.

Propagation material for *Acacia woodmaniorum* collected so far includes:

- Twelve plants grown from seed as part of a genetic study by Millar and Coates (2012) were planted outside mining camp grounds. Currently seven remain alive.
- A total of 1,040 cuttings and 98 plants from Mungada East, and 1,696 cuttings and 27 plants from Mungada West have been taken by KML for a future translocation.
- Approximately 1,229 seeds were collected from *Acacia woodmaniorum* (see Table 5 below). Seed from the Mungada Ridge was collected by Greening Australia in 2012.

Table 5. Seed collection details for *Acacia woodmaniorum*

TPFL population number	Population location	Seed accession code	Number of seeds	Weight of seed collection
3	Terapod	-	145 seeds	N/A
1	Mungada Ridge	121031Acwoo6GA	460 seeds	25grams
1	Mungada Ridge	121031Acwoo6 GA	252 seeds	34grams
1	Mungada Ridge	121030Acwoo6 GA	372 seeds	30 grams

A rehabilitation strategy, which is yet to be finalised and approved by Parks and Wildlife, was developed for Mungada Ridge by KML in 2012 (Giltay *et al.* 2012). The objective of this strategy is to rehabilitate previous exploration works undertaken by the company on Mungada Ridge in accordance with tenement conditions and Department of Mines and Petroleum (DMP) guidelines. The objectives of this document are:

- To select a suitable trial rehabilitation area for the initial rehabilitation methodology and monitoring schedule to determine its success;
- Identify the flora surveys required to determine the presence of priority flora at Mungada Ridge and the impact of rehabilitation works on existing priority flora;
- Determine the need for approvals and/or licences to take/disturb priority flora;
- Identify the earthworks required to re-instate compatible slope gradients on the ridge;
- Determine access and logistics of earthworks on the ridge; and
- Provide a schedule of time to complete rehabilitation of the selected trials sites.

A translocation proposal, which aims to establish viable populations of *Acacia woodmaniorum* at three sites previously disturbed by mining operations, has been submitted. These sites will be used to create a seed orchard using plants propagated from seed obtained from the extinct Population 3 to conserve genetic diversity and increase the availability of propagation material for potential future translocation attempts. Viable populations of *A. woodmaniorum* will be considered to have been achieved when there is a minimum of 250 and preferably 500 adult plants, the populations

are self-sustaining, there is adequate levels of genetic diversity based on information from natural populations and there is adequate connectivity between populations through pollen movement based on information from studies on gene flow between populations and population groups (KML 2013).

Future recovery actions

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

1. Coordinate recovery actions

Parks and Wildlife will coordinate recovery actions for *Acacia woodmaniorum* and, with assistance from the GDTFRT, will include information on progress in annual reports to the Department's Corporate Executive and funding bodies. Underlying tenements holders should assist in the coordination of recovery actions for populations within the tenements.

Action:	Coordinate recovery actions
Responsibility:	Parks and Wildlife (Geraldton District), with assistance from the GDTFRT and KML
Cost:	\$8,000 per year

2. Monitor populations

All populations will be inspected annually (included translocated populations) with accurate counts undertaken and locational information recorded. Monitoring of factors such as grazing, weed invasion, habitat degradation, population stability (expansion or decline), pollinator activity, seed production, recruitment, and longevity will also be undertaken.

Action:	Monitor populations
Responsibility:	Parks and Wildlife (Geraldton District)
Cost:	\$20,000 per year

3. Ensure long-term protection of habitat

In consultation with relevant stakeholders, Parks and Wildlife shall undertake conservation reserve planning over the Karara block area. The planning shall identify areas of high conservation value, and this may include areas that include habitat and populations of *Acacia woodmaniorum*.

In direct reference to mining tenement M59/650, Parks and Wildlife shall await the results of the current review that has been initiated and any approvals by the Minister for Environment on the advice of the Chairman of the Environmental Protection Authority (EPA).

Action:	Ensure long-term protection of habitat
Responsibility:	Parks and Wildlife (Geraldton District, Land Unit), KML, DOP, DMP
Cost:	\$4,000 per year

4. Protect plants from herbivory

The level of threat posed by herbivores such as goats and rabbits may vary from year to year. When monitoring ascertains the threat is high, baiting for rabbits using 1080 oats should be undertaken in summer when less green feed is available. Where areas of high infestation occur, fumigating warrens may also be implemented. Control measures such as baiting are likely to be required on an ongoing basis.

Potential options for the control of goats may include aerial shooting and trapping. Aerial shooting is costly and would require temporarily closing down areas of the mine to exclude access to workers during shooting. Such a method of control would probably be undertaken in the later stages of a broader eradication program once trapping has significantly reduced goat numbers. Any control programs undertaken would require close liaison with the mine.

Seed predation by beetle larvae has been observed and will need to be controlled with an appropriate insecticide undertaken if required. Short-term small trials on a subset of plants within populations affected are recommended.

Action:	Protect plants from herbivory
Responsibility:	Parks and Wildlife (Geraldton District)
Cost:	\$15,000 per year

5. Develop and implement a fire management strategy

Fire will be prevented (if possible) from occurring in the habitat of the populations except where it is being used experimentally as a recovery tool. A fire management strategy will be developed that recommends fire frequency, intensity, season, and control measures.

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

6. Collect and store seed

Preservation of genetic material is essential to guard against extinction of the species if the wild populations are lost. The standard targets for germplasm conservation should aim to capture as much diversity as possible, ideally 90 to 95% of the existing genetic variability found within a population. Material should be collected from at least 50 individuals if a population comprises more than 50 individuals and from all plants if a population comprises fewer than 50 individuals. For *Acacia woodmaniorum* the aim would be to collect from all populations. These guidelines are outlined in 'Plant germplasm conservation in Australia: Strategies and guidelines for developing, managing and utilising ex-situ collections' (Cochrane *et al.* 2009). The commonly accepted target for collection size is 10,000 to 20,000 seeds, providing that seed can be obtained without threatening the survival of natural populations. Although this target is for an individual collection it can be applied as a target for a population. This seed should be viable and meet the sampling requirements outlined. It is recommended that seed be collected and stored in the Threatened Flora Seed Centre (TFSC) and Botanic Gardens and Parks Authority (BGPA).

Action:	Collect and store seed
Responsibility:	Parks and Wildlife (Geraldton District, TFSC), BGPA
Cost:	\$20,000 per year

7. Obtain additional biological and ecological information

A study on population genetic variation and structure of *Acacia woodmaniorum* and its phylogenetic relationship to other *Acacia* species has been undertaken by Millar and Coates (2012). Improved knowledge of the further aspects of the biology and ecology of the species will provide a scientific basis for management of *Acacia woodmaniorum* in the wild and will include:

1. Pollination biology, pollen movement and reproductive output.
2. Soil seed bank dynamics and the role of various factors including disturbance, competition, drought, inundation and grazing in recruitment and seedling survival.
3. Reproductive strategies, phenology and seasonal growth.
4. The impact of changes in hydrology in the habitat.

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

8. Undertake regeneration trials

Natural disturbance events (physical or fire) may be the most effective means of germinating *Acacia woodmaniorum* seed in the wild. Different disturbance techniques should be investigated (i.e. soil disturbance and fire), to determine the most successful and appropriate method. Records will need to be maintained for future research. Any disturbance trials will need to be undertaken in conjunction with weed control.

Action:	Undertake regeneration trials
Responsibility:	Parks and Wildlife (Science and Conservation Division, Geraldton District), KML, other relevant stakeholders
Cost:	\$10,000 in years 1 and 3, \$4,000 in years 2, 4 and 5

9. Develop and implement translocations

Information on the translocation of threatened plants and animals in the wild is provided in Parks and Wildlife's Policy No. 35 *Conserving Threatened Species and Ecological Communities* (2015) and Corporate Guideline No. 36 *Recovery of Threatened Species through Translocation and Captive Breeding or Propagation* (2015), and the Australian Network for Plant Conservation translocation guidelines (Vallee *et al.* 2004). The 2004 guidelines state that a translocation may be needed when a species is represented by few populations and the creation of additional self-sustaining, secure populations may decrease its susceptibility to catastrophic events and environmental stochasticity. For small populations which may be declining in size or subject to high levels of inbreeding, successful population enhancement may increase population stability and hence long-term viability. Translocation is not an alternative to *in situ* conservation and is not a suitable ameliorative, compensatory, or mitigating measure for development and should be considered as a last resort when all other options are deemed inappropriate or have failed (Vallee *et al.* 2004).

Depending on the characteristics of the species, Vallee *et al.* (2004) suggest a minimum viable population size estimated between 50 and 2,500 individuals will be required. Suitable translocation sites may include where the taxon occurs, where it was known to have occurred historically and other areas that have similar habitat (soil, associated vegetation type and structure, aspect etc.), within the known range of the taxon (Vallee *et al.* 2004).

A translocation proposal for *Acacia woodmaniorum* has been drafted by KML and requires endorsement by Parks and Wildlife's Director of Science and Conservation. KML aims to establish viable populations of *A. woodmaniorum* at three sites, previously disturbed by mining operations. These sites will be used to create a seed orchard to aid in conserving genetic diversity and increasing the availability of propagation material for potential future translocation attempts. Viable populations of *A. woodmaniorum* will be considered to have been achieved when there is a minimum of 250, and preferably 500, adult plants, the populations are self-sustaining, there is adequate levels of genetic diversity based on information from natural populations, and there is adequate connectivity between populations through pollen movement based on information from studies on gene flow between populations and population groups (KML 2013). Monitoring of translocations is essential and will be included in the Translocation Proposal.

Action:	Develop and implement translocations
Responsibility:	KML with advice from Parks and Wildlife, and other proponents of translocation proposals
Cost:	Cost (to be determined) to be covered by proponent of translocation proposal

10. Liaise with mining companies and Aboriginal communities

Staff from Parks and Wildlife's Departments Geraldton District will liaise with KML and SMC to ensure that populations of *Acacia woodmaniorum* are not accidentally damaged or destroyed and the habitat is maintained in a suitable condition for the conservation of the species. Aboriginal consultation will take place to determine if there are any issues or interests in areas that are habitat for *A. woodmaniorum*.

Action:	Liaise with mining companies and Aboriginal communities
Responsibility:	Parks and Wildlife (Geraldton District)
Cost:	\$4,000 per year

11. Undertake surveys

It is recommended that areas of potential suitable habitat, including areas outside of mining tenements, be surveyed for the presence of *Acacia woodmaniorum*. 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 be involved.

Action:	Undertake surveys
Responsibility:	Parks and Wildlife (Geraldton District)
Cost:	\$15,000 per year

12. If further populations of *Acacia woodmaniorum* are found, map habitat critical to their survival

Habitat critical to the survival of known populations of *Acacia woodmaniorum* has been mapped by KML. If further populations are found, habitat critical to their survival will also be mapped.

Action:	If further populations of <i>Acacia woodmaniorum</i> are found, map habitat critical to their survival
Responsibility:	KML
Cost:	\$6,000 in year 2

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

If *Acacia woodmaniorum* is still ranked as VU at the end of the five-year term of this plan, the plan will be reviewed and the need for further recovery actions assessed.

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

Table 6. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Coordinate recovery actions	High	Parks and Wildlife (Geraldton District), with assistance from the GDTFRT and KML	Ongoing
Monitor populations	High	Parks and Wildlife (Geraldton District)	Ongoing
Ensure long-term protection of habitat	High	Parks and Wildlife (Geraldton District, Land Unit), KML DOP, DMP	Ongoing
Protect plants from herbivory	High	Parks and Wildlife (Geraldton District)	Ongoing
Develop and implement a fire management strategy	High	Parks and Wildlife (Geraldton District)	Developed by 2015 with implementation ongoing
Collect and store seed	High	Parks and Wildlife (Geraldton District TFSC), BGPA	2019
Obtain additional biological and ecological information	High	Parks and Wildlife (Science and Conservation Division, Geraldton District)	2017
Undertake regeneration trials	High	Parks and Wildlife (Science and Conservation Division, Geraldton District), KML, other relevant stakeholders	2019
Develop and implement translocations	High	KML with advice from Parks and Wildlife, other proponents of translocation proposals	2019
Liaise with mining companies and Aboriginal communities	High	Parks and Wildlife (Geraldton District)	Ongoing
Undertake surveys	High	Parks and Wildlife (Geraldton District)	Ongoing
If further populations of <i>Acacia woodmaniorum</i> are found, map habitat critical to their survival	Medium	KML	Ongoing
Review this plan and assess the need for further recovery actions	Medium	Parks and Wildlife (SCB, Geraldton District)	2019

4. Term of plan

This plan will operate from December 2015 to November 2020 but will remain in force until withdrawn or replaced. If *Acacia woodmaniorum* is still VU or at a higher threat category after five years, the need for further recovery actions will be assessed and a revised plan prepared if necessary.

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6. Taxonomic description

Acacia woodmaniorum

Maslin and Buscumb (2007)

Intricately branched, sprawling, harsh, prickly *shrubs* (0.5–)1–2m tall and up to 2m across, the dead (grey) phyllodes persisting on lower branches below the living crown. *Bark* grey, slightly roughened. *New shoots* glabrous, red when first initiated. *Branchlets* shallowly flexuose, glabrous. *Phyllodes* continuous and bifurcately decurrent to form opposite wings along the branchlets, each wing continued to the next below and notched at the nodes between adjacent phyllodes, the wings 2–10mm broad, coriaceous, glabrous, glaucous to sub-glaucous, ± lightly pruinose and dull but aging green and ± shiny, the marginal nerve yellow (except red when young); *free portion of phyllodes* bearing 2 or 3 very prominent, rigid, straight, sharp, brown spines 3–6(–8)mm long, sinus between spines concave; with 1 or 2 main *nerves* extending from the branchlet to the lowermost point of the sinuses or to near the base of the uppermost spine, minor nerves (sub-parallel to the main nerves, or branching from main nerves) often sparingly bifurcating. *Gland* situated on upper margin of free portion of phyllode 1–6mm above the base (often about half-way between the branchlet and the first spine), circular to elliptic, about 0.4mm long, sessile and plane (i.e. flush with the margin, not situated on a triangular spur). *Inflorescences* simple or rudimentary racemes with axis less than 1mm long, 1 or 2 per node; *heads* globular, 27–28-flowered, light golden; *peduncles* 8–15mm long when in flower, to 20mm long in fruit; *basal peduncular bracts* sub-persistent, c. 1mm long, scarious, concave, obscurely striate, brown, fimbriolate otherwise glabrous. *Bracteoles* c. equal to sepals in length, spatulate, claws linear to narrowly oblong and glabrous or sparsely hairy; laminae dark brown and fimbriolate. *Flowers* 5-merous; *sepals* free, c. ½ length of petals, narrowly oblong to linear, fimbriolate at the often brown apices; *petals* 2.2mm long, nerveless, glabrous. *Pods* narrowly oblong, flat but slightly rounded over seeds along the midline, ± thinly coriaceous-crustaceous, straightedged or very slightly constricted between seeds, 10–45mm long, 5–7mm wide, straight to shallowly or moderately curved, sometimes strongly recurved or twisted upon dehiscence, glabrous, dark brown; *marginal nerve* indistinct. *Seeds* mostly transverse in pods, some occasionally longitudinal, somewhat irregularly shaped, obloid to ellipsoid or ± globose, cubic or rhomboidal, obliquely truncate along edge adjacent to aril, 3–4mm long, 3–3.5mm wide, raised at centre and narrowed toward the margins, glossy, dark greyish brown to black; *pleurogram* very obscure; *areole* 'u' shaped, open toward hilum, c. 0.5–0.7mm long; *funicle* folded beneath an expanded sometimes ± flattened white *aril*.