INTERIM RECOVERY PLAN NO. 215

# SHRUBLAND ASSOCIATION ON SOUTHERN SWAN COASTAL PLAIN IRONSTONE (BUSSELTON AREA) (SOUTHERN IRONSTONE ASSOCIATION)

# INTERIM RECOVERY PLAN 2005-2010

by

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Photo: Rachel Meissner

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# FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

CALM is committed to ensuring that Critically Endangered ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by CALM's Director of Nature Conservation.

This Interim Recovery Plan replaces plan number 44 – 'Shrublands on southern Swan Coastal Plain Ironstones', Interim Recovery Plan 1999-2002, by V. English.

This Interim Recovery Plan will operate from March 2005 to February 2010 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan will be assessed.

This IRP was given Regional approval on 21 November 2005 and was approved by the Director of Nature Conservation 13 December 2005. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at March 2005.

**ACKNOWLEDGMENTS**

The National Reserve System Program of Environment Australia funded the project entitled 'identifying and conserving threatened ecological communities in the south west botanical province'. The project confirmed the threatened status of this plant community.

The following people provided valuable advice and assistance in the preparation of this Interim Recovery Plan;

| | |
|---|---|
| Neil Gibson, Greg Keighery, | CALM, Science Division |
| Kim Williams, Russell Smith | CALM South West Region |
| Andrew Webb, Aaron Grant, John Cater | CALM Blackwood District |
| Will Oldfield | Agriculture Western Australia, Bunbury |
| Henry Smolinsky | Agriculture Western Australia, Perth |
| Bronwen Keighery | Department of Environment |
| David Coates | CALM, Science Division |

## Summary

**Name**: **Southern Swan Coastal Plain Ironstone (Busselton Area) (Busselton or Southern Ironstone Association).**

**Description**: Species rich plant community located on seasonal wetlands on ironstone and heavy clay soils on the Swan Coastal Plain near Busselton. Much of the high species diversity comes from annuals and geophytes. Typical and common native species are the shrubs *Kunzea* aff. *micrantha* (B.J. Keighery and N. Gibson 040), *Pericalymma ellipticum, Hakea oldfieldii, Hemiandra pungens* and *Viminaria juncea*, and the herbs *Aphelia cyperoides* and *Centrolepis aristata* (Gibson *et al*. 1994 community type 10b).

**CALM Region(s):** South West

**CALM District(s):** Blackwood

**Shire(s)**: Busselton

**Recovery Team**: Established in 1996 as the South West Region Threatened Flora and Communities Recovery Team. Membership: representatives from CALM's Central Forest Region (Chair) and Blackwood District, Environmental Officer Shire of Busselton, Bunbury Naturalists Club, and CALM's WA Threatened Species and Communities Unit. The Recovery Team reports annually to CALM's Corporate Executive.

**Current status**: Assessed 21 November 1995 as Critically Endangered. Also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Note: the community name is listed as 'shrublands on southern Swan Coastal Plain ironstones' under the EPBC Act).

**Habitat requirements**: The community is located upon skeletal soils developed over massive ironstone and undergoes seasonal inundation with fresh water. Many taxa in the community are highly restricted in distribution, dieback susceptible and/or are obligate seeders.

**IRP Objective(s)**: To maintain or improve the overall condition of the plant community in the known locations and reduce the level of threat with the aim of transferring it from Critically Endangered to Endangered.

**Guide for decision-makers**: Any on-ground works (clearing, firebreaks, roadworks, spraying of herbicides, burning, proposals with potential to cause changes to water levels or quality, etc) in the immediate vicinity of the Southern Ironstone community will require assessment. Proponents should demonstrate that on-ground works will not have an impact on the community, or on its habitat or potential habitat.

**Habitat critical to survival, and important populations**: The habitat critical to the survival of the Southern Ironstone community is the area of occupancy of known occurrences, similar habitat adjacent to important occurrences (ie within approximately 200m), remnant vegetation that surrounds or links several occurrences, and the local catchment for the surface and groundwaters that maintain the winter-wet habitat of the community. Given that the community is listed as Critically Endangered, it is considered that all known occurrences of the community, and the catchments for the surface and groundwater that support this wetland habitat are critical to the survival of the community.

**Benefits to other species/ecological communities**: There are a total of 11 Declared Rare Flora (*Brachyscias verrucundus, Gastrolobium modestum, Gastrolobium papilio, Chamelaucium roycei* ms, *Darwinia* sp. Williamson, *Dryandra nivea* subsp. *uliginosa*, *Dryandra squarrosa* subsp. *argillacea, Grevillea elongata Grevillea maccutcheonii, Lambertia echinata* subsp. *occidentalis*, and *Petrophile latericola* ms) and six Priority species (*Andersonia ferricola* ms, *Calothamnus* sp. Scott River, *Calothamnus* sp. Whicher, *Calytrix* sp. Tutunup *Hakea oldfieldii, Loxocarya magna*) that occur in the Busselton Ironstone community. Recover actions implemented to improve the quality or security of the community are also likely to improve the status of component species within the community.

**Role and interests of indigenous people**: An Aboriginal Sites Register is kept by the Department of Indigenous Affairs, and lists one Artefact/Scatter site and a camping site within the vicinity of the occurrences. Indigenous communities interested or involved in the region affected by this plan have not yet been identified, however, implementation of recovery actions under this plan includes consideration of the role and interests of indigenous communities in the region.

**Social and economic impacts**: The implementation of this recovery plan has the potential to have some social and economic impact, where occurrences are located on private property and other areas not specifically managed for conservation such as a disused rail reserve, and a road reserve. Recovery actions refer to continued liaison between stakeholders with regard to these areas. Several occurrences occur on private land and negotiations will continue with the land managers with respect to the future management of these occurrences. A mineral sands mine is located

adjacent to several occurrences and a mining lease is held over an area that includes an occurrence. Recovery actions refer to continued liaison between stakeholders with regard to all of these areas.

**Affected Interests:** Occurrences of the Southern Ironstone community occur within the Shire of Busselton. They occur on land managed by Main Roads WA, CALM, Ruabon-Tutunup Rail Reserve Preservation Group and on land managed by six different private land managers.

**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 Southern Ironstone Association is not listed under any specific international treaty, however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

**Evaluation of the Plan's Performance**: CALM, in conjunction with the South West Region Threatened Flora and Communities Recovery Team will evaluate the performance of this Interim Recovery Plan. The plan is to be reviewed within five years of its implementation. Any changes to management / recovery actions will be documented accordingly.

**IRP Objective(s):** To maintain or improve the overall condition of the Shrublands on southern Swan Coastal Plain Ironstone community and reduce the level of threat with the aim of reclassifying it from Critically Endangered to Endangered.

**Criteria for success:**
An increase of 10% or more in the area, and/or increase in the number of occurrences of this community under conservation management.

Maintenance in terms of diversity and basic composition of native plant taxa (as described in Gibson *et al*. 1994, Gibson *et al*. 2000) taking account of natural change in the community over time. This will be measured as a loss of no more than 10% of the native plant taxa in any occurrence over the life of the plan.

Improvement in the condition of the habitat, in terms of reduction of numbers of exotic species and of other threatening processes as defined in this document. This will be measured as follows:

- reduction of 10% or more in the cover of exotic plant taxa in any occurrence,
- groundwater levels and quality maintained within the parameters expected as a consequence of natural change, by comparison with monitoring results for the Blackwood Groundwater area in areas remote from development.

**Criteria for failure:**
A decrease of 10% or more in the area covered by the community, and/or decline in the number of occurrences of this community under conservation management.

A decline in terms of diversity and basic composition of native plant taxa (as described in Gibson *et al*. 1994, Gibson *et al*. 2000) taking account of natural change of the community over time. This will be measured as a loss of more than 10% of the native plant taxa in any one occurrence over the life of the plan.

Decline in the condition of the habitat, in terms of increase in numbers of exotic species and other threatening processes as defined in this document. This will be measured as follows:

- increase in the cover of exotic plant taxa of more than 10% in any occurrence of the community
- groundwater levels and quality not maintained within the parameters expected as a consequence of natural change, by comparison with monitoring results for the Blackwood Groundwater area in areas remote from development.

**Recovery Actions:**

| | |
|---|---|
| 1. Coordinate Recovery Actions | 12. Monitor salinity and groundwater levels |
| 2. Liaise with relevant land managers | 13. Monitor weeds |
| 3. Monitor the extent and boundaries of occurrences | 14. Implement weed control |
| 4. Map Critical Habitat | 15. Implement control of grazing animals |
| 5. Disseminate information about the community | 16. Develop strategy for broadscale reconstruction |
| 6. Design and implement flora monitoring program | 17. Design and conduct research |
| 7. Monitor dieback | 18. Develop fire management strategy for Ruabon-Tutunup Road occurrences |
| 8. Implement dieback treatment | 19. Develop a management plan for road and rail reserve |
| 9. Ensure hygiene conditions | 20. Encourage landowners to access incentives for conserving the ironstone community |
| 10. Implement fire management strategy | 21. Seek to acquire occurrences |
| 11. Research population dynamics and viability | |

## Background

### 1.1. History, defining characteristics, conservation significance and status

The ironstone soils are extremely restricted in distribution on the Swan Coastal Plain. These soils may have been historically associated with bogs - the iron being deposited by water percolating through the soil (Tille and Lantzke 1990 a, b and c; H. Smolinsky[1] personal communication). Restricted areas of ironstone soils associated with unusual plant communities occur in a number of areas in the southwest of Western Australia; near Kalbarri (A. Brown[2], personal communication), near Eneabba (Griffin *et al.* 1983), in the Scott River area (Gibson *et al.* 2000), near Albany (G. Keighery[3] personal communication) and at Gingin and Busselton (Department of Environmental Protection 1996; Gibson *et al.* 1994). Each of these areas contain plant communities that are characterised by different taxa.

The plant community 'shrublands on southern Swan Coastal Plain ironstone' occurs on a soil type that is restricted to the eastern side of the Swan Coastal Plain along the base of the Whicher Scarp near Busselton. This area contains heavy soils that are particularly useful for agricultural purposes and are around 97% cleared (CALM 1990; Keighery and Trudgen 1992).

Tille and Lantzke (1990a, 1990b) mapped the southern ironstone soils in the Busselton area, and the original extent of the community can be derived from this. There are about 1,200 hectares of the soil type, of which about 90 ha remain uncleared. This represents a loss of over 90 percent of the area of a plant community that was originally highly restricted in distribution.

The ironstone soils near Busselton are associated with shallow seasonal inundation with fresh water. This inundation may occur due to ponding of rainfall as a consequence of the impermeable nature of the surface outcrops of ironstone and the associated heavy soils. In addition, groundwater levels in the community come very close to or may reach the surface in the wetter months (Tille and Lantzke 1990c).

Typical and common native species in the community are the shrubs *Kunzea* aff. *micrantha* (Collection Bronwen Keighery and Neil Gibson 040), *Pericalymma ellipticum*, *Hakea oldfieldii*, *Hemiandra pungens* and *Viminaria juncea*, and the herbs *Aphelia cyperoides*, *Centrolepis aristata* and the introduced species *Hypochaeris glabra* (Gibson *et al.* 1994). A list of taxa that occur in 50% or more plots in occurrences in the community (from Gibson *et al.* 1994) is given in Appendix 1.

It is not known to what extent fire has influenced the present structure or composition of the community. Grazing, where it occurred, would almost certainly have increased the invasion of exotic species such as *Hypochaeris glabra* within the community. However, weed cover in most occurrences is currently very low.

The community type contains a number of taxa that are listed as Declared Rare Flora (DRF) or Priority Flora (Atkins 2005; refer Table 1) and are either totally confined or largely confined to it, or may be shared with the ironstone of the Scott Coastal Plain (Gibson *et al.* 2000). Only four of the 18 taxa listed in Table 1 are common to both areas, however, and the plant communities are considered to be quite distinct (Gibson *et al.* 2000).

Major threats to the community are dieback, clearing, too frequent fire, weed invasion, and possibly salinisation and waterlogging.

[1] Henry Smolinsky, Agriculture Western Australia.
[2] Andrew Brown, Threatened Flora Coordinator, CALM Threatened Species and Communities Unit
[3] Gregory Keighery, Senior Principal Research Scientist, CALM Science Division.

**TABLE 1: Taxa totally or largely confined to ironstone soils (Gibson *et al.* 2000; Greg Keighery, personal communication )**

| Taxon | Priority Listing (from Atkins 2005) | Busselton ironstone areas | Scott Coastal Plain | Wildlife Conservation Act status | EPBC Act Status | Obligate seeder |
|---|---|---|---|---|---|---|
| *Andersonia ferricola* ms | P1 | + | | | | + |
| *Brachyscias verrucundus* | DRF | + | | CR | - | + |
| *Calothamnus* sp. Scott River (RD Royce 84) (aff. *crassus*) | P2 | + | + | | | + |
| *Calothamnus* sp. Whicher (BJK and NG 230) | P4 | + | | | | + |
| *Calytrix* sp. Tutunup | P2 | + | | | | ? (known to reshoot from base) |
| *Chamelaucium roycei* ms | DRF | + | | VU | VU | + |
| *Darwinia ferricola* | DRF | | + | EN | EN | + |
| *Darwinia* sp. Williamson (GJK 12717) (aff. *apiculata*) | DRF | + | | CR | EN | + |
| *Dryandra nivea* subsp. *uliginosa* | DRF | + | + | EN | EN | + |
| *Dryandra squarrosa* subsp. *argillacea* | DRF | + | | VU | VU | + |
| *Gastrolobium modestum* | DRF | + | | VU | VU | + |
| *Gastrolobium papilio* | DRF | + | | CR | EN | + |
| *Grevillea elongata* | DRF | + | | EN | VU | + |
| *Grevillea maccutcheonii* | DRF | + | | CR | EN | + |
| *Hakea oldfieldii* | P3 | + | | | | + |
| *Lambertia echinata* subsp. *occidentalis* | DRF | + | | CR | EN | + |
| *Loxocarya implexa* ms | | + | | | | + |
| *Loxocarya magna* | P3 | + | + | | | + |
| *Opercularia* aff. *vaginata* (BJK and NG 238) | | + | | | | + |
| *Petrophile latericola* ms | DRF | + | | CR | EN | + |
| *Stylidium* sp. nov (GJK & NG 2955) | | + | | | | + |

Definitions of DRF and Priority ratings for plant taxa occur in the Glossary.
CR=Critically Endangered; EN=Endangered; VU=Vulnerable
BJK=Bronwen Keighery, GJK =Greg Keighery, NG=Neil Gibson

**TABLE 2: Extent and location of occurrences**

| Occurrence Number | Location | Land Tenure | Estimated area |
|---|---|---|---|
| Occurrence 1 and 2 | Ruabon – Tutunup Rd 2 (WONN03, 04) | Rail and road reserves, Nature Reserve and adjacent private land | 65.9 ha |
| Occurrence 3 | Ruabon – Tutunup Rd 3 (WONNEW1) | Rail and road reserves | 1.4 ha |
| Occurrence 4 | Ruabon – Tutunup Rd 4 (WONN06) | Rail and road reserves | 3.8 ha |
| Occurrence 5 | Ruabon – Tutunup Rd 5 (WONN05) | Rail and road reserves | 0.1 ha |
| Occurrence 6 | Oates Road verge (OATESIRON) | Road reserve and Nature Reserve | 0.2 ha |
| Occurrence 7 | Williamson Road east (WIL01) | State Forest - Abba block | 4.2 ha |
| Occurrence 8 | Williamson Road west (WIL03) | State Forest - Abba block | 4.2 ha |
| Occurrence 9 | Smith Road (SMITH01) | State Forest - Treeton block | 9.4 ha |
| Occurrence 10 | Jacka Road (JACKA01) | State Forest - Treeton block and adjacent private land | 7.8 ha |
| Occurrence 11 | Kolhagen Road (SMITH04) | State Forest - Treeton block, road reserve | 0.3 ha |
| Occurrence 12 | Ironstone Gully (IRON01, 02) | State Forest - Treeton block | 7.0 ha |
| Occurrence 13 | Sussex Location 5114 (YIRON) Corner of Jindong-Treeton and Gale Roads | Nature Reserve | 12.5 ha |
| Occurrence 14 | Private land and Nature reserve Kaloorup (PAYNE02, 03, 04) | Nature Reserve and adjacent private land | 14.2 ha |
| Occurrence 15 | Private land Carbanup River | Private land | 7.7 ha |

**TABLE 3: Tenure information for occurrences**

| Occurrence Number | Vesting | Purpose | Tenure |
|---|---|---|---|
| Occurrence 1 & 2 | Conservation Commission<br>Private Freehold<br>Public Transport Authority of WA<br>Shire of Busselton | Conservation of Flora and Fauna<br>Freehold – purpose not listed<br>Rail Reserve<br><br>Road reserve | Nature Reserve<br>Non-CALM Act -Freehold<br>Non-CALM Act Reserve<br>Non-CALM Act Reserve |
| Occurrence 3 | Shire of Busselton<br>Public Transport Authority of WA | Road Reserve<br>Rail Reserve | Non-CALM Act Reserve<br>Non-CALM Act Reserve |
| Occurrence 4 | Public Transport Authority of WA<br>Shire of Busselton | Rail Reserve<br><br>Road Reserve | Non-CALM Act Reserve<br>Non-CALM Act Reserve |
| Occurrence 5 | Public Transport Authority of WA | Rail Reserve | Non-CALM Act Reserve |
| Occurrence 6 | Shire of Busselton | Road Reserve | Non-CALM Act Reserve |
| Occurrence 7 | Conservation Commission | State Forest | State Forest |
| Occurrence 8 | Conservation Commission | State Forest | State Forest |
| Occurrence 9 | Conservation Commission | State Forest | State Forest |
| Occurrence 10 | Conservation Commission | State Forest | State Forest |

| | | | |
|---|---|---|---|
| | Private Freehold | Freehold – purpose not listed | Non-CALM Act - Freehold |
| Occurrence 11 | Conservation Commission | State Forest | State Forest |
| Occurrence 12 | Conservation Commission | State Forest | State Forest |
| Occurrence 13 | Conservation Commission<br>Shire of Busselton | Conservation of Flora and Fauna<br>Road Reserve | Nature Reserve<br>Non-CALM Act Reserve |
| Occurrence 14 | Conservation Commission<br>and Private Freehold | Conservation of Flora and Fauna<br>Freehold – no purpose listed | Nature Reserve<br>Non-CALM Act - Freehold |
| Occurrence 15 | Private Freehold | Freehold – no purpose listed | Non-CALM Act – Freehold |

**Description of Occurrences**

All occurrences are located in the Shire of Busselton.

Occurrences 1 and 2 occur on road, and rail reserve (reserve 12969) and extend onto adjacent private land and nature reserve. Cleared agricultural lands surround all other Ruabon-Tutunup Road occurrences. Neither of the privately owned areas is currently grazed. The northern part of Occurrence 2 occurs on shallow, fast drying sandy loam soils over ironstone. It extends into a CALM Nature Reserve and partly into private property. The southern part of the occurrence extends into adjacent private land, owned by a mining company. Occurrence 1 extends into adjacent private property.

Occurrences 3-5 are located on disused railway reserve 12969, and on the adjacent road reserve along Ruabon-Tutunup Road that is managed by the Shire of Busselton. The rail reserve is vested in Public Transport Authority of Western Australia, but has been leased by the Shire of Busselton since 1998, and the Ruabon-Tutunup Rail Reserve Preservation Group manages the site. The rail and road reserves were burnt in a hot fire in April 1993. Many of the species in occurrences on these reserves are obligate seeders and taxa could be lost through too frequent fire. In 2004, an area of the road reserve had a heavy mineral spill as a consequence of a truck accident, however this did not affect any part of the ironstone occurrence.

Occurrence 6 is located on a degraded road reserve on Oates Road managed by the Shire of Busselton. Few of the species that originally occurred at the site remain, so the community is considered very highly modified. It is recommended this site be managed for species conservation. Adjacent land on Sussex locations 4049 and 5162 were purchased as part of a program for germination and translocation trials for ironstone taxa being conducted by CALM staff.

Occurrences 7 and 8 occur on the boundary of State Forest in Abba block. Cleared agricultural lands occur to the north of both occurrences. A mineral sands mine occurs immediately to the west and north of Occurrence 8. This area was burnt in a hot fire in 1992 when a controlled burn escaped from adjacent areas of State Forest. Deaths caused by *Phytophthora* species have been detected in both of these occurrences. This is discussed further under threatening processes. Also, canker probably caused by *Armillaria luteobubalina* has swept through Occurrence 8 resulting in massive deaths of *Dryandra nivea* subsp. *uliginosa*.

Occurrences 9, 10, 11 and 12 are in Treeton block of State Forest. Cleared agricultural lands occur to the north of Occurrences 10 and 11. Occurrence 9 extends into private property. A buffer area of native vegetation surrounds Occurrence 12, which is located in an area called Ironstone Gully. Occurrence 9 was burnt in a hot fire in 1993. Much of occurrence 10 was been mined for gravel and an area was recently burnt. However, portions of the site are regenerating well from seed and rhizomes. About half of Occurrence 10 is on private land. Most of Occurrence 11 and some of Occurrence 10 were mistakenly cleared to mineral earth in 1995 for road widening. At Occurrence 11, topsoil was then redistributed over the site and it was fenced. The site has since regenerated quite well.

Occurrence 13 is located on Sussex Location 5114 (previously part Sussex Location 2650), which was purchased in 1999 with funds from CALM and Environment Australia. Cleared agricultural lands surround this site. The occurrence was last burnt in the late 1960s (R. Smith[4], personal communication).

[4] Russell Smith, Plant Ecologist, CALM South West Region

Occurrence 14 is located in Kaloorup. The ironstone community occurs on soils that range from surface rock with shallow pockets of clay soil to grey sandy soils over ironstone rock at varying depth. The property was purchased in 2004 with CALM and Environment Australia funds, with some contribution from Cable Sands Pty Ltd. The occurrence extends into the adjacent property to the east and is surrounded by agricultural land including vineyards. Remnant vegetation surrounds the occurrence within the reserve. The occurrence extends into adjacent private property.

Occurrence 15 is located on private property. It is a small occurrence with shallow clay soil over sheet rock. The occurrence was discovered when the landowner enquired about a Conservation Covenant. Cleared Agricultural lands surround the occurrence to the north and south. The occurrence has recovered well since grazing ceased five years ago.

Data on all known occurrences of threatened ecological communities are held in the threatened ecological communities database at CALM's Wildlife Research Centre, Woodvale.

**Biological and ecological characteristics**

The ironstone soils near Busselton are seasonally inundated (surface water in wetter months). Many of the plant taxa present, including priority and DRF species, are restricted to sites that experience shallow seasonal inundation. The herb layer that is characteristic of this community would also probably rely on inundation in the wetter months.

Tille and Lantzke (1990a, 1990b) mapped the soils and landforms on private land in the Busselton-Margaret River-Augusta area, and the following descriptions are from those publications. Although most occurrences of the community occur on public land, and the soils were not mapped on public land by Tille and Lantzke (1990a, 1990b), they are adjacent to private property, and soil and landform units can be interpreted. The eastern occurrences of the community (Occurrences 1-8, 14 and 15) and two of the western occurrences (Occurrence 14 & 15) occur on 'Abba Wet Ironstone Flats' (Awi) and 'Abba Wet Flats' (Aw). 'Abba Wet Ironstone Flats' are described as "winter wet flats and slight depressions with shallow red brown sands and loams over ironstone (ie bog iron ore soils)". 'Abba Wet Flats' are defined as "winter wet flats and slight depressions with sandy grey brown duplex (Abba) and gradational (Busselton) soils". The remaining western occurrences (Occurrences 9-13) are on 'Yelverton Wet Flats' (Yw) or 'Yelverton Wet Ironstone Flats' (Ywi). The former are described as "poorly drained flats with mottled pale grey (Mungite) soils". The Yelverton Wet Ironstone Flats are defined as "winter wet flats with shallow red brown sandy and loamy soils over sheet laterite (bog iron ore)".

All of the land units on which the community occurs are poorly drained flats that are waterlogged in winter. Tille and Lantzke (1990c) describe additional characteristics of these land units. Winter water tables are observed to be either very close to or at the soil surface. In addition, degradation from waterlogging and salinity were observed in some areas located on the two Abba land units, but were not detected in the two Yelverton land units. Tille and Lantzke (1990c) also state that salinity may become a major problem in future for areas located on the 'Abba Wet Flats'.

Plant taxa that commonly occur in the community are listed in Appendix 1. The average number of species recorded in 100 $m^2$ plots is 53.7 (Gibson *et al.* 1994), which indicates a high level of species richness. The mean weed frequency recorded in the same plots in the community is 4.9 (Gibson *et al.* 1994), which is quite low. Weed cover was also low.

**Hydrology**

Hydrological data on the ironstone community at Busselton are derived from the personal observations of those who originally identified the plant community (G. Keighery and N. Gibson[5] personal communication); from Tille and Lantzke (1990c); from data collected by the Water and Rivers Commission and the local Land Conservation District Committee; from Hirschberg (1989) and Smith (1994).

[5] Neil Gibson, Senior Research Scientist, CALM Science Division

Historically, water levels have been very close to the surface where the ironstone occurs. The ironstone is believed to form as a result of precipitation of iron oxides associated with fluctuating groundwater levels (Smith 1994). Seasonal inundation is limited to very shallow surface water during the winter months (Tille and Lantzke 1990c). Inundation usually persists for a period of around three months, although some occurrences may typically have little surface water. The surface water may be linked to the water table in some areas. This may have implications for increasing threat of waterlogging and salinisation if groundwater levels have risen historically and are continuing to rise.

Clearing is likely to have increased surface runoff and recharge of the groundwater in the localised area. Degradation from waterlogging observed in some occurrences of this community (Tille and Lantzke 1990c) indicates that there has probably been an increase in groundwater levels.

Hirschberg (1989) measured levels of salinity in the groundwater in the Busselton area and found some significant amounts, although levels were highest at points closer to the coast. Salinity was less than 500 milligrams per litre total dissolved solids (mg/L T.D.S; Hirschberg 1989) where the community occurs, which is quite fresh. Salinity was highest in the more northerly sites (Occurrences 1-8), at around 200-400 mg/L T.D.S., as compared to less than 150 mg/L T.D.S in the southerly sites (Occurrences 9-13).

The Department of Agriculture and the local Land Conservation District Committee have recently measured salinity of surface waters in the Busselton area and found significant levels of salt at specific sites (W. Oldfield[6] personal communication). Data on salinity of surface waters were collected along a transect across the Swan Coastal Plain at Busselton (W. Oldfield personal communication). These data indicate that salty water is very patchy and may be associated with upwelling of saline groundwater, and/or enhanced accumulation of surface salt by deposition and evaporation, at specific sites (W. Oldfield personal communication). In particular, this patchiness was noted along the Ruabon-Tutunup Road near Occurrences 1-5.

The Southern Ironstones have been identified as groundwater dependant ecosystems and as a consequence any changes in the level of groundwater may have a deleterious affects on the occurrences of this community.

Within the Swan Coastal plain there are 3 main aquifers, the Superficial, Leederville and Yarragadee. The superficial aquifer consists of a thin layer of clays and sands that lie over the Swan and Scott Coastal Plain and occur to a depth of 20m. The Leederville aquifer is a multilayered body of sand, clay and shale sediment up to 150m thick and extends over the majority of the Blackwood Groundwater area (which consists of the Swan and Scott Coastal plain, and the Blackwood Plateau). Underlying the Leederville, the Yarragadee aquifer is the largest and most extensive aquifer of the south west of Western Australia and is about 1,200 m thick (Department of Environment 2003).

The Southern Ironstone occurrences are located within the Bunbury-Capel area (part of the Swan Coastal Plain). The three main aquifer zones, the Superficial, Leederville and Yarragadee, occur within the sand or sandstone units of the formations located in the Bunbury-Capel area (URS 2003). Currently, approximately 25GL/year and 47GL/year is allocated for abstraction from bores in the Leederville and Yaragadee aquifers, respectively. Trends in groundwater levels in these aquifers are towards a decrease in levels attributed to abstraction for irrigation, town water supply, mining, horticulture and industrial uses, and possibly as a consequence of declining rainfall.

The Superficial aquifer is recharged by rainfall and leakage from underlying aquifers. Historical records show the groundwater level trends are stable or declining long-term (Gillgallon 2003 - cited in URS 2003). Changes in groundwater level within this aquifer would have the most influence upon the associated ironstone community as plant roots have been found to occur just above the summer saturation zone within the formation (B. Jennings[7], personal communication). The groundwater in this superficial aquifer where the ironstone occurs demonstrate stable trends in groundwater level.

[6] Will Oldfield, Department of Agriculture, Bunbury
[7] Barbara Jennings, Environment Officer, Cable Sands Pty Ltd

The Leederville aquifer, underlying the Superficial aquifer, is recharged from rainfall and minor streams in the Blackwood Plateau and from other groundwater movement in other formations (Yoganup and Bassendean Sand). This aquifer is widely used on the Swan Coastal Plain for town water supply, industrial use and horticulture. Occurrences 9-15 of the Southern Ironstone occur in an area where trends show decreasing water level and/or large seasonal variations, while Occurrences 1-8 are located in an area where groundwater trends are towards decreasing or stable levels.

The Yaragadee aquifer is recharged via the overlying Superficial formation and possibly the Leederville formation. The eastern occurrences (Occurrences 1-8) of the Southern Ironstone occur in the area where ground water levels show a long-term decline in this aquifer.

**Guide for decision-makers**

Any on-ground works (clearing, firebreaks, roadworks, spraying of herbicides, burning, proposals with potential to cause changes to water levels or quality, etc) in the immediate vicinity of the Southern Ironstone community will require assessment. Proponents should demonstrate that on-ground works will not have an impact on the community, or on its habitat or potential habitat.

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

The habitat critical to the survival of the Southern Ironstone community comprises:

- the area of occupancy of known occurrences;
- similar habitat adjacent to important occurrences (ie within approximately 200m), i.e. poorly drained flats, depressions or winter wet flats with shallow red brown sands and loams over massive ironstone
- remnant vegetation that surrounds or links several occurrences (this is to provide habitat for pollinators or to allow them to move between occurrences; and
- the local catchment for the surface and groundwaters that maintain the winter-wet habitat of the community (the plant community would be dependent on maintenance of the local hydrological conditions).

Given that the community is listed as Critically Endangered, it is considered that all known occurrences of the community, and the catchments for the surface and groundwater that support this wetland habitat are critical to the survival of the community.

**Benefits to other species/ecological communities**

There are a total of 11 Declared Rare Flora (*Brachyscias verrucundus, Gastrolobium modestum, Gastrolobium papilio, Chamelaucium roycei* ms, *Darwinia* sp. Williamson, *Dryandra nivea* subsp. *uliginosa*, *Dryandra squarrosa* subsp. *argillacea, Grevillea elongata Grevillea maccutcheonii, Lambertia echinata* subsp. *occidentalis,* and *Petrophile latericola* ms) and six Priority species (*Andersonia ferricola* ms, *Calothamnus* sp. Scott River, *Calothamnus* sp. Whicher, *Calytrix* sp. Tutunup, *Hakea oldfieldii*, and *Loxocarya magna*) that occur in the Busselton Ironstone community. Recover actions implemented to improve the quality or security of the community are likely to improve the status of species that are components of the community.

**Role and interests of indigenous people**

An Aboriginal Sites Register is kept by the Department of Indigenous Affairs, and lists one Artefact/Scatter site and a camping site within the vicinity of the occurrences. Indigenous communities interested or involved in the region affected by this plan have not yet been identified, however, implementation of recovery actions under this plan includes consideration of the role and interests of indigenous communities in the region.

**Social and economic impacts**

The implementation of this recovery plan has the potential to have some social and economic impact, where occurrences are located on private property and other areas not specifically managed for conservation such

as a disused rail reserve, and a road reserve. Recovery actions refer to continued liaison between stakeholders with regard to these areas. Several occurrences occur on private land and negotiations will continue with the land managers with respect to the future management of these occurrences. Occurrence 7 and 8 occur adjacent to a mineral sands mine and negotiations are continuing to minimise the impact of the mining on the community. There is a mining lease over part of Occurrence 2, although no mining is currently occurring at the site. Recovery actions refer to continued liaison between stakeholders with regard to all of these areas.

**Affected Interests**

Occurrences of the Southern Ironstone community occur within the Shire of Busselton. They also occur on land managed by Main Roads, CALM, Ruabon-Tutunup Rail Reserve Preservation Group and on land managed by six different private owners.

**Evaluation of the Plan's Performance**

CALM, in conjunction with the South West Region Threatened Flora and Communities Recovery Team will evaluate the performance of this Interim Recovery Plan. The plan is to be review within five years of its implementation. Any changes to management/recovery action will be documented accordingly.

**International Obligations**

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. However, as the community not specifically listed under any international agreement, the implementation of other international environmental responsibilities is not affected by this plan.

**Historical and Current Threatening Processes**

**Clearing**

Clearing for agriculture has been extensive on the heavy soils on the eastern side of the Swan Coastal Plain, with some 97% of all vegetation in the area cleared historically (Keighery and Trudgen 1992; CALM 1990). The vegetation on the ironstone soils near Busselton occurs on this portion of the plain in an area very highly cleared for agriculture and has suffered almost total destruction.

The presence of TECs is considered by the Department of Environment when evaluating the impact of any proposed development. As a result of recent amendments to the *Environmental Protection Act 1986*, any clearing of native vegetation requires a permit, unless done for an exempt purpose. Threatened ecological communities have been defined under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, as environmentally sensitive areas. Provisions in these regulations that allow day-to-day routine vegetation clearing activities without a permit do not therefore apply to clearing within threatened communities. Any clearing proposals in a TEC are to be undertaken under a specific permit.

The occurrence on Jacka Road (Occurrence 10) has been partially cleared and gravel extracted from the site. Some of the original taxa are, however, regenerating in the gravel pit in the absence of subsequent disturbance. Mining tenements exist over most of the northern occurrences of the community (Occurrences 1-8). Other areas of the community were probably cleared historically for gravel extraction, and have been grazed, cropped or otherwise disturbed since being mined and have not regenerated.

Illegal firewood collection has occurred in Treeton block near Occurrence 9 but minimal activity has occurred in the last 2 years (A.Webb[8] personal communication). Firewood collection has the potential to cause significant damage through crushing and clearing of vegetation and the spread or amplification of disease (see below).

[8] Andrew Webb, Nature Conservation Officer, CALM Blackwood District

**Introduction of Disease**

A number of plant taxa that occur in the community, particularly members of the families Proteaceae and Epacridaceae, are very susceptible to dieback caused by *Phytophthora* species. Three of the ironstone DRF taxa, *Dryandra nivea* subsp. *uliginosa*, *Dryandra squarrosa* subsp. *argillacea* and *Lambertia echinata* subsp. *occidentalis*, are especially susceptible. All occurrences except Ironstone Gully (Occurrence 12) are thought to be infected with the disease (R. Smith personal communication). Dieback has the potential to seriously impact the community and, indeed, species diversity, through loss of remaining populations of some taxa.

Since the last Interim Recovery plan, deaths in Southern ironstone shrublands apparently due to *Phytophthora* continue in some areas even where phosphite spraying has been conducted to help reduce the impact of the disease. The deaths are generally scattered and do not form 'fronts' typical in other vegetation.

Unexplained deaths were noted in *Dryandra nivea* subsp. *uliginosa* at the Williamson Road west site (Occurrence 8) in the mid 1990s. These are likely to have been caused by another fungal disease - *Armillaria luteobubalina* (F. Bunny[9] personal communication). It is likely that this disease is spread by root to root contact, and airborne spores may also have an involvement (F. Bunny personal communication). The random patterns of deaths at the Williamson Road site are more consistent with aerial spread of the disease, however (B. Keighery and N. Gibson personal communication). The disease has been monitored regularly and no further outbreaks have since been detected.

**Weed invasion**

Disturbances such as fires and grazing can predispose areas to weed invasion if weed propagules are present. All of the occurrences of this community are close to agricultural areas that act as weed sources, and would be vulnerable to weed invasion following any disturbance. Current weed levels in most occurrences are still quite low, however, with the possible exception of areas immediately adjacent to the rail line on the Ruabon-Tutunup Road (Occurrences 1-5).

There are tracks through most occurrences of the community. Weeds have invaded to varying extents along these tracks and such areas should be considered a high priority for weed control. In particular, piles of soil scraped from tracks often contain high concentrations of weeds and act as a source of weed invasion. Such piles should be avoided when tracks are cleared, or be removed where they already exist.

A weed control program would be necessary to maintain or improve the current condition of occurrences of the community in the long term. Panetta and Hopkins (1991) state that the aims of weed control are to maintain the pre-invasion condition of the habitat (prevention); control or arrest ongoing weed invasion (intervention); and reverse the degraded condition of the habitat where applicable (rehabilitation). A weed control program would involve the following steps (adapted from Panetta and Hopkins 1991):

1. Accurately mapping the boundaries of weed populations.
2. Selecting an appropriate herbicide or other method of weed control after determining which weeds are present.
3. Controlling weeds that pose the greatest threat to the community in the early stages of invasion where possible, e.g. invasive perennial grasses, *Watsonia*.
4. Rehabilitation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

The highest priority will be to control weeds, in the early stages of invasion where possible, that pose the greatest threat to the community, eg some perennial grass weeds and *Watsonia*. Appropriate methods of weed control are found in Brown and Brooks (2002) and may include hand weeding or localised application of herbicide.

[9] Felicity Bunny, formerly Department of Environment, Perth

**Grazing**

Grazing of the community is likely to have caused alterations to the species composition, by the selective grazing of edible species, the introduction of weeds and nutrients, trampling and general disturbance. The portion of the Oates Road occurrence (Occurrence 6) that occurred on private land has been severely degraded by grazing and only larger shrubs remain. The community is therefore highly modified and the site should be managed for threatened species. This site contains the only remaining wild population of *Grevillea mccutcheonii*. Other occurrences currently or previously located on private land (portions of Occurrences 1 and 2; and Occurrence 13 and 15) may be grazed, or have been grazed historically. The significance of this impact in these occurrences is not known.

**Altered fire regimes**

Fires are likely to have a significant effect on the vegetation composition in Mediterranean ecosystems such as those in the south-west of Western Australia (Abbott and Burrows 2003).

Different ecosystems may require particular fire regimes to assist regeneration. It seems likely that too frequent burns, post-fire grazing (eg by rabbits) as well as long periods of fire exclusion, will all be detrimental to the community. If an appropriate frequency of fires is exceeded however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may become senescent and unable to regenerate. Almost all of the Declared Rare and Priority flora, in particular, that occur in this community are obligate seeders (see Table 3). Therefore, fires will need to occur at appropriate intervals and possibly at the appropriate season and intensity to maintain the composition and structure of this plant community. There are few data available which allow the optimal fire regimes for this ironstone community to be determined. What constitutes an appropriate fire regime will require investigation of the population dynamics of seeder species in this community.

The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the original native species in the herb layer.

All of the occurrences on the Ruabon-Tutunup Road (Occurrences 1-5), the Williamson Road occurrences (Occurrences 7 and 8) and Occurrence 9 in Treeton block of State Forest have been burnt since 1993. Too frequent fires cause increased weed invasion, especially in smaller remnants such as those along Ruabon-Tutunup Road. Fire also appears to cause increased plant deaths in communities already infected with dieback.

**Hydrological changes**

A number of the occurrences are located on the boundary of areas that are highly cleared, with uncleared forest areas upslope (Occurrences 7-12). Surface flow and groundwater recharge may be increased further in these areas if additional parts of the catchment are cleared. Occurrence 10 (Jacka Road) occurs on a ridge, however, and is unlikely to be affected by altered hydrology as a consequence of further clearing upslope. The occurrences along Ruabon-Tutunup Road (Occurrences 1-5), on Oates Road (Occurrence 6), Jindong-Treeton Road (Occurrence 13) and on private property in Carbanup River (Occurrence 15) are completely surrounded by cleared agricultural areas while Occurrence 14 has uncleared vegetation on the western border of the reserve. Additional clearing of the catchment with subsequent changes in surface flow or groundwater levels seems unlikely but groundwater levels may still be rising as a consequence of historical clearing.

Occurrence 8 is located adjacent to the southern part of a mineral sands mine. To enable mining, water was abstracted to lower the groundwater level. Lowering of the water table began in early March 2004 with the commencement of mining. As a condition of the mining adjacent to the occurrence, an artificial recharge system (ARS) was installed to maintain groundwater levels within the community. Backfill of the southern end of the pit was completed in January 2005 with a rapid response in the water levels (still with the ARS being maintained). Monitoring of groundwater levels and plant health is continuing. However, when CALM staff visited the site in February 2005 an area of 100 by 60 m was found to be highly stressed, possibly as a consequence of hydrological change or drought.

The Water Corporation propose to abstract 45 gigalitres per annum from the southern flowing portion of the Yarragadee Formation (known as the Yarragadee aquifer) from a proposed borefield in the Blackwood Groundwater area (URS 2003). URS (2003) states that it is likely that drying as a consequence of climate change will decrease the water levels in the superficial aquifers, and that any additional impacts of lowering of groundwater as a consequence of abstraction will exacerbate these changes. The likelihood that groundwater decline would impact on the Busselton Ironstone community is rated as relatively low however, but requiring further investigation and clarification (URS 2003). There is currently no monitoring in place to provide information about the water regime of important groundwater dependent ecosystems in the Blackwood Groundwater area, and apparently no plans to complete this work, even though current levels of abstraction from the Yarragadee aquifer are about 7.8 gigalitres (GL) per year, mainly from the Scott Coastal Plain (URS 2003). URS (2003) recommend that information gathered in the next phase of the proposal be collated and updated for integration into the models being developed for assessing the ecological values and the associated ecological water requirements for specific species and communities, such as this community.

Altered periods of ponding may affect the timing of growth of herbs in the understorey, and may also affect the species composition of the community by favouring different taxa.

Surface water in occurrences adjacent to farm lands may be polluted by animal droppings and artificial fertilisers. This is likely to favour weeds as they are adapted to higher levels of nutrients than native species.

**Salinisation**

Hydrological changes such as increased groundwater levels, depth or period of inundation may also cause salt accumulation near the surface. This has been occurring in areas of the southern Swan Coastal Plain since around the 1950s as a result of clearing (Smith and Ladd 1994).

Tille and Lantzke (1990c) record salinisation as a source of existing degradation and a possible cause of major problems in the future for the eastern occurrences and two of the western occurrences of the community (Occurrences 1-8 and 14 and 15). This is supported by Short and McConnell (2000), who show that the area is at medium to high risk in terms of dryland salinity within the next 50 years. No existing salinisation (or waterlogging) problems were recorded by Tille and Lantzke (1990c) for the land units occupied by the more western occurrences (Occurrences 9-13).

The levels of salinity in the community will be monitored to determine if salinisation poses a major threat to the community, and the sources of the salt determined. Remedial actions such as replanting with deep rooted vegetation in strategic parts of the catchment may be necessary if monitoring indicates salinisation is a problem.

**Road, track and firebreak maintenance**

Road, track and firebreak maintenance activities threaten the community. Threats include actions such as creation of new firebreaks, grading of road reserves, road widening, spraying of chemicals, constructing drainage channels and mowing the roadside vegetation to improve visibility and reduce the fire risk. These disturbance events often encourage weed invasion into the adjacent habitat, as well as causing damage to vegetation, and may spread dieback.

Several of the occurrences occur on road reserves and are subject to road maintenance and accidents. Tutunup Road (Occurrences 1-5) is currently used for transporting heavy minerals from an Iluka mine to the east. In July 2004, a trailer containing heavy mineral concentrate from Iluka rolled over on Tutunup Rd, spilling heavy mineral concentrate and damaging the flora. The spoil was removed with a non-intrusive vacuum, with no incursion into the vegetation by machinery. The gravel road base and road shoulders were replaced with limestone (dieback free).

**Mining**

Currently mining threatens only one occurrence of Southern Ironstone, although a portion of Occurrence 2 is currently under a mining lease for exploration and survey. Liaison between CALM and the mining company is ongoing.

As previously mentioned under hydrological changes, Occurrence 8 is located adjacent to a mineral sands mine. The impact of manipulation of groundwater level through the Artificial Recharge System (ARS) is unknown at the time writing this IRP. However, a site visit in February 2005 found an area of 100 by 60 m affected by stress, possibly induced by hydrological change or drought. See existing recovery actions for further information. Mining and backfill of the mining pit adjacent to the occurrence was completed in January 2005.

### 1.2. Conservation status

The community meets criterion B (ii) as follows, for Critically Endangered (from English and Blyth 1997):

B ii) current distribution is limited and there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes.

### 1.3. Strategy for recovery

To identify, and influence the management of, the areas in which the community occurs, so maintaining natural biological and non-biological attributes of the sites and the current area covered by the community.

To conduct appropriate research into the ecological characteristics of the community to develop further understanding about the management actions required to maintain or improve its condition.

## 2. RECOVERY OBJECTIVE AND CRITERIA

### Objective

To maintain or improve the overall condition of the Shrublands on southern Swan Coastal Plain Ironstones community and reduce the level of threat, with the aim of reclassifying it from Critically Endangered to Endangered.

### Criteria for success

An increase of 10% or more in the area, and/or increase in the number of occurrences of this community under conservation management.

Maintenance in terms of diversity and basic composition of native plant taxa (as described in Gibson *et al*. 1994, Gibson *et al*. 2000) taking account of natural change in the community over time. This will be measured as a loss of no more than 10% of the native plant taxa in any occurrence over the life of the plan.

Improvement in the condition of the habitat, in terms of reduction of numbers of exotic species and of other threatening processes as defined in this document. This will be measured as follows:

- reduction of 10% or more in the cover of exotic plant taxa in any occurrence,
- groundwater levels and quality maintained within the parameters expected as a consequence of natural change, by comparison with monitoring results for the Blackwood Groundwater area in areas remote from development.

### Criteria for failure

A decrease of 10% or more in the area covered by the community, and/or decline in the number of occurrences of this community under conservation management.

A decline in terms of diversity and basic composition of native plant taxa (as described in Gibson *et al*. 1994, Gibson *et al*. 2000) taking account of natural change of the community over time. This will be

measured as a loss of more than 10% of the native plant taxa in any one occurrence over the life of the plan.

Decline in the condition of the habitat, in terms of increase in numbers of exotic species and other threatening processes as defined in this document. This will be measured as follows:

- an increase in the cover of exotic plant taxa of more than 10% in any occurrence of the community
- groundwater levels and quality not maintained within the parameters expected as a consequence of natural change, by comparison with monitoring results for the Blackwood Groundwater area in areas remote from development.

## 3. Recovery Actions

Note: The responsible authority is frequently listed as the relevant CALM District. This refers largely to initiating and guiding actions. However, in general the relevant CALM District, the Species & Communities Branch (SCB) and the Recovery Team share the primary responsibility for securing funds for recovery actions.

### Existing Recovery Actions

Since the previous Interim Recovery Plan, many of the recovery actions within the plan have been implemented.

The extent and boundaries of all occurrences have been mapped using aerial photographs and soil and landform mapping (Tille and Latzke 1990a and b). The extent of DRF species at Occurrence 7 and 8, and the boundaries of Occurrences 7 and 8, and Ruabon-Tutunup (Occurrences 1-5) have been mapped using differential GPS.

In 2002, with assistance from CALM staff, local catchment group Geocatch developed a brochure about the Abba plains that mentions the Southern Ironstone community. Also, information brochures have been produced for five of the critically endangered DRF taxa that occur within this ironstone community (*Grevillea maccutcheonii*, *Lambertia echinata* subsp. *occidentalis*, *Darwinia* sp. Williamson, *Gastrolobium papilio* and *Petrophile latericola*).

DRF markers have been installed at Oates Road (Occurrence 6), Williamson Road (Occurrences 7 and 8), Kolhagen Road (Occurrence 11), Jacka Road (Occurrence 10), and Smith Road (Occurrence 9), and on Western Power poles to indicate TEC occurrence at Occurrence 2. In addition, Ruabon-Tutunup Road has been designated a 'Flora Road' with the appropriate signs installed.

Translocations have been undertaken for five of the ironstone DRF taxa. Translocations were conducted at Oates Rd (reserve adjacent to Occurrence 6 and a highly disturbed ironstone area) and at Negus block (part Occurrence 2). Translocated species were: *Gastrolobium papilio* (2001 and 2002); *Petrophile latericola* (2001); *Grevillea maccutcheonii* (2000, 2001 and 2002); *Darwinia* sp. Williamson (2001); and *Lambertia echinata* subsp. *occidentalis* (2000, 2001), and this taxon was also translocated to Williamson Rd (Occurrence 8 in 2000). A watering system was installed at the Oates Road site in June 2000 to enhance survival of translocated plants.

Translocated plants were grown from either cuttings or seed at Botanic Garden and Parks Authority (BGPA). Translocations appear to have a higher survival at Negus block than Oates. Translocated plants of *Grevillea maccutcheonii* have produced seed which has since germinated. Plants from the original population along the roadside appear to be recruiting 'naturally' as a response to road grading.

Trials have been conducted at Oates Road with sowing seed on raised gravel beds and using branches/brushing as a seed source of common ironstone species. The maintenance of adequate water supply was problematic, with below average rainfall and difficulty in maintaining the components of the irrigation system. As a result of new growth around irrigation systems, fauna such as rabbits, insects and bandicoots have been attracted during the summer drought.

In early 2005, all relevant managers of private property that contains the Southern Ironstone community

were notified of the presence of the community and its importance. Managers of land that contains the DRF that are components of the community have also been notified.

*Phytophthora* is present at several occurrences, however, it has been observed as scattered deaths within the community rather than forming a front. Aerial phosphite spraying of sites with susceptible species and Critically Endangered DRF has been conducted. Williamson Road (Occurrence 7 and 8) is sprayed annually due to the high number of susceptible DRF that occur only at that occurrence. All other sites are sprayed every one to two years.

Several occurrences have been fenced to prevent access and help minimise spread of *Phytophthora*. To date, the western boundary of Williamson Road has been blocked, and occurrences at Ruabon-Tutunup Rd (Occurences 1-5), Jacka Road (Occurrence 10), Negus block (part Occurrence 2), Oates Road (Occurrence 6), Williamson Rd (Occurrence 7 and 8), Gale Road (Occurrence 13) and Occurrence 14 are all fenced from stock.

Interim Recovery plans have been developed for six of the Declared Rare Flora (DRF) present in the Southern Ironstone community.

Monthly groundwater measurement are conducted by the Department of Environment using piezometers established along Ruabon-Tutunup Road and by Cable Sands Pty Ltd using piezometers at Oates Road and Williamson Road.

Weed control has mainly been undertaken at Negus block and Oates Reserve, which are highly modified sites with high weed loads. There has been control of major weeds, such as kikuyu (*Pennisetum clandestinum*) and pennyroyal (*Mentha pulegium*) at Negus block (Occurrence 2). Guildford grass (*Romulea* sp.) control has also been trialed at Negus block and Oates Reserve. Herbicide treatment, predominately Roundup and some Fusilade, has been used at Oates Rd in conjunction with slashing treatment. *Watsonia* control has been undertaken at the Ruabon-Tutunup Rd occurrences.

Seed has been collected by CALM's Threatened Flora Seed Centre (TFSC) from seven ironstone species, *Brachysema papilio*, *Darwinia* sp. Williamson, *Dryandra nivea* subsp. *uliginosa*, *Grevillea mccutcheonii*, *Hakea oldfieldii*, *Lambertia echinata* subsp. *occidentalis* and *Petrophile latericola*. Seed is stored at CALM's TFSC at -18°C. The TFSC test the viability of the seed initially and after one year in storage.

Several areas of land have been purchased since 1999. Negus block (part of Occurrence 2) was purchased in 1999. Land adjacent to Occurrence 6 at Oates Road was purchased by CALM in 1997 and 2003. The Payne Road occurrence was purchased in April 2004 with combined funds from CALM, a grant from the Commonwealth Department of Environment and Heritage and a donation from Cable Sands Pty Ltd.

An artificial recharge system (ARS) was established on the western and northern sides of the Williamson Road TEC (Occurrences 7 and 8) to maintain the groundwater level and prevent plants deaths in the TEC due to mine pit dewatering. In early 2005, there was evidence of stress in the north west corner of Occurrence 8 in several deep and shallow rooted species. This stressed area was 100 m long by 60-80 m wide extending from the northwest corner to the south east. Ninety percent of the vegetation in this area is severely stressed and has the potential for complete collapse. Shallow rooted species, such as *Caustis dioica*, and deep rooted species such as *Corymbia calophylla* (Marri) appear to be equally affected by the stress event. Healthy vegetation occurs adjacent to this area. This event has potential for a massive impact on the Critically Endangered *Gastrolobium papilio* and *Darwinia* sp. Williamson, as a large proportion of the populations occur within this zone of stress and this site is the only known locality for the single wild populations of each of these taxa. It is not known if changes in the water table and/or *Phythophthora* impacts are implicated in the stress event.

Immediate action was undertaken to determine the cause and lessen the impact on *Gastrolobium papilio* in particular, as the species is confined to a very small area. Aerial photographs and on-ground mapping using a differential GPS were utilized to determine the extent of the stress event within the occurrence. *Darwinia* sp. Williamson and *Gastrolobium papilio* were remapped and plant health scored to determine priority for watering with drip irrigation. Monitoring of vegetation health, and plant water potential (i.e. if plants are

under stress due to the dewatering) are being conducted quarterly at Williamson Road. It is intended that new bores will be placed to determine the depth to the water table within the area of stressed vegetation.

**Future Recovery Actions**

### 3.1. Coordinate Recovery Actions

The South West Region Threatened Flora and Communities Recovery Team was formed in 1996 and covers all Threatened Ecological Communities and threatened flora in CALM's South West Region. The recovery team will continue to coordinate recovery actions for the Southern ironstone community and other Declared Rare Flora and Threatened Ecological Communities in their region. They will include information on progress in their annual reports to CALM's Corporate Executive and funding bodies.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $2,000 per year
**Completion date**: Ongoing

### 3.2. Liaise with relevant groups and individuals to implement recommendations

Some of the occurrences of the community are managed by authorities other than CALM, or are privately owned. The involvement of land managers, local landholders and industry in the recovery of the community wherever possible and practical is therefore essential to the recovery process. Input and involvement will also be sought from any Indigenous groups that have an active interest in areas of the Southern Ironstone community.

Close liaison with the Water Corporation will be required to ensure that the knowledge gaps, and monitoring required to clarify the situation with regard to any possible impacts of the proposal to abstract water from the Yarragadee aquifer on this community, are addressed.

The occurrences along the Ruabon-Tutunup Road (Occurrences 1-5) are managed by Westrail for the Minister for Railways, and by the Shire of Busselton. As mentioned previously, the Ruabon Tutunup Rail Preservation Group actually implement on-ground management actions for the site. Occurrences 1 and 2 extend into private land. A mining company is one of the owners of some parts of these occurrences and may wish to become more involved in conservation of the community. Mining and/or exploration tenements are held over areas that contain the community. Occurrence 10 also extends onto private land.

**Responsibility**: CALM (Blackwood District; SCB) through the SWRTFCRT
**Cost**: $2,500 per year for all liaison (not including vehicle costs)
**Completion Date:** Ongoing

### 3.3. Monitor the extent and boundaries of occurrences

To date many of the occurrences have been manually mapped or mapped using aerial photographs, with Occurrence 7 and 8, and Ruabon-Tutunup (Occurrences 1-5) remapped using differential GPS. All Southern Ironstone occurrences will be remapped using differential GPS to increase accuracy.

Accurate GPS mapping of community boundaries has commenced and a Geographic Information System database has been developed. Extent and boundary information will continue to be updated on the threatened ecological communities database as recommended in English and Blyth (1997), as well on the District's Geographic Information System database.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $1,200 first year, $500 to monitor every second year
**Completion date**: Ongoing

### 3.4. Map habitat critical to survival

Although habitat critical to survival is described in Section 1, the areas as described have not yet been mapped and that will be done under this action. If any additional occurrences are located, then this habitat will also be determined and mapped for these locations.

**Responsibility**: CALM (Blackwood District, SCB) through the SWRTFCRT
**Cost**: $2,000 in the first year
**Completion date**: Year 1

### 3.5. Disseminate information about the community

To prevent accidental destruction or damage to the community (for example, through disturbance caused by illegal timber cutting) and gain public support for its conservation, notification letters providing information about the community have been sent to all stakeholders including management bodies, landholders, and managers of land that contains the community. The letter included information from the threatened ecological communities database, and maps indicating the location of the community. Information about private land will only be disseminated if permission is granted by the landholder. This action is recommended in English and Blyth (1997).

Local CALM staff will ensure regular liaison with managers of land that contains the community to ensure threatened ecological community information is up to date.

A publicity campaign utilising local media and poster displays in prominent areas will be undertaken to encourage awareness about this threatened ecological community. Information on the community was included in an issue of Landscope (English *et al.* 1996) and reprints of this article were widely distributed to relevant groups and individuals.

Signs will also be erected on site, where appropriate, to indicate the significance of the community and the illegality of timber cutting.

**Responsibility**: CALM (Corporate Relations Division Perth, Blackwood District, SCB) through the SWRTFCRT
**Cost**: $500 per year
**Completion date**: Ongoing

### 3.6. Design and implement a program for monitoring flora

Occurrences will be monitored every two years to provide information on condition. This information will be added to the threatened ecological communities database as recommended in English and Blyth (1997). The method of assessment will be determined in consultation with Science Division, and is dependent upon the desired outcome of the monitoring. Data collected will include weed levels, plant species diversity, species composition and plant health.

Data will be entered on a database program and unfamiliar plant species will be collected (except DRF). Following the second monitoring period, data will be analysed and compared as part of the full Recovery Plan, if developed.

**Responsibility**: CALM (Blackwood District, Science Division) through the SWRTFCRT
**Cost**: $6,000 every second year for field survey, specimen identification, and databasing for 1 monitoring period. Cost of quarterly monitoring of vegetation health at Occurrences 7 and 8 $20,000 pa.
**Completion date**: Ongoing

### 3.7. Monitor dieback

Priority areas for dieback treatment in the community have been determined since the first IRP was developed, however improved mapping of the distribution of susceptible species within the Southern Ironstone occurrences is needed. This will allow for further prioritisation of phosphite spraying. Priority

areas for dieback treatment in the community will be determined using CALM's Dieback Management Guidelines (CALM 1999).

Methods are currently in place for monitoring dieback disease. Plant health is monitored regularly using random counts of dead/live plants, counts of entire populations of DRF, count of live/dead plants within quadrats, monitoring survival of tagged plants and monitoring phosphite levels within the treated plants.

There have been initial discussions about a possible walk trail through Ruabon Tutunup Road. Such a trail would necessarily pass through occurrences of the Southern Ironstone community, and would therefore have the potential to spread or amplify dieback disease. The dieback status of any proposed alignment would need to be assessed to establish the viability of such a trail.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $1,200 yearly
**Completion** date: Ongoing

### 3.8. Implement dieback treatment

CALM will continue to implement the treatments recommended in the current Dieback Protocol document for infected areas, commencing with the highest priority areas (as determined in Action 3.7).

Currently, a regime of 24kg/ha of phosphite is applied with wetting agent by aerial spraying twice in autumn at Williamson Road (Occurrence 7 & 8) and bi-annually at other occurrences. Monitoring indicates that this application rate appears to minimise the impact of dieback-on susceptible taxa. This treatment will be continued.

**Responsibility**: CALM (Blackwood District; Dieback Coordinating Group) through the SWRTFCRT
**Cost**: $7,800 every year for Occurrence 7 and 8; $29, 800 every second year for Occurrences 1-5, 9, 10 and 13.
**Completion date**: Ongoing

### 3.9. Ensure hygiene conditions

*Phytophthora* has been isolated from many of the occurrences, while the incidence of the disease in the remainder of the sites is unknown. The community is known to be highly susceptible to the disease. Risk of introduction of disease will therefore be minimised by ensuring good hygiene procedures. This would involve washdown of any equipment used adjacent to the community, and restricting access by vehicles and machinery to dry soil conditions.

No vehicle access will be allowed onto bushland areas near the occurrences. Hygiene procedures will be applied for tracks adjacent to occurrences. Standard practice will therefore be that all vehicles being used adjacent to remnants that contain the community will be free of soil, and plant propagules.

**Responsibility**: All personnel using machinery in the occurrences
**Cost**: Costs of all liaison to be undertaken by CALM (Blackwood District), is included in 3.2; other costs to be underwritten by user of machinery.
**Completion date**: Ongoing

### 3.10. Develop and implement fire management strategy that encompasses the following (3.10.1-3.10.4)

#### *3.10.1 Implement fire response plans*

Fire response plans have been developed for all occurrences and are reviewed annually.

There is a need for research into recovery of the community from fire (to be completed under Action 3.6

(flora monitoring)), and to determine the implications of findings for management. This would also include developing a fire history map of the occurrences, which is updated annually.

As little is known of the response of the community to fire, no planned burns will be implemented for the life of this IRP, unless results of future studies suggest that it is necessary and urgent.

**Responsibility**: CALM (Blackwood District; SCB); in consultation with all stakeholders
**Cost**: $500 per year for annual review
**Completion date**: Ongoing

### *3.10.2 Maintain strategic firebreaks*

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to cause spread or intensification of dieback or otherwise degrade the community. Careful use of herbicides is the preferred method of maintenance of firebreaks to minimise soil movement and risk of dieback spread or intensification in the community. No new firebreaks will be constructed on occurrences. Firebreaks are currently maintained at Occurrence 2, 6, 7, 8 and 13.

Local CALM staff will be involved in planning fire break construction and maintenance for all occurrences of the community.

**Responsibility**: CALM (Blackwood District) in liaison with surrounding landholders
**Cost**: Cost of firebreaks $2,500 pa; costs of liaison included in 3.2
**Completion date**: Ongoing

### *3.10.3 Liaise with surrounding landholders to ensure strategies for fuel reduction on their lands do not impact the community*

For example, burning at inappropriate times when fires are likely to spread to adjacent lands will ideally be avoided.

**Responsibility**: CALM (Blackwood District) in liaison with relevant land managers
**Cost**: Costs of liaison included in 3.2
**Completion date**: Ongoing

### *3.10.4 Ensure fire suppression actions do not impact the community*

Fire fighting authorities need to recognise the importance of not constructing new tracks during their operations, including during wildfires. The use of heavy machinery to create new fire breaks within the community will be avoided because additional disturbance would encourage further weed invasion, and chemicals that may be toxic to the community should not be used. Guidelines for appropriate fire suppression actions should be developed as part of 3.10.1.

A local CALM staff member will be present during wildfires and controlled burns in remnants that contain occurrences of the community, to advise on protecting the conservation values of the community.

**Responsibility**: CALM (Blackwood District) in liaison with local Bush Fire Brigades and Fire and Rescue Service
**Cost**: Costs of preparation of guidelines and liaison included in 3.10.1 plus additional funds for District staff to attend fires in the community - $500 pa
**Completion date**: Ongoing

## 3.11. Research population dynamics and viability

Fire is a major threat to the community and by understanding the population dynamics of key species and processes of the community, an appropriate fire regime can be implemented. Biological processes that need to be understood include pollination and germination. In addition, longevity and time taken to reach

maturity of plant taxa, especially DRF and Priority species in the community, need to be investigated. A research project was proposed in 2003 (Yates *et al*. 2003) to investigate if the remaining fragments of the community are large enough and close enough to support the pollinator communities that ensure plants produce enough seeds to replace themselves. In addition, the proposal recommends investigation of the demographic dependence of the ironstone species on seeds, whether seeds are being produced, and the importance of fire, seasonal inundation and weed invasion for plant population dynamics. This proposal will be implemented under this action.

**Responsibility:** CALM (Blackwood District, Science Division, SCB, TFSC), BGPA, through the SWRTFCRT
**Cost**: $100,000 for years 1, 2 and 3, $110,000 for year 4
**Completion date**: Ongoing

### 3.12. Monitor hydrological processes

Occurrences of the community may be at risk from salinisation due to rising groundwater and increased ponding (Tille and Lantzke 1990c). Monitoring salinity and ponding in a few of the each of the eastern (Occurrences 1-8) and western (Occurrences 9-15) sites would indicate if remedial action was necessary in the catchment. This may include strategic planting of deep-rooted vegetation to increase water usage.

Salinity of surface waters could be monitored in liaison with Department of Agriculture and the local Land Conservation District Committee (LCDC). The levels and salinity of groundwater are monitored by the Department of Environment (DoE) in specific areas and data for areas close to the ironstone community will be analysed.

Monthly groundwater measurements are conducted by the DoE using piezometers established along Ruabon-Tutunup Road and by Cable Sands Pty Ltd using piezometers at Oates Road and Williamson Road.

**Responsibility**: CALM (Blackwood District) in liaison with Department of Agriculture, the LCDC and the DoE, through the SWRTFCRT
**Cost**: Costs of liaison included in Action 3.2; $2,500 pa for monitoring of depths.
**Completion date**: Ongoing

### 3.13. Monitor weeds

Detailed mapping of harmful or high impact weeds such as *Watsonia* sp., (ideally using differential GPS) will aid in setting priorities for weed control work in the occurrences.

Floristic data from Gibson *et al.* (1994) may help determine weeds that pose the greatest threat to each occurrence as all weed species that occur in plots have been recorded. Some significant weeds in occurrences may not occur in plots, however. Weed populations will be accurately mapped and appropriate herbicides or other method of weed control determined. Monitoring of weed levels can be included in Action 3.6 and will continue following the implementation of weed control in Action 3.14.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $4,000 first year; $1,000 every second year.
**Completion date**: Ongoing

### 3.14. Implement weed control

The highest priority will be to control weeds that pose the greatest threat to the community, in the early stages of invasion where possible. This may include some perennial grass weeds and *Watsonia*. Appropriate methods of weed control are found in Brown and Brooks (2002) and may include hand weeding or localised application of herbicide. Weeds pose a threat in occurrences along the Ruabon - Tutunup Road, and in other disturbed areas and will be included in post-fire management of the Ruabon-Tutunup Road burn in Autumn 2005. This will not include any management within the TEC.

The herb layer is an integral part of this plant community and care will be taken to minimise disturbance of native herbs in any weed control program.

Weed control in this community is difficult due to inundation of the occurrences in winter that prevents the application of herbicides. Currently, only broadscale weed control has been undertaken in highly disturbed areas, primarily using Roundup and Fusilade.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $3,000 per year
**Completion date**: Ongoing

### 3.15. Implement control of grazing animals

Presence of rabbits and kangaroos has increased in the last few years within the occurrences, especially at the watering trials at Oates Reserve, where lush vegetation is maintained over the summer. A proposal for removal of rabbits using 1080 is being written, and includes a follow-up monitoring trial.

**Responsibility**: CALM (Blackwood District) through the SWRTFCRT
**Cost**: $3,000 per year
**Completion date**: Ongoing

### 3.16. Develop strategy for broadscale reconstruction of Southern Ironstone community

Occurrences 2 and 6 of the southern ironstone community are highly degraded and are currently used for trials in reconstruction.

Occurrences cleared historically (Occurrence 6 and portions of Occurrence 2 located in the Nature Reserve) will be utilised as seed orchards for DRF that occur in the community such as *Grevillea mccutcheonii* and *Petrophile latericola* ms. Seed from individual occurrences only will be used to establish seed orchards, and then seed reintroduced into the original sites. Trials are continuing at Oates Reserve (Occurrence 6) to investigate recruitment of ironstone taxa.

**Responsibility**: CALM (Blackwood District, Science Division, TFSC), BGPA, through the SWRTFCRT
**Cost**: $15,000 in years 1, 3 and 5.
**Completion date**: Year 5

### 3.17. Design and conduct research

Research will be designed to increase the understanding of characteristics of the community to assist future management decisions. Such research will include:

1. The hydrogeology of occurrences of the community.
2. The impact of weeds on the community.
3. The development of a monitoring system. Protocols will be developed as part of a future policy on threatened ecological communities based on recommendations in English and Blyth (1997).
6. Gathering information on susceptibilities of both Dryandras to *Phytophthora cinnamomi*. The TFSC database indicates that both *Dryandra nivea* subsp. *uliginosa* and *Dryandra squarrosa* subsp. *argillacea* are moderately resistant.
7. Investigate effectiveness of phosphite on dieback control in *Lambertia echinata* subsp. *occidentalis*.

**Responsibility:** CALM (Blackwood District, Science Division, SCB, TFSC), BGPA, through the SWRTFCRT
**Cost**: $30,000 per year (includes new bores to assist hydrological monitoring at Occurrences 7 and 8)
**Completion date**: Ongoing

**SPECIFIC MANAGEMENT ACTIONS; SECTIONS OF OCCURRENCES 1 - 5 ON PUBLIC LANDS**

### 3.18. Develop and implement Management Plan for the Ruabon-Tutunup Road

Currently, there is no detailed Management Plan in place for Ruabon-Tutunup Road occurrences (1-5). In addition to the occurrence of the TEC along this road, several DRF also occur within the road reserve. The Management Plan will include a detailed fire management strategy, as described in Actions 3.10.1-3.10.3.

**Responsibility**: CALM (Blackwood District), in liaison with surrounding landholders
**Cost**: $20,000 for preparation of plan and liaison with Ruabon-Tutunup group
**Completion date**: Year 1

### 3.19. Implement approved controlled burn on Ruabon Tutunup Road and rail reserves

A plan has been developed by the Ruabon-Tutunup Rail Reserve Preservation Group in liaison with CALM staff for a controlled burn of a small portion of the road and rail reserves along Ruabon Tutunup Road that does not contain the TEC. Assistance is being provided to the Preservation Group for monitoring of the vegetation and weed control adjacent to the TEC (Occurrences 1-5). A draft plan has been completed and is being implemented by the Ruabon Tutunup Rail Reserve Preservation Group with support from a Mining Company and CALM on areas immediately adjoining the ironstone occurrences.

**Responsibility**: CALM (Blackwood District, SCB), in liaison with all stakeholders through the SWRTFCRT
**Cost**: $500 for annual monitoring; costs of liaison included as part of 3.2
**Completion date**: Ongoing

**SPECIFIC MANAGEMENT ACTIONS - PART OCCURRENCES 1, 2, 9, 10 AND 15 - PRIVATE LANDS**

### 3.20. Encourage and assist landowners to access available incentives and mechanisms for conserving the ironstone community

Incentives for protection include funds available under the 'Bushland Benefits' scheme, and the Natural Heritage Trust to ensure long term protection of the community.

**Responsibility**: CALM (Blackwood District, SCB), in liaison with landholders
**Cost**: Costs of liaison included in 3.2
**Completion date**: Ongoing

### 3.21. Seek to acquire occurrences if the community is not being successfully managed for conservation, or if they become available

The majority of the occurrences are in reserves with only a few owned privately. If management for conservation seems unlikely to result from actions in this IRP, if blocks containing occurrences of the community become available, or new occurrences are discovered, CALM will seek funds and negotiate to acquire occurrences and adequate buffer areas. Such areas will then be declared Class A reserves for the purpose of 'Conservation of Flora and Fauna' and will be placed under the care, control and management of the Conservation Commission.

**Responsibility**: CALM (Land Acquisitions Section, Blackwood District, SCB), Environment Australia, through the SWRTFCRT
**Cost**: Market price of land at time of purchase
**Completion date**: When available

**TABLE 4: Summary of costs for each recovery action**

| Recovery Action | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Coordinate Recovery Actions | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 |
| Liaise with relevant land managers | $2,500 | $2,500 | $2,500 | $2,500 | $2,500 |
| Monitor the extent and boundaries of occurrences | $1,200 | | $500 | | $500 |
| Map critical habitat | $2,000 | | | | |
| Disseminate information about the community | $500 | $500 | $500 | $500 | $500 |
| Design and implement a program for monitoring flora | $20,000 | $26,000 | $20,000 | $26,000 | $20,000 |
| Monitor dieback | $1,200 | $1,200 | $1,200 | $1,200 | $1,200 |
| Implement dieback treatment | $37,600 | $7,800 | $37,600 | $7,800 | $37,600 |
| Ensure hygiene conditions | - | - | - | - | - |
| Implement fire management strategies | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 |
| Research population dynamics and viability | $100,000 | $100,000 | $100,000 | $110,000 | - |
| Monitor hydrology | $2,500 | $2,500 | $2,500 | $2,500 | $2,500 |
| Monitor weeds | $4,000 | $1,000 | | $1,000 | |
| Implement weed control | $3,000 | $3,000 | $3,000 | $3,000 | $3,000 |
| Implement control of grazing animals | $3,000 | $3,000 | $3,000 | $3,000 | $3,000 |
| Strategy for broadscale reconstruction of Southern Ironstone community | $15,000 | | $15,000 | | $15,000 |
| Design and conduct research | $30,000 | $30,000 | $30,000 | $30,000 | $30,000 |
| Develop fire management strategy for the Ruabon-Tutunup Road occurrences | $20,000 | | | | |
| Implement a management plan on the road and rail reserve | $500 | $500 | $500 | $500 | $500 |
| Encourage landowners to access incentives for conserving the community | - | - | - | - | - |
| Seek to acquire occurrences | To be determined | | | | |
| **Total** | 248,500 | 183,500 | 221,800 | 193,500 | 121,800 |

**Summary of known costs over five years:**
**Total $969,100**

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## 5. APPENDIX 1

Typical and common Vascular Plants in the ironstone community at Busselton (from Gibson *et al.*, 1994) (Taxa that occurred in at least 50% of plots in the community).

| | Taxon | Status (from Atkins 2005) |
|---|---|---|
| | *Acacia stenoptera* | |
| | *Aphelia cyperoides* | |
| | *Borya scirpoidea* | |
| | *Caladenia marginata* | |
| | *Caustis dioica* | |
| | *Centrolepis aristata* | |
| | *Centrolepis drummondiana* | |
| | *Dampiera linearis* | |
| | *Drosera glandulifera* | |
| | *Drosera rosulata* | |
| | *Hakea oldfieldii* | P3 |
| | *Hemiandra pungens* | |
| * | *Hypochaeris glabra* | |
| | *Kunzea* aff. *micrantha* (BJK & NG 040) | |
| | *Loxocarya fasciculata* | |
| | *Loxocarya magna* | P3 |
| | *Mitrasacme paradoxa* | |
| | *Opercularia vaginata* | |
| | *Pericalymma ellipticum* | |
| | *Philydrella pygmaea* | |
| | *Polypompholyx multifida* | |
| * | *Romulea rosea* | |
| | *Schoenus odontocarpus* | |
| | *Stylidium calcaratum* | |
| | *Thelymitra antennifera* | |
| | *Thysanotus thyrsoides* | |
| | *Viminaria juncea* | |

* Introduced

## 6. GLOSSARY

Declared Rare Flora (DRF): 'taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such pursuant to the *Wildlife Conservation Act 1950*.'

Priority 1 (P1): 'taxa which are known from one or a few populations which are under threat.'

Priority 2 (P2): 'taxa which are known from one or a few populations, at least some of which are not believed to be under immediate threat.'

Priority 3 (P3): 'taxa which are known from several populations, at least some of which are not believed to be under immediate threat.'

Alluvial: made up of sediments deposited by flowing water

Geophyte: a perennial plant that propagates by underground bulbs or tubers or corms.

**APPENDIX 2**

**CONFIDENTIAL LOCATIONS, NOT FOR PUBLICATION**

| **Occurrence Number** | **Location** | **Latitude GDA94** | **Longitude GDA94** |
|---|---|---|---|
| Occurrence 1 and 2 | Ruabon – Tutunup Rd 2 (WONN03, 04) | WONN03 (-33.666389$^0$)<br>WONN04 (-33.665773$^0$) | (115.581944$^0$)<br>(115.571632$^0$) |
| Occurrence 3 | Ruabon – Tutunup Rd 3 (WONNEW1) | -33.653718$^0$ | 115.531988$^0$ |
| Occurrence 4 | Ruabon – Tutunup Rd 4 (WONN06) | -33.652554$^0$ | 115.528182$^0$ |
| Occurrence 5 | Ruabon – Tutunup Rd 5 (WONN05) | -33.656900$^0$ | 115.542115$^0$ |
| Occurrence 6 | Oates Road verge (OATESIRON) | -33.68115$^0$ | 115.531112$^0$ |
| Occurrence 7 | Williamson Road east (WIL01) | -33.699674$^0$ | 115.539793$^0$ |
| Occurrence 8 | Williamson Road west (WIL03) | -33.700444$^0$ | 115.534093$^0$ |
| Occurrence 9 | Smith Road (SMITH01) | -33.796388$^0$ | 115.293565$^0$ |
| Occurrence 10 | Jacka Road (JACKA01) | -33.806909$^0$ | 115.265316$^0$ |
| Occurrence 11 | Kolhagen Road (SMITH04) | -33.805654$^0$ | 115.239707$^0$ |
| Occurrence 12 | Ironstone Gully (IRON01, 02) | IRON01 (-33.813459$^0$)<br>IRON02 (-33.812509$^{0)}$ | (115.221766$^0$)<br>(115.222716$^0$) |
| Occurrence 13 | Sussex Location 5114 (YIRON) Corner of Jindong-Treeton and Gale Roads | -33.795131$^0$ | 115.212175$^0$ |
| Occurrence 14 | Sussex Location 2561 Payne Road (PAYNE02, 03, 04) | PAYNE02 (-33.75323$^0$)<br>PAYNE03 (-33.75366$^0$)<br>PAYNE04 (-33.75397$^0$) | (115.2006$^0$)<br>(115.20118$^0$)<br>(115.20198$^0$) |
| Occurrence 15 | Lot 5 Chambers Road | CHAMBERS01(-33.70865)<br>CHAMBERS02 (-33.70935) | (115.1437$^0$)<br>(115.14276666$^0$) |