INTERIM RECOVERY PLAN NO. 44

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

INTERIM RECOVERY PLAN 1999-2002

by

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Photo: Val English

September 1999

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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This Interim Recovery Plan will operate from September 1999 to August 2002 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered after three years, this IRP will be replaced by a full Recovery Plan.

This IRP was approved by the Director of Nature Conservation on 9 September 1999. The 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 September 1999.

SUMMARY.

Name: Shrublands on southern Swan Coastal Plain Ironstones

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 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* sp. Williamson (B.J.Keighery and N.Gibson 226), *Hemiandra pungens* and *Viminaria juncea*, and the herbs *Aphelia cyperoides* and *Centrolepis aristata.*

CALM Region(s): Central Forest

CALM District(s): South West Capes (Busselton)

Shire(s): Busselton

Recovery Team: Already established through the Central Forest Region Threatened Flora and Communities Recovery Team. Membership: representatives from CALM's Central Forest Region (Chair) and South West Capes District, Environmental Office Shire of Busselton, Bunbury Naturalists Club, and CALM's WA Threatened Species and Communities Unit. The Recovery Team will report annually to CALM's Corporate Executive.

Current status: Assessed 21 November 1995 as Critically Endangered

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.

Criteria for success:
1. An increase in the area of this community under conservation management.

2. Maintenance in terms of diversity and basic composition of native species (as described in Gibson *et al* 1994) as well as hydrological and biological processes, taking account of natural change of the community over time.

3. Improvement in terms of reduction of numbers of exotic species and of other threatening processes as defined in this document.

Criterion for failure: *Significant loss of area or further modification of occurrences of the threatened ecological community.*

Recovery Actions:

1. Establish Recovery Team
2. Liaise with landholders, management bodies and managers
3. Monitor boundaries
4. Install markers
5. Monitor dieback
6. Implement dieback treatments, and dieback hygiene
7. Develop fire management strategy
12. Fence private land
13. Access funding incentives for conservation
14. Seek to acquire community on private land
15. Disseminate information
16. Monitor depth and timing of inundation
17. Monitor flora
18. Monitor recovery from Armillaria

8. Implement fire management plans
9. Implement weed control
10. Transfer care, control and management of road and rail reserve to NPNCA
11. Develop management plan for road and rail reserves
19. Monitor weeds
20. Develop strategy for ex-situ propagation
21. Conduct research
22. Report on management strategies

1. BACKGROUND

1.1 History, defining characteristics of ecological community, 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.P. Brown[2], personal communication), near Eneabba (Griffin *et al.* 1983), in the Scott River area (N. Gibson and M. Lyons[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.

Until recently, there were only approximately 36 ha of the community remaining on public lands. Of this, 28 ha is in State Forest and about 9 ha is on lands with the care, control and management placed in other authorities, mainly the Minister for Railways. Another 55 ha of the community occurred on private land. Approximately 12 ha of this was recently purchased by CALM and Environment Australia (funding from the National Reserve System Program, Natural Heritage Trust) and is a proposed Nature Reserve. Areas of threatened ecological communities that occur in State Forest are to be managed for their conservation or recovery as recommended in English and Blyth (1997). A policy is being developed to help guide management of all threatened ecological communities that occur on lands managed by CALM.

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* (Bronwen Keighery and Neil Gibson 040), *Pericalymma ellipticum*, *Hakea* sp. Williamson (Bronwen Keighery and Neil Gibson 226), *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

[1] Henry Smolinsky, Agriculture Western Australia, Baron-Hay Court, South Perth, 6151.
[2] Andrew Brown, Threatened Species and Communities Unit, Department of Conservation and Land Management, PO Box 51, Wanneroo, WA 6065.
[3] Neil Gibson and Mike Lyons, CALM**Science** Division, Department of Conservation and Land Management, PO Box 51, Wanneroo, WA 6065

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 Priority or Declared Rare Flora (DRF) (CALM 1998; refer Table 1) and are either totally confined or largely confined to it (N. Gibson personal communication). As mentioned, another area of ironstone soils occurs on the Scott Coastal Plain near Augusta, and some of the taxa that are confined to ironstone soils occur in both these areas (N. Gibson personal communication - see Table 1). Only four of the 18 taxa listed in this table are common to both areas, however, and the plant communities are considered to be quite distinct (N. Gibson personal communication).

TABLE 1 Taxa totally or largely confined to ironstone soils (N. Gibson unpublished data)

Taxon	Priority Listing (from CALM 1998)	Busselton ironstone areas	Scott Coastal Plain
Andersonia ferricola ms	P1	+	
Brachysema modestum	DRF	+	
Brachysema papilio	DRF	+	
Calothamnus sp. Scott River (RD Royce 84) (aff. *crassus*)	P2	+	+
Calothamnus sp. Whicher (BJK and NG 230)	P1	+	
Chamelaucium roycei ms	DRF	+	
Darwinia sp. Williamson (GJK 12717) (aff. *apiculata*)	DRF	+	
Dryandra nivea subsp. *uliginosa*	DRF	+	+
Dryandra squarrosa subsp. *argillacea*	DRF	+	
Grevillea elongata	DRF	+	
Grevillea maccutcheonii	DRF	+	
Hakea tuberculata	P2		+
Hakea oldfieldii	P2	+	
Lambertia orbifolia	DRF		+
Lepyrodia aff. *macra* ms (NG and ML 1275)		+	+
Loxocarya magna ms	P3	+	+
Melaleuca aff. *incana subsp.* Gingilup (NG and ML 593)	P2		+
Opercularia aff. *vaginata* BJK and NG 238)		+	
Petrophile latericola ms	DRF	+	

Definitions of DRF and Priority ratings for plant taxa occur in the Glossary.
Major threats to the community are dieback, clearing, too frequent fire, weed invasion, and possibly salinisation and waterlogging . BJK=Bronwen Keighery, GJK =Greg Keighery, NG=Neil Gibson, ML=Mike Lyons

Table 2: Extent and location of occurrences

Occurrence Number	Location	Land Tenure	Estimated area
Occurrence 1	Wonnerup – Tutunup Rd 1 (WONN03)	Rail and road reserves and adjacent private land	0.6 ha
Occurrence 2	Wonnerup – Tutunup Rd 2 (WONN04)	Rail and road reserves and adjacent private land	42.4 ha
Occurrence 3	Wonnerup – Tutunup Rd 3 (WONNEW1)	Rail and road reserves	1.4 ha
Occurrence 4	Wonnerup – Tutunup Rd 4 (WONN06)	Rail and road reserves	3.8 ha
Occurrence 5	Wonnerup – Tutunup Rd 5 (WONN05)	Rail and road reserves	0.1 ha
Occurrence 6	Oates Road verge (OATESIRON)	Road 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 (?and adjacent private land)	9.4 ha
Occurrence 10	Jacka Road (JACKA01)	State Forest - Treeton block and adjacent private land	3.2 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

1.2 Description of Occurrences

All occurrences are located in the Shire of Busselton (see Figure 1).

Occurrences 1-5 are located on disused railway reserve 12969, with care, control and management placed in the Minister for Railways for 'Railway Purposes', and on the adjacent road verge along the Wonnerup-Tutunup Road that is managed by the Shire of Busselton. 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.

Occurrences 1 and 2 extend onto private land adjacent to the road and rail reserves. Cleared agricultural lands surround all other Wonnerup-Tutunup Road occurrences. Neither of the privately owned areas is currently grazed. Occurrence 2 extends into Sussex Locations 3203, 3194 and 1773. Occurrence 1 extends into Sussex Location 2266, which is privately owned.

Occurrence 6 is located on a degraded road verge 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, and CALM District staff propose to rip the site to assist germination of other taxa that previously occurred in the community (G. Voigt[4], N. Gibson personal communication).

[4] Greg Voigt, South West Capes District, Department of Conservation and Land Management, Busselton, WA 6280

Occurrences 7 and 8 occur on the boundary of State Forest in Abba block. Cleared agricultural lands occur to the north of both occurrences and to the west 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 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 9, 10 and 11 but the community may be regenerating adjacent to Occurrence 9. 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 has 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.

Occurrence 13 is located on Sussex Location 5114 (previously part Sussex Location 2650), which has recently been purchased by CALM and Environment Australia. Cleared agricultural lands surround this site.

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

1.3 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 eg. *Kunzea* aff *micrantha* (DRF). The characteristic herb layer 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, they are adjacent to private property, and soil and landform units can be interpreted. The northerly occurrences of the community (Occurrences 1-8) are 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 southerly 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.

1.4 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[5] and N. Gibson 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).

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; G. Keighery and N. Gibson personal communication). 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).

Agriculture Western Australia 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 Wonnerup-Tutunup Road near Occurrences 1-5.

1.5 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. In accordance with the Memorandum of Understanding for the protection of remnant vegetation on private land in the agricultural region of Western Australia (Commissioner for Soil and Land Conservation *et al*. 1997), new proposals to clear occurrences of this community would be subject to EPA assessment.

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

[5] Greg Keighery, CALM**Science** Division, Department of Conservation and Land Management, PO Box 51, Wanneroo, WA 6065

[6] Will Oldfield, Agriculture Western Australia, Bunbury, WA 6230

(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 also recently occurred in Treeton block near Occurrence 9 (A.Webb[7] personal communication), and has the potential to cause significant damage through crushing and clearing of vegetation and the spread or amplification of disease (see below).

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. All occurrences except Ironstone Gully (Occurrence 12) are thought to be infected with the disease (R. Smith[8] personal communication.). Dieback has the potential to seriously impact the community and, indeed, species diversity, through loss of remaining populations of some taxa.

The Williamson Road west (Occurrence 8) site has recently been treated with phosphite applied three times over a period of 18 months by crop dusting aircraft. The site will not be sprayed again for several years, unless there is evidence the disease has become active again, and the area will be monitored for spread of dieback.

Risk of amplification or introduction of disease should be minimised by ensuring good hygiene procedures in all occurrences. This would involve washdown of any equipment used adjacent to the community, and restricting access by vehicles and machinery to dry soil conditions.

Unexplained deaths have been noted in *Dryandra nivea* subsp. *uliginosa* at the Williamson Road west site (Occurrence 8). 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). There is no treatment currently available for this disease.

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 Wonnerup-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):

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[8] Russell Smith, Phosphite Program, Department of Conservation and Land Managment, PO Box 1693, Bunbury, WA 6230

[9] Felicity Bunny, formerly Department of Environmental Protection, 141 St Georges Terrace, Perth, 6000

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, eg invasive perennial grasses, Watsonia.
4. Rehabilitation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

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 population (13 individuals) of *Grevillea mccutcheonii*. Other occurrences located on private land (portions of Occurrences 1 and 2; and Occurrence 13) 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 (Gill *et al.* 1981). It is also likely that the fire regime in the area has been modified since European settlement, probably with fires, especially hot burns, more frequent.

The Mediterranean ecosystems would be adapted to fire and indeed may require a particular fire regime to assist regeneration. 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. Many of the taxa, in particular Declared Rare and Priority flora that occur in this community are obligate seeders. 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.

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 Wonnerup-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 Wonnerup-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 Wonnerup-Tutunup Road (Occurrences 1-5) on Oates Road (Occurrence 6), and on private land on Jindong-Treeton Road (Occurrence 13) are completely surrounded by cleared agricultural areas. 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.

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 1950's 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 northern occurrences of the community (Occurrences 1-8). No existing salinisation (or waterlogging) problems were recorded by Tille and Lantzke (1990c) for the land units occupied by the more southern occurrences (Occurrences 9-13).

The levels of salinity in the community should 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.

1.6 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.

1.7 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

2.1 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.

2.2 Criteria for success

An increase in the area, and number of occurrences, of this community under conservation management.

Maintenance in terms of diversity and basic composition of native species (as described in Gibson *et al.* 1994) as well as hydrological and biological processes, taking account of natural change of the community over time.

Improvement in terms of reduction of numbers of exotic species and of other threatening processes as defined above.

2.3 Criterion for failure

Significant loss of area or further modification of occurrences of the threatened ecological community.

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 Western Australian Threatened Species and Communities Unit (WATSCU) and the Recovery Team share the primary responsibility for securing funds for recovery actions.

3.1 Establish a Recovery Team

Already established through the Central Forest Region Threatened Flora and Communities Recovery Team. Membership: Representatives from CALM's Central Forest Region (Chair) and South West Capes District, Environmental Office Shire of Busselton, Bunbury Naturalists Club, and CALM's WA Threatened Species Unit. The Recovery Team will report annually to CALM's Corporate Executive.

Responsibility: CALM's Central Forest Region
Cost: $0
Completion date: Year 1

3.2 Liaise with current management bodies, owners, land managers and other relevant groups to implement recommendations held in this IRP

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.

The occurrences along the Wonnerup-Tutunup Road (Occurrences 1-5) are managed by Westrail for the Minister for Railways, and by the Shire of Busselton. Occurrences 1 and 2 extend into private land. Iluka Resources Limited (previously Westralian Sands) is one of the owners of some parts of these occurrences and may wish to become more involved in conservation of the community. Other companies also hold mining tenements over areas that contain the community (Ilmenite Pty Ltd and Yardarino Pty Ltd). Occurrence 10 also extends onto private land.

Responsibility: CALM (South West Capes District; WATSCU)
Cost: $2,500 for all liaison (not including vehicle costs)
Completion date: Ongoing

3.3 Monitor the extent and boundaries of occurrences

Occurrences should be monitored every two years. Boundaries can be determined from current aerial photographs and minimal on-site checking. Permission should be sought from the owners of the area that may contain the community adjacent to Occurrence 9 to survey the site.

Extent and boundary information should be added to the threatened ecological communities database as recommended in English and Blyth (1997). English and Blyth (1997) also recommended the establishment of a Geographic Information System database for information on threatened ecological communities. Accurate GPS mapping of community boundaries has commenced and a Geographic Information System database is being constructed.

Responsibility: CALM (South West Capes District; WATSCU)
Cost: $500 every second year
Completion date: Ongoing

3.4 Disseminate information about the community

To prevent accidental destruction of or damage to the community (for example, through disturbance caused by illegal timber cutting) and gain public support for its conservation, it is recommended that information about the community be provided by local CALM staff to all stakeholders including management bodies, landholders, and managers of land containing the community. This would include information from the threatened ecological communities database, and maps indicating the location of the community. Information about private land should only be disseminated if permission is granted by the landholder. This action is recommended in English and Blyth (1997).

Local CALM staff should ensure regular liaison with landowners and management bodies of land containing the community to ensure threatened ecological community information is up to date.

A publicity campaign utilising local media and poster displays in prominent areas should 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 reprinted and widely distributed to relevant groups and individuals.

Signs should 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, South West Capes District; WATSCU)
Cost: $3,000
Completion date: Ongoing

3.5 Install markers to indicate the locations of occurrences of the community alongside tracks, firebreaks and roads

To reduce the likelihood of accidental destruction CALM will mark, or encourage the appropriate authorities to mark roadside occurrences of threatened ecological communities, and occurrences located on tracks or firebreaks, with the same pegs as used to mark DRF. Pegs are already in place alongside some occurrences, as they mark the location of DRF. Where these pegs are located on the boundary of the community there is no need to put additional pegs in place, but additional pegs should be put in where the full extent of the community is not marked. These should be placed 50 m either side of the boundaries of the community to provide a protective buffer.

This action is recommended in English and Blyth (1997).

Responsibility: CALM (South West Capes District; WATSCU)
Cost: $1,000
Completion date: Year 1

3.6 Design and implement a program for monitoring flora

Data collected should include weed levels, plant species diversity, species composition of flora.

Occurrences should be monitored every two years to provide information on condition. This information should be added to the threatened ecological communities database as recommended in English and Blyth (1997).

Floristic plots occur in all occurrences (total of 10 plots - Gibson *et al.* 1994), except Occurrences 1, 3, 6 and 10. Additional plots should be put into the cleared and uncleared portions of Occurrence 10, but it is probably not necessary to place additional plots along the Wonnerup-Tutunup Road, or on Oates Road where the community is very highly modified (Occurrences 1, 3 and 6 respectively). All native and weed species have been recorded for all other plots but density or cover values for each species were not included in these data. This additional information would be essential for determining changes over time

(eg as a result of too frequent fire or the success of a rehabilitation strategy). Line intercept and photographic methods as described in Hopkins *et al.* (1987) could be utilised to monitor these parameters, using permanent plots already in place from other surveys (Gibson *et al.* 1994).

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

Responsibility: CALM (South West Capes District; WATSCU)
Cost: $6,000 every second year (total of 12 plots in the community) for field survey, specimen identification, and databasing for 1 monitoring period.
Completion date: Ongoing

3.7 Monitor dieback

Priority areas for dieback treatment in the community should be determined using CALM's Dieback Protocol (K. Vear[10] Personal Communication). Data on dieback presence and impact, and future biodiversity implications, such as the loss or decline of DRF or Priority taxa, or structurally or functionally important taxa, are likely to be important determinants of the priority of treatment of individual occurrences.

The dieback front has been mapped accurately using differential GPS, and a photo monitoring point set up at the Williamson Road west site (Occurrence 8) where phosphite spraying is being undertaken. The dieback front should be monitored at least every two years in summer and flagging marking the front replaced regularly. Other occurrences should be surveyed, then monitored for dieback. Additional plot information (refer 3.6) would provide useful monitoring data for all sites.

Responsibility: CALM (South West Capes District)
Cost: $6,000 every second year
Completion date: Ongoing

3.8 Implement dieback treatment

CALM will 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).

CALM is developing a strategy for treatment of areas infected with dieback. Such a strategy could initially be implemented in the community on CALM lands, then, with the cooperation of landholders, extended to occurrences on private lands. The protocol will incorporate results of monitoring from current and future methods of experimental dieback treatments.

Experimental dieback management using a crop dusting aircraft to spread phosphite is being undertaken at the Williamson Road west occurrence (Occurrence 8). The ironstone community was sprayed on 1 May 1996 with 20% phosphite at a rate of 30 litres per hectare and the *Banksia attenuata* community upslope (south) at a rate of 60 litres per hectare. The whole area was then sprayed with 10% phosphite at 60 litres per hectare on 13 June 1996, and again in spring 1996. The spread of the disease is being monitored. Additional treatment should be undertaken when active dieback is again noted, or within approximately three years, whichever comes first (F. Bunny, personal communication). Dieback caused by *Phytophthora* species is likely to be present in all occurrences except Ironstone Gully (Occurrence 12) (R. Smith personal communication).

Priority occurrences for treatment in the near future are likely to include Occurrences 7, 9 and 13 (R. Smith personal communication)

Responsibility: CALM (South West Capes District; Dieback Coordinating Group; WATSCU)

[10] Kevin Vear, Department of Conservation and Land Management, Hayman Road, Como, WA 6152

Cost: $25,200 for initial treatments (three sprayings) of Occurrences 1, 2, 3, 4, 5, 7, 9, 10, 11 and 13 (private land not included in costings). Follow-up treatment for Occurrence 8 - $1,400.
Completion date: Ongoing

3.9 Monitor the recovery of Dryandra from Armillaria luteobubalina

Other areas of the community should be monitored for *Armillaria luteobubalina* and priority areas determined for future treatment if treatment options become available.

Deaths of *Dryandra nivea* subsp. *uliginosa* caused by *Armillaria* have been located in the ironstone community at Williamson Road - Occurrence 8 (F. Bunny, personal communication). Other areas should be monitored for infections. At the time of drafting this IRP, no treatment options were available for this disease.

Responsibility: CALM (South West Capes District; WATSCU)
Cost: Survey could be incorporated into monitoring under Actions 3.6 and 3.13. Treatment costs to be determined if treatment options become available.
Completion date: Ongoing

3.10 Ensure hygiene conditions

Most occurrences have not been tested for presence of dieback and the community is known to be highly susceptible to the disease. Risk of introduction of disease should 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 should be allowed onto bushland areas. Hygiene procedures apply if using tracks adjacent to occurrences. Standard practice should therefore be that all vehicles being used adjacent to remnants that contain the community 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 (South West Capes District), is included in 3.2; other costs to be underwritten by user of machinery
Completion date: Ongoing

3.11 Develop and implement a fire management strategy

3.11.1 Develop and implement a fire management strategy that encompass the following (3.11.1-3.11.4) and include an annual fire monitoring and reporting schedule.

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 should be implemented for the life of this IRP, unless results of future studies suggest that it is necessary and urgent.

A fire management strategy has been developed for Talbot Road bushland in Stratton by the Fire and Rescue Service, with input from the Shire of Swan and CALM. It specifies no planned burns without consultation with CALM, no construction of new fire breaks, a fire-fighting strategy, implementation of dieback hygiene for all vehicles, routine fuel and weed monitoring, and maintenance of fire breaks. A similar plan should be developed for all occurrences of this community, using the plan for Talbot Road bushland as a guide. Close liaison with all stakeholders is required to develop Fire Management Plans.

Responsibility: CALM (South West Capes District; WATSCU); in consultation with all stakeholders

Cost: $6,000 for preparation of guidelines
Completion date: plan completed for Wonnerup - Tutunup Road; for other occurrences Year 1: implementation ongoing

3.11.2 Ensure maintenance of strategic firebreaks on occurrences or construction of new strategic fire breaks on surrounding lands to help prevent fire spreading to community.

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 would be the preferred method of maintenance of firebreaks to minimise soil movement and risk of dieback spread or intensification in the community. No new fire breaks should be constructed on occurrences.

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

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

3.11.3 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 should be avoided.

Responsibility: CALM (South West Capes District) in liaison with surrounding landholders
Cost: Costs of liaison included in 3.2
Completion date: Ongoing

3.11.4 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 should 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 3.11.1.

A local CALM staff member should 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 (South West Capes District) in liaison with local Bush Fire Brigades and Fire and Rescue Service
Cost: Costs of preparation of guidelines and liaison included in 3.11.1 plus additional funds for district staff to attend fires in the community - $500 pa
Completion date: Ongoing

3.12 Monitor salinity and groundwater levels, and depth and timing of inundation in the community

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 northern (Occurrences 1-8) and southern (Occurrences 9-13) 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 Agriculture Western Australia and the local Land Conservation District Committee (LCDC). The levels and salinity of groundwater are monitored by the Water and Rivers Commission (WRC) in specific areas and data for areas close to the ironstone community should be analysed.

The depth and timing of inundation should be measured by checking against a depth gauge at specific intervals (say weekly during winter, and monthly thereafter).

Responsibility: CALM (South West Capes District) in liaison with Agriculture Western Australia, the LCDC and the WRC
Cost: Costs of liaison included in Action 3.2; $2,500 pa for monitoring of depths
Completion date: Ongoing

3.13 Monitor weeds

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 should be accurately mapped and appropriate herbicides or other method of weed control determined. Monitoring of weed levels can be included in Action 3.6.

Responsibility: CALM (South West Capes District)
Cost: $2,000 every second year to monitor boundaries of weed populations that pose the greatest threat to the community
Completion date: Ongoing

3.14 Implement weed control

The highest priority should be to control weeds, in the early stages of invasion where possible, that pose the greatest threat to the community, eg invasive perennial grasses and *Watsonia*. Weeds pose a threat in occurrences along the Wonnerup - Tutunup Road, and in other disturbed areas.

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

Responsibility: CALM (South West Capes District)
Cost: $3,000
Completion date: Ongoing

3.15 Develop strategy for ex-situ propagation

Develop and implement a strategy for use of degraded areas of the ironstone community for ex-situ propagation of critically endangered ironstone taxa.

Occurrences cleared historically (Occurrence 6; the cleared portions of Occurrence 10 and 11; and cleared areas of Occurrences 1 and 2 on land owned by Westralian Sands) could 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 should be used to establish seed orchards, and then seed reintroduced into the original sites.

Responsibility: CALM (South West Capes District; CALMScience Division; Threatened Flora Seed Centre (TFSC)); Kings Park and Botanic Garden (KPBG)
Cost: $30,000 to grow plants (200 plants of each of ten species)
Completion date: No date set

3.16 Design and conduct research

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

1. The hydrogeology of occurrences of the community.
2. The impact of weeds on the community.
3. The role of disturbance in regeneration of the community.
4. The recovery of the community following recent fires (this will be considered in the Fire Management Plan developed under 3.11). (Note: there are data on recovery of *Chamelaucium roycei* after fire in Smith (1994)).
5. 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. Biological processes in the community, eg pollination biology, germination requirements, longevity and time taken to reach maturity of important plant taxa in the community.

Responsibility: CALM (South West Capes District; CALMScience; WATSCU; TFSC); KPBG
Cost: Recovery Team to determine costs and likely funds available through other sources and to recommend a research program and sources of funds to CALM
Completion date: Ongoing

3.17 Report on success of management strategies for the occurrences

Reporting should be part of annual reports prepared by the Recovery Team for CALM's Corporate Executive. A final report would be presented as part of or complementary to the full recovery plan for the community, if a full recovery plan is necessary.

Responsibility: CALM (South West Capes District; WATSCU); Recovery Team
Cost: $0
Completion date: Year 3

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

3.18 Transfer care, control and maintenance of areas of the community on public land to the NPNCA for conservation of flora and fauna

CALM negotiate to have the road and rail reserves on Wonnerup Road between Ludlow-Hithergreen and Armstrong Roads declared Class A reserve for the purpose of 'Conservation of Flora and Fauna' vested in the National Parks and Nature Conservation Authority.

Responsibility: CALM (South West Capes District; Land Acquisitions Section; WATSCU)
Cost: Costs of liaison included as part of 3.2
Completion date: Indefinite, depending on negotiations

3.19 Develop a management plan for the community on the road and rail reserve

If action 3.18 is not successful, CALM will seek involvement in the cooperative preparation of management plans that would conserve the threatened ecological community on the road and rail reserves on Wonnerup Road between Ludlow-Hithergreen and Armstrong Roads.

Responsibility: CALM (South West Capes District; WATSCU), Management bodies
Cost: Costs of liaison included as part of 3.2; cost of plan preparation $10,000
Completion date: A draft plan has been completed and is being implemented by a local community/landholder group with support from Iluka Resources and CALM on areas immediately adjoining the ironstone occurrences.

SPECIFIC MANAGEMENT ACTIONS - PART OCCURRENCES 1, 2 AND 10 - PRIVATE LANDS, WONNERUP-TUTUNUP ROAD, AND JACKA ROAD BUSSELTON (and possibly part Occurrence 9 if the community extends onto adjacent private land).

3.20 Fence occurrences where appropriate

On the basis of the results of Action 3.3, determine where fences are necessary (eg to prevent grazing by stock or inappropriate vehicle access). Fence areas to protect occurrences, and include suitable buffer areas if required. Encourage landholders to fence ironstone areas on private land adjacent to the road and rail reserves on Wonnerup Road between Ludlow-Hithergreen and Armstrong Roads (Occurrences 1 and 2); and adjacent to Treeton Forest Block (Occurrence 10). If the community is identified on private land adjacent to Occurrence 9, then fencing requirements of this area should also be determined.

Responsibility: CALM (South West Capes District) in liaison with landholders
Cost: Costs of liaison included in 3.2; fencing costs to be determined
Completion date: Year 2

3.21 Encourage and assist landowners to access available incentives and mechanisms for conserving the ironstone community

Incentives for protection include the Remnant Vegetation Protection Scheme and funds that would be available under the planned 'nature conservation foundation' to ensure long term protection of the community.

Responsibility: CALM (South West Capes District; WATSCU); liaison with landholders
Cost: Costs of liaison included in 3.2
Completion date: Ongoing

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

If management for conservation seems unlikely to result from actions in this IRP, or if blocks containing occurrences of the community become available, CALM will seek funds and negotiate to acquire occurrences and adequate buffer areas. Such areas should then be declared Class A reserves for the purpose of 'Conservation of Flora and Fauna' vested in the National Parks and Nature Conservation Authority (NPNCA).

The highest priority for areas to be acquired are the largest areas in good condition on private land (N. Gibson personal communication).

Responsibility: CALM (Land Acquisitions Section; South West Capes District; WATSCU); Environment Australia
Cost: Market price of land at time of purchase
Completion date: Ongoing. (One lot has been purchased, another is in negotiation.)

Table 2: Summary of recovery actions

Recovery Action	Occurrences	Responsibility	Completion date
Establish Recovery Team	All	CALM (WATSCU)	Year 1
Liaise with landholders, Management bodies and managers	All	CALM (South West Capes District, WATSCU)	Ongoing
Monitor boundaries	All	CALM (SID, South West Capes District, WATSCU)	Ongoing
Install markers	All	CALM (South West Capes District, WATSCU)	Year 1
Monitor dieback	All	CALM (South West Capes	Ongoing

		District)	
Implement dieback treatments	1-5, 7, 8, 10, 11,13 (excluding private land)	CALM (South West Capes District, WATSCU, Dieback Coordinating Group)	Ongoing
Develop Fire Management Plans	All	CALM (Busselton, District, WATSCU) in consultation with all stakeholders	Year 1
Implement Fire Management Plans, implement dieback hygiene	All	CALM (South West Capes District), Bush Fire Brigades, Fire and Rescue Service	Ongoing
Implement weed control	All	CALM (South West Capes District)	Ongoing
Transfer care, control and maintenance of road and rail reserve to NPNCA	1-5	CALM (Land Acquisitions Section; South West Capes District; WATSCU), DOLA	Indefinite
Develop management plan for road and rail reserve	1-5	CALM (South West Capes District; WATSCU), management bodies	Year 1
Fence private land	1, 2, 10	CALM (South West Capes District); landholders	Year 2
Access funding incentives for conservation	1, 2, 10	CALM (South West Capes District; WATSCU), landholders	Ongoing
Seek to purchase community on private land	2, 9	CALM (South West Capes District, Land Acquisitions Section); Environment Australia	When required or as available
Disseminate information	All	CALM (Corporate Relations Division, South West Capes District, WATSCU)	Ongoing
Monitor flora	All	CALM (South West Capes District, WATSCU)	Ongoing
Monitor recovery from Armillaria	8	CALM (South West Capes District, WATSCU)	Ongoing
Monitor depth and timing of inundation	Examples of northern and southern group of occurrences	CALM (South West Capes District); liaison with WRC, LCDCs and Agriculture Western Australia	Ongoing

Table 2: Summary of recovery actions…Cont

Recovery Action	Occurrences	Responsibility	Completion date
Monitor weed populations	All	CALM (South West Capes District)	Ongoing
Develop strategy for ex-situ propagation	6, 10, 11	CALM (South West Capes District, SID, TFSC), KPBG	No date set
Conduct research	All	CALM (South West Capes District, SID, WATSCU, TFSC), KPBG	No date set
Report on management strategies	All	CALM (South West Capes District; WATSCU), Recovery Team	2000

Table 3: Summary of costs for each recovery action

Recovery Action	Year 1	Year 2	Year 3
Establish Recovery Team	-		
Liaise with landholders, management bodies and managers	1,000	1,000	500
Monitor boundaries	500		500
Install markers	1,000		
Monitor dieback	6,000		6,000
Implement dieback treatments	25,200		1,400
Develop Fire Management Plans	6,000		
Implement Fire Management Plans, implement dieback hygiene	3,000	3,000	3,000
Implement weed control	1,000	1,000	1,000
Transfer care, control and maintenance of road and rail reserve to NPNCA	-		
Develop management plan for road and rail reserve		(if plan necessary) 5,000	
Fence private land		To be determined	
Access funding incentives for conservation	-		
Acquire part Occurrence 2	In negotiation		
Seek to acquire other areas of the community on private land		To be determined	
Disseminate information	1,500	1,500	
Monitor flora	6,000		6,000
Monitor recovery from Armillaria			
Monitor depth and timing of inundation	2,500	2,500	2,500
Monitor weeds	2,000		2,000
Develop strategy for ex-situ propagation	15,000	15,000	
Conduct research	To be determined		
Report on management strategies	-		
Total	**70,700**	**29,000**	**22,900**

Summary of known costs over three years
Total $122,600

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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 CALM, 1997)
	Acacia stenoptera	
	Aphelia cyperoides	
	Borya scirpoidea	
	Caladenia marginata	
	Caustis dioica	
	Centrolepis aristata	
	Centrolepis drummondiana	
	Dampiera linearis	
	Drosera glandulifera	
	Drosera rosulata	
	Hakea sp. Williamson *(BJK & NG 226)*	P1
	Hemiandra pungens	
*	*Hypochaeris glabra*	
	Kunzea aff. micrantha (BJK & NG 040)	
	Loxocarya fasciculata	
	Loxocarya magna (ms)	P3
	Mitrasacme paradoxa	
	Opercularia vaginata	
	Pericalymma ellipticum	
	Philydrella pygmaea	
	Polypompholyx multifida	
*	*Romulea rosea*	
	Schoenus odontocarpus	
	Stylidium calcaratum	
	Thelymitra antennifera	
	Thysanotus thyrsoides	
	Viminaria juncea	

*Introduced

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 plant with an underground bud