Department of Parks and Wildlife

Interim Recovery Plan No. 339

Scott River Ironstone Association (update)

Interim Recovery Plan
2015-2020

Department of Parks and Wildlife, Kensington

April 2015

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Parks and Wildlife Policy Statements Nos. 44 and 50 (CALM 1992; CALM 1994). The Department of Conservation and Land Management (CALM) formally became the Department of Environment and Conservation (DEC) in July 2006 and the Department of Parks and Wildlife in July 2013 (the Department).

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

The Department is committed to ensuring that threatened 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 after listing.

This plan will operate from April 2015 but will remain in force until withdrawn or replaced. It is intended that, if the community is still listed after five years, the need for an updated plan will be evaluated.

This plan was approved by the Director of Science and Conservation on 7 April 2015. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting the Department, as well as the need to address other priorities.

This plan replaces IRP no. 217 *Scott River Ironstone Association* 2004-2009 by R. Luu and V. English.

Information in this plan was accurate at December 2014.

Plan preparation: This reviewed and updated plan was prepared by Jill Pryde (Department of Parks and Wildlife).

Cover photograph by Andrew Webb.

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Summary

Name: Scott River Ironstone Association

Description: Winter wet shrubland that occurs on skeletal soils over massive ironstone on the Scott Coastal Plain. Heath and shrublands are variously dominated by *Melaleuca preissiana*, *Hakea tuberculata*, *Kunzea micrantha* or *Melaleuca incana* subsp. Gingilup depending on the degree of waterlogging. The understorey is generally dominated by *Loxocarya magna*.

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

Current status: Endorsed by the WA Minister for Environment as an Endangered threatened ecological community (TEC) in November 2001 and also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in April 2012.

Important occurrences: Occurrences with comparatively large intact areas of the community that are in relatively good condition are considered important. Occurrences that provide for representation of the community across its geographic range and those that can be managed for conservation and/or with conservation included in their purpose are also considered important.

Threats: The main threats to the community are land clearing, disease caused by *Phytophthora* species, weed invasion, altered fire regimes, and hydrological change.

Department region: South West, Warren

Department district: Blackwood, Donnelly

Local Government Authorities: Nannup, Augusta-Margaret River

Recovery Team(s): South West Region and Warren Region Threatened Flora and Communities Recovery Teams.

Affected interests: Land owners and managers of all occurrences may be affected by actions in this plan, in particular on those lands not managed by Parks and Wildlife or intended to be transferred to the Department for management.

Indigenous interests: The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Table 2 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. Background, 1.10 identifies the intention to continue liaison with relevant groups, including indigenous groups.

Social and economic impacts and benefits: Where specific active recreational pursuits such as four wheel driving and motorbike riding are prevented through access control, this may be perceived as a social impact, however, such access control also helps to prevent the continued degradation of the community and maintain other social benefits.

Occurrences may be threatened by proposals to clear for various developments or from hydrological change following clearing and development of adjacent land. Implementation of actions such as seeking to protect the hydrological processes in areas adjacent to the community may result in a perceived impact on development.

Related biodiversity impacts and benefits: Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community and other associated vegetation types within managed areas of remnant vegetation. One EPBC-listed ecological community and five priority ecological communities occur close to remnant vegetation that contains the community. Twelve declared rare and six priority flora occur within the community, and 27 threatened and priority fauna have been identified as occurring within or close to this community.

Habitat critical to survival, and important occurrences: The critical habitat for this community is the area occupied by the community, areas of similar habitat within 200 metres of known occurrences, remnant vegetation that surrounds or links several occurrences, and the local catchment for the surface and groundwater that maintain the winter-wet habitat of the community.

Comparatively large intact areas of the community that are in good condition or better are considered important occurrences. Occurrences that provide for representation of the community across its geographic range and include representative sub types, and that can be managed for conservation and/or with conservation included in their purpose are also considered important. Important sites include Gingilup Nature Reserve, other Crown reserves, and freehold sites that are being managed by the Department of Parks and Wildlife (the Department). Occurrence 10 is considered to be highest priority for acquisition or an alternative mechanism for pursuing conservation management.

Term of plan: The plan will operate from 2015 to 2020 but will remain in force until withdrawn or replaced. It is intended that if the community is still ranked vulnerable in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated.

IRP Objective: To conserve the ecological and conservation values of the Scott River Ironstone Association through conservation management of representative samples of each of the identified sub communities of the Scott River Ironstone Association; and minimising the loss and maximising the conservation of all remaining community occurrences as far as practicable, including recovering degraded occurrences where it is cost-effective and practical to do so.

Criteria for success:

- an increase in the number of occurrences of the community managed for conservation and/or with conservation included in their purpose
- An increase in the representation of the sub-types of the community in reserves managed for conservation.
- the total area of the community remains above 300ha
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales).
- increased knowledge about hydrological processes such that there is a comprehensive description of the maximum and minimum water levels that will maintain the community

Criteria for failure:

- all occurrences of an identified sub-community are cleared, or decline to degraded or completely degraded condition
- total area covered by the community falls below 300ha
- 10% or more of the known extent of occurrences fall into a lower category of condition (Bush Forever scales 2000)

Summary of recovery actions:

1. Coordinate recovery actions	9. Map habitat critical to survival
2. Continue liaison with land stakeholders to implement this plan	10. Monitor water quality and levels
3. Seek long term protection of areas of the community	11. Develop and implement a weed control strategy
4. Fence remnants that contain the community	12. Design and implement flora monitoring program
5. Monitor dieback disease, treat and prevent further spread	13. Develop strategy for ex-situ propagation
6. Develop and implement fire management strategy	14. Install roadside markers
7. Survey and describe known and potential occurrences	15. Report on success of management strategies
8. Monitor extent, boundaries and condition of occurrences	

1 Background

1.1 History, defining characteristics, and conservation significance

Restricted areas of massive ironstone associated with unusual plant communities occur in a number of areas in the southwest of Western Australia; in the Scott River area, Gingin, Eneabba and Busselton (Gibson *et al.* 1994; Gibson *et al.* 2000). Each of these areas contains plant communities that are characterised by different taxa. The periodic inundation of the ironstones prevents local typically occurring plant communities from growing, and results in specialised communities having dominance (GCS 2007).

The ironstone soils are extremely restricted in distribution on the Scott River Plain (refer Figure 1). These soils may have been historically associated with bogs, the iron being deposited by water percolating through the soil and bacterial action on the surface (de la Hunty 1960; Tille and Lantzke 1990 b, c, d and e). Seasonal fluctuations of the water table precipitated iron as various oxide minerals from iron-containing groundwater over a long period of time, and the iron oxides have cemented the original sediment (GCS 2007). Research also indicates that the characteristics of ironstone are likely to have been influenced by the plant community that historically occurred on these wetlands (Pate *et al.* 2001). The ironstones are still in the process of accumulating in the pore spaces of the existing geological materials whilst the shallow groundwater level fluctuates (GCS 2007).

The ironstone appears to be relatively impermeable. However, when exposed, cavities and vertical holes that penetrate the ironstone are evident. It is likely that occurrences that are devoid of larger plants have fewer or smaller cavities, as these cavities would be utilised by plant roots to access the groundwater within and beneath the ironstone. The origin of cavities within the ironstone is not known, but it is possible they represent pre-existing plant roots around which the ironstone was deposited (GCS 2007).

The community relies on relatively shallow groundwater depth in summer and autumn (1-2 m below ground). Ponding occurs in low-lying areas during the winter because vertical drainage of rainfall and runoff is prevented by shallow groundwater (Burton 2007). Inundation usually persists for a period of around three months, although some occurrences may typically have little surface water.

The heath and shrublands of the Scott River Ironstone Association are variously dominated by *Melaleuca preissiana*, *Hakea tuberculata*, *Kunzea micrantha* or *Melaleuca incana* subsp. Gingilup, depending on the degree of waterlogging. The understorey is generally dominated by *Loxocarya magna*. All occurrences, except the long inundated wetlands and dense thickets, have very diverse annual flora of *Stylidium* spp., *Centrolepis* spp., *Schoenus* spp., *Aphelia* spp. and other herbs. A list of taxa that occur in at least two sites in the community (from Gibson *et al.* 2000) occurs in Appendix 1.

The community contains a number of taxa that are listed as threatened or priority flora (Smith 2013; Table 1) and are either restricted or largely restricted to it (Gibson *et al.* 2000). As mentioned, another area of ironstone soils occurs on the Swan Coastal Plain near Busselton, and some of the taxa that are confined to ironstone soils occur in both these areas. Only three of the 20 taxa listed in this table are common to both areas however, and the plant communities are considered to be quite distinct.

Tille and Lantzke (1990d, 1990e) mapped the ironstone substrate in the Scott River area. Gibson *et al.* (2000) determined from this mapping that the original extent of the community was about 1780 hectares. Currently about 405 ha remain uncleared. This represents a loss of 78% of the area of a plant community that was originally highly restricted in distribution. Since the first recovery plan was completed all areas of the TEC that are known on private land, have been surveyed. These surveys indicated that there is now approximately 1385

ha less of the community than previously thought. The loss is related to some occurrences being identified as completely degraded and therefore no longer being representative of the community. Vegetation in other areas was found not to correlate with the floristics and habitat as described for the Scott Ironstone community. New occurrences have now been located within D'Entrecasteaux National Park however.

A total of 405 ha of the community is recorded on the TEC database; 311 ha is on public lands, which includes 111 ha in nature reserves, 16 ha in the Scott River and D'Entrecasteaux National Parks and 184 ha under the care, control and management of other authorities, mainly the Shire of Augusta-Margaret River. Another 94 ha of the community occurs on private land.

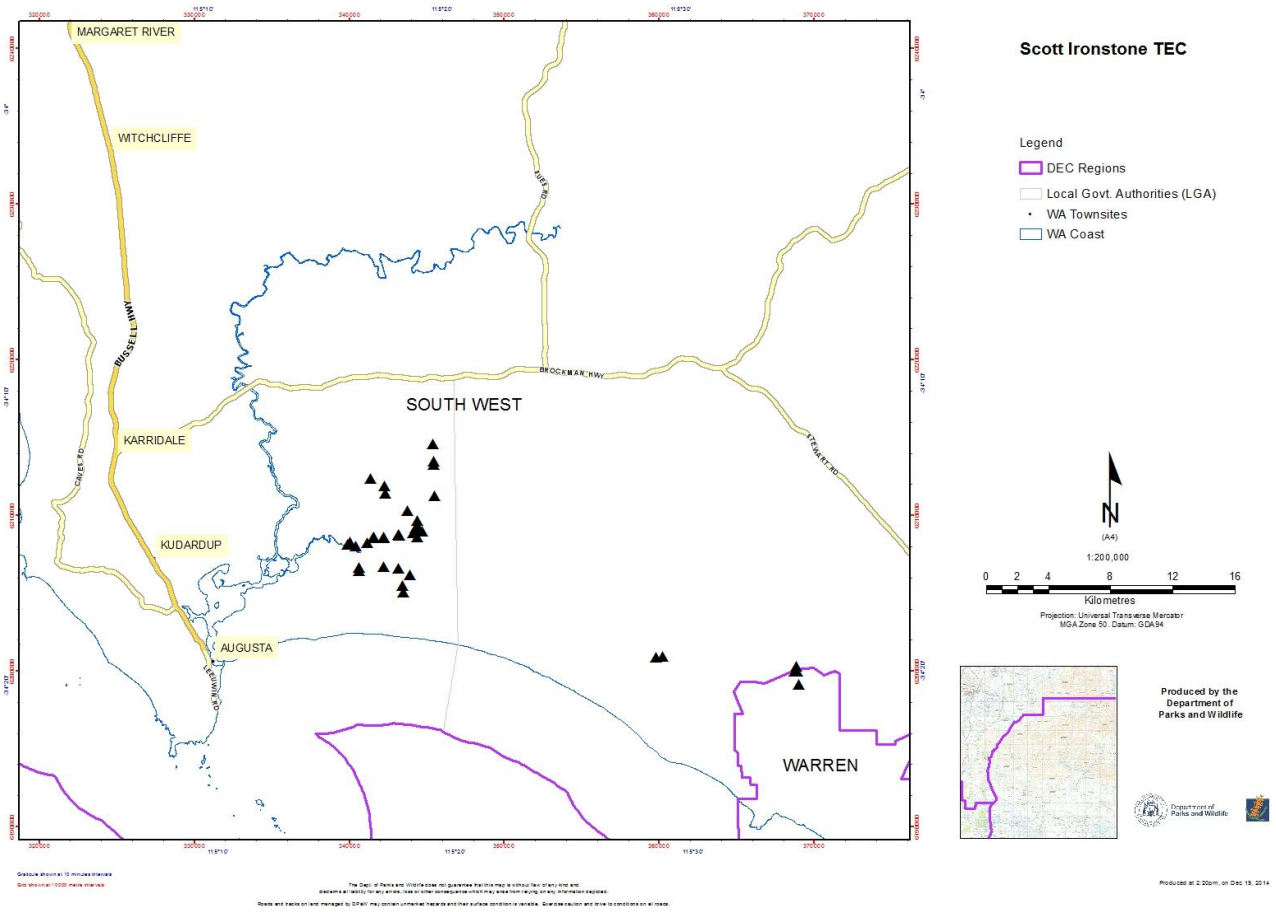

Figure 1 Location map of occurrences

Table 1: Taxa restricted or largely restricted to ironstone soils of the Swan, and Scott Coastal Plain (from Gibson *et al*. 2000).

Taxon	Conservation status (WA)	Swan Coastal Plain ironstone	Scott Coastal Plain
Andersonia ferricola	P1	+[E]	
Gastrolobium modestum	Declared rare flora (DRF) (VU)	+	
Gastrolobium papilio	DRF (CR)	+[E]	
Chamelaucium sp. S coastal plain (R.D. Royce 4872) (formerly *Chamelaucium roycei* ms)	DRF (VU)	+	
Darwinia whicherensis Keighery (formerly *Darwinia* sp. Williamson (GJ Keighery 12717) [aff. *apiculata*])	DRF (CR)	+[E]	
Banksia squarrosa subsp. *argillacea*	DRF (VU)	+[E]	
Grevillea elongata	DRF (EN)	+[E]	
Grevillea maccutcheonii	DRF (CR)	+[E]	
Hakea oldfieldii	P3	+	
Lambertia echinata subsp. *occidentalis*	DRF (CR)	+[E]	
Petrophile latericola	DRF (CR)	+[E]	
Banksia nivea subsp. *uliginosa* (formerly *Dryandra nivea* subsp. *uliginosa)*	DRF (EN)	+[E]	+
Calothamnus lateralis var. *crassus*	P3	+[E]	+
Loxocarya magna	P3	+	+
Darwinia ferricola	DRF (EN)		+[E]
Grevillea manglesioides subsp. *ferricola*	P3		+[E]
Hakea tuberculata			+
Lambertia orbifolia subsp. Scott River Plains (LW Sage 684)	DRF (EN)		+[E]
Melaleuca incana subsp. Gingilup (N Gibson & M Lyons 593)	P2		+[E]

[E] = Endemic to ironstone

VU = vulnerable; EN = endangered; CR = critically endangered

Table 2: Extent and location of occurrences
Total area = 405 ha

Occ. number	Location and site ID	Land use	Land manager	Purpose (if officially listed)	Estimated area (ha)	Major threats	Comments and vegetation condition rating
1	Gingilup Swamps Nature Reserve (NR) 30626 (GSNR8, GSNR9)	Nature Reserve	Department of Parks and Wildlife	Conservation of Flora and Fauna	59.9 ha	Clearing for access tracks and firebreaks, fire (too frequent).	Condition 2013: Excellent (except tracks). Pig activity observed in 2013. Contains quadrats.
2	Milyeannup Coast Road reserve and unallocated Crown land (UCL) (SCOTT02NTH)	public roads/UCL	Shire of Augusta Margaret River/ Department of Regional Development	Road reserve/ no purpose listed	2.4 ha	Road maintenance activities, historically grazed, invasion by pasture and grassy weeds.	Remaining occurrence on road reserve and UCL: degraded, (decline in ironstone species north on road reserve). previously on private property, now completely degraded.
3	Crown reserves 25373 and 12951 (SR19, SRFE01, SRFE02)	National Park/Camping Reserve	Department of Parks and Wildlife / Shire of Augusta Margaret River	Conservation of Flora and Fauna/ Water, Camping and Recreation Reserve	20.4 ha	Clearing, fire (too frequent), road maintenance activities	Condition 2013: Excellent, some minor weed invasion. Contains quadrats.
4	Western verge of Dennis Road (MYDENIS01)	public roads	Shire of Augusta Margaret River	Road reserve	3.5 ha	Road maintenance activities, historically grazed, invasion by pasture and grassy weeds	Occurrence requires survey to determine condition and extent.
5	Denis Road reserve; Pagett Nature Reserve 45922 (CHESTER01)	Public roads, Nature Reserve	Shire of Augusta/ Margaret River Department of Parks and Wildlife	Road Reserve / Conservation of Flora and Fauna	2.6 ha	Grazing (kangaroos), recreational activities, off road vehicles,	Condition 2010: Mainly excellent, Contains quadrats in Pagett Nature Reserve.
6	Scott River; (MY4155STH)	UCL	None listed (adjacent to river)	No purpose listed	0.7 ha	Grazing (cattle and kangaroos)	Condition 2010 very good. Previously extended into adjacent private land. Fenced in 2013. Aboriginal site
7	Scott River Road (MY4155WEST)	Freehold	Private landowner	No purpose listed	4.9 ha	Grazing (cattle, historically sheep grazing caused severe erosion), weed invasion, mostly pasture weeds.	Condition 2010: Very good Fenced in 2013. Aboriginal site

Occ. number	Location and site ID	Land use	Land manager	Purpose (if officially listed)	Estimated area (ha)	Major threats	Comments and vegetation condition rating
8	Scott River Road (MY4155CNTR)	Freehold	Private landowner	No purpose listed	1.7 ha	Grazing (cattle, kangaroos), weed invasion (a few native species including. *Melaleuca incana* surviving despite pasture weeds.	Condition 2010: mostly degraded. Aboriginal site
9	Scott River Road (MY4155EAST)	Freehold	Private landowner	No purpose listed	8.5 ha	Grazing (cattle, kangaroos), weed invasion by pasture weeds	Condition 2010: good in area fenced adjacent to river. Additional fencing installed in 2013. Unfenced area completely degraded. Aboriginal site (western portion)
10	Governor Broome Road (MY4156) (MYGVBMN4) (MYGVBMN5)	Freehold	Private landholder	No purpose listed	66 ha	Historical disturbance in north eastern portion. High levels of kangaroo impact, cattle grazing, fire (too frequent), vegetation clearing, (accidental destruction of road reserves	Condition 2013: majority excellent, remainder completely degraded.
11	Crown Reserve 12951; Scott River Road (MY12951SE)	Crown Reserve/ Freehold	Shire of Augusta Margaret River/ Private landholder	Water, Camping and Recreation Reserve/ no purpose listed	16.1 ha	Cattle use firebreak as thoroughfare between private land and reserve, kangaroo grazing and disturbance, weed invasion (along firebreaks).	Condition 2010: excellent Aboriginal Site - Scott River tributary.
12	Scott River Road 38071 (MY4264NTH) (MY4264STH)	Freehold	Department of Parks and Wildlife	No purpose listed	116 ha	Vegetation clearing, disease (dieback detected) grazing impacts (kangaroos and pigs), fire (too frequent), weed invasion (minor weeds on easement through the middle).	Condition 2005: excellent. The area is surrounded by a 1.8m high herbivore exclusion fence which will reduce the impact of trampling and grazing on the vegetation.
13	Governor Broome Road (MY4262NTH)	Freehold	Private landholder	No purpose listed	3.4 ha	Cattle grazing, fragmentation (large edge to area ratio), weed invasion, vegetation clearing, fire (too frequent).	Skeletal soils with low species richness, difficult to determine threat impacts. Condition 2005: 100% very good. Requires fencing.

Occ. number	Location and site ID	Land use	Land manager	Purpose (if officially listed)	Estimated area (ha)	Major threats	Comments and vegetation condition rating
14	Governor Broome Road (MY4262CN2)	Freehold	Private landholder	No purpose listed	2.2 ha	Cattle grazing, fragmentation (large edge to area ratio), weed invasion, vegetation clearing, fire (too frequent).	Skeletal soils with low species richness, difficult to determine threat impacts. Condition 2005: excellent
15	Governor Broome Road (MY4262CN3)	Freehold	Private landholder	No purpose listed	1.0 ha	Cattle grazing, fragmentation (large edge to area ratio), weed invasion, vegetation clearing, fire (too frequent).	Skeletal soils with low species richness, difficult to determine threat impacts. Condition 2005: excellent Requires fencing
16	Scott River Road adjoining Crown Reserve 25373 (MYSCTRDW)	public roads	Shire of Augusta Margaret River	Road Reserve	0.6 ha	Altered surface drainage (ponding from road)	Condition 2010: mainly excellent, remainder very good
17	Crown Reserve 42377 (MY42377)	Nature Reserve (C Class)	Department of Parks and Wildlife	Conservation and protection of flora and fauna	48.0 ha	No obvious threats observed. Some low level kangaroo grazing.	Condition 2005: excellent
18	Scott River Road adjoining Crown Reserve 25373 (MYSCTRDW2)	public roads	Shire of Augusta Margaret River	Road reserve	0.66 ha	Vegetation clearing (road reserves subject to accidental destruction), fire (road reserves frequently subject to burns), disease (inundated shallow soils extremely dieback susceptible).	Condition 2003: Mostly excellent, remainder very good
19	Crown Reserve 12951 and Governor Broome Road (MYGVBMN1) (SRFE03)	Crown Reserve/public roads	Shire of Augusta Margaret River	Camping, Recreation, Waterway/Road reserve	4.6ha	Fire (too frequent- pole top fire in 2007), vegetation clearing (road maintenance activities), disease (shallow, inundated soils extremely susceptible to dieback), grazing (kangaroos, cattle).	Crown Reserve condition 2010: excellent. Road Reserve condition 2003: mainly excellent, remainder very good Contains quadrats. Aboriginal site on Scott River tributary
20	Governor Broome Road (MYGVBMN2) (MYGVBMS2)	public roads	Shire of Augusta Margaret River	Road reserve	3.3 ha	Fire (too frequent- pole top fire in 2007), road/rail/utility maintenance- clearing/ slashing/ herbicide drift.	Condition 2010: excellent (edge survey)

Occ. number	Location and site ID	Land use	Land manager	Purpose (if officially listed)	Estimated area (ha)	Major threats	Comments and vegetation condition rating
21	Governor Broome Road (MYGVBMS3) (SRFE04)	public roads	Shire of Augusta Margaret River	Road reserve	8.2 ha	Fire (too frequent- pole top fire 2007), road/rail/utility maintenance-clearing/slashing/herbicide (transmission power line installed at east end), cattle movement along road verge, dieback and weeds.	Condition 2010: excellent Contains quadrats.
22	Dennis01	public roads	Shire of Augusta Margaret River	Road reserve	0.3 ha	Vegetation clearing (road reserves subject to accidental destruction), fire (road reserves frequently subject to burns), disease (inundated shallow soils extremely dieback susceptible	Condition 2012: good
23	Dennis02	public roads	Shire of Augusta Margaret River	Road reserve	0.3 ha	Vegetation clearing (road reserves subject to accidental destruction), fire (road reserves frequently subject to burns), disease (inundated shallow soils extremely dieback susceptible	Condition 2012: good
24	Crown Reserve 36996; UCL Gingilup Road Reserve (BPointiron, DentNP01, 02, 03)	D'Entrecasteaux National Park UCL public roads	Department of Parks and Wildlife Shire of Nannup	National Park and Water UCL Road reserve	24.6 ha	Fire (too frequent). Last burnt 2011),	Occurrence extent and community sub type need elucidation. Occurrence requires survey to determine extent and to attribute, where appropriate, the sub-community type as per Gibson *et al.* (2000).
25	Scott River Road (MY4264Wst)	Freehold	Private landholder	No purpose listed	5.6ha	Vegetation clearing, disease (dieback), grazing impacts (kangaroos), fire (too frequent), weed invasion.	New occurrence inspected December 2012. Good to degraded condition Fence requires maintenance.

Vegetation condition rank based on Bush Forever scales (2000)
Occurrences MYGVBMN6 and MYGVBMS6 were deemed not to represent this community and have been deleted from the TEC database.

1.2 Description of occurrences

Occurrence 1 (GSNR8, GSNR9) is located in the north central section of Gingilup Swamps Nature Reserve. The occurrence has been burnt a number of times including 1993, 2002, 2004 and 2011. Observations in 2013 noted vegetation is recovering well post fire. A dieback gate is located at the western end of the reserve.

Occurrence 2 (SCOTT02NTH) historically occurred on north and south Milyeannup Coast Road. Survey in 2010 indicated the section of the occurrence to the north on private property was completely degraded.

Occurrence 3 (SR19, SRFE01, SRFE02) occurs on Crown Reserves 25373 and 12951, Scott River Road. This occurrence was burnt in 1995 however appears to have fully recovered, with observations recorded in 2013 indicating the vegetation was in excellent condition.

Occurrence 4 (MYDENIS01) is a small occurrence located on the western side of Dennis Road reserve.

Occurrence 5 (CHESTER01) occurs in Pagett Nature Reserve and adjoining road reserve. Previously included the site (MYDENIS02) which ran along a large section of Dennis Road reserve, however survey in 2010 indicated this area did not align with the floristics of the community.

Occurrence 6 (MY4155STH) is located along the Scott River banks. Fencing was extended in 2013 to protect the remaining vegetation in good condition.

Occurrence 7 (MY4155WEST) is located on private property near the Scott River. The area was historically grazed but in 2013 the ironstone community and the vegetation extending to the Scott River was fenced.

Occurrence 8 (MY4155CNTR) is located on private property north east of Scott River. Weeds within this occurrence are significant and have virtually out-competed the native understory. Some native herbs still persist however. Fencing is required to alleviate grazing pressure.

Occurrence 9 (MY4155EAST) occurs on private property adjacent to the Scott River Reserve. A fence remains which previously surrounded the mapped occurrence, however the majority of this vegetation is now degraded. In 2013 fencing was erected along the north west boundary of the occurrence that contains vegetation in good condition.

Occurrence 10 (MY4156, MYGVBMN4, MYGBMN5) is located south of Governor Broome Road and is mostly in excellent condition, with small areas completely degraded. A diverse suite of vegetation units that do not co-occur with any other occurrences of the Scott ironstone community occur at this site. The area was recently purchased by a private owner and is proposed for intensive farming with large areas of vegetation recently proposed for clearing. Maintaining close liaison with the new owner is required to ensure the areas in good condition are conserved and values are protected.

Occurrence 11 (MY12951SE) is located on a tributary of the Scott River on Augusta-Margaret River Shire reserve land and private property. The Shire reserve portion has been proposed as an addition to the Scott River National Park. The landowner noted that most of the property has not been burnt since the 1980s, and no evidence of fire was observed during a survey in 2010. A fire management plan has been prepared as part of the requirements of a subdivision on the private lot.

Occurrence 12 (MY4264NTH) (MY4264STH) occurs on land that was previously owned by a mining company, but has been transferred to the State and is under the care, control and management of the Department. The weed infested firebreak is being revegetated. Two previously separate remnants now comprise a single occurrence.

Occurrences 13, 14 and 15(MY4262NTH) (MY4262CN2) (MY4262CN3) are all on skeletal soils over ironstone outcropping. Occurrences are not fenced and are subject to grazing. These areas are a priority for survey.

Occurrences 16 and 18 (MYSCTRDW) (MYSCTRDW2) are affected by altered surface drainage, with water accumulating in areas from runoff from Scott River Road. A recorded occurrence east of Scott River Road was cleared. The boundaries require survey.

Occurrence 17 (MY42377) occurs in Nature Reserve 42377 off Dennis Road. The site is surrounded by cleared agricultural land.

Occurrence 19 (MYGVBMN1, SRFE03) is located along Governor Broome Road reserve and adjoining crown land. The majority of vegetation is in excellent condition.

Occurrence 20 (MYGVBMN2, MYGVBMS2) is located on Governor Broome Road reserve, with the majority of vegetation in excellent condition.

Occurrence 21 (MYGVBMS3, SRFE04) is located on Governor Broome Road reserve with the majority of vegetation in very good to excellent condition.

Occurrences 22 and 23 (Dennis01, Dennis 02) are partly located in Dennis Road reserve, with the majority of the vegetation in good condition.

Occurrence 24 (BPointiron, DentNP01, DentNP02, DentNP03) This is the only occurrence that occurs within the Department's Warren Region. Occurs mainly within D'Entrecasteaux National Park and extends north into Gingilup Road reserve and unallocated Crown land (UCL).

Occurrence 25 (MY4262Wst) is located approximately 300m north west of Occurrence 12.

Data on all known occurrences of threatened ecological communities are held in the Threatened Ecological Community Database at the Department's Species and Communities Branch, Kensington.

1.3 Biological and ecological characteristics

The ironstone soils of the Scott Coastal Plain generally experience surface water in wetter months. Many of the plant taxa present, including priority and threatened flora species, are restricted to sites that experience seasonal inundation, for example *Darwinia ferricola* Keighery. The characteristic herb layer is also likely to rely on inundation in the wetter months.

Occurrences of the Scott River Ironstone Association are highly variable in floristic composition. This level of variation appears to be quite closely linked to soil depth and type. Gibson *et al.* (2000) analysed data from 16 floristic plots to identify different 'sub-communities' on the ironstones of the Scott River Plain. The following units from Gibson *et al.* (2000) are considered sub-communities of the Scott River Ironstone Association, in this plan. Not all occurrences have been attributed to these sub-communities.

Community type 4 consists of the species rich (average of 50.7 species per plot) vegetation on massive ironstones of the Scott Plain. It is differentiated by the occurrence of *Calothamnus lateralis* var. *crassus* and *Velleia trinervis*. Occurrences 1, 3, 5, 19, 21 contain this sub-community.

Community types 5 and 6 occur on the Scott Plain on sandier substrates over massive ironstone. Community type 5 is species rich (average 44 taxa), when compared to community type 6 (average 27 taxa). Community type 5 occurs in Occurrence 10 and 11. Community type 6 occurs closer to the coast, and the presence of species such as *Agonis flexuosa* reflect this. Occurrence 2 contains sub-community type 6.

Community type 8 occurs on massive ironstones on the Scott Coastal Plain. This community type typically is a dense tall shrubland with low species richness (average of 27.3 species). The dense, closed nature of the community prevents the occurrence of the diverse herb flora that is seen in the more open sub-community type 4 that occurs on similar massive ironstones. Occurrences 12 and 21 contain this sub-community.

Community type 9 is a single occurrence found in Gingilup Nature Reserve (Occurrence 1) and consists of a deep winter wet swamp dominated by the ironstone endemic *Melaleuca incana* subsp. Gingilup. Species richness is low (average of 14 taxa), apparently restricted by the long period of inundation (up to 30-50cm) which extends well into the summer. Species typical of winter wet swamps such as *Hakea linearis*, *Baumea juncea*, *Meeboldina scariosa*, *M. tephrina* ms. and *Platychorda applanata* occur in this site.

1.4 Groundwater hydrology

The Scott River Ironstone Association is located within the superficial formations of the Scott Coastal Plain. The major formations are the Guildford Formation sands, overlain by Bassendean Sands (Rockwater 2004). Aquifers in the superficial formations comprise the superficial aquifer. The aquifer has a thickness of about 10 metres (Baddock 1995) and is characterised by a shallow water table positioned at or near the ground surface. Seasonal water table fluctuations in the superficial aquifer are variable, ranging from one metre at the coast to three metres further inland. The aquifer is unconfined and receives recharge from rainfall, and in the northwest, discharge from the Leederville and Yarragadee aquifers (Rockwater 2004). Vertical and lateral hydraulic gradients vary and are generally low, with the general flow direction being to the south (URS 2003).

The major aquifer of the Scott Coastal Plain is the Yarragadee Aquifer. It is recharged through infiltration of rainfall on outcrop areas and through leakage from overlying aquifers to the east and southwest. Groundwater gradients are generally southwards to the coast and the average groundwater salinity is less than 500 mg/L (fresh).

Secondary processes have locally changed the physical properties of some of the superficial formations. Rockwater (2004) reports on ferruginous-cemented sandstone, termed bog-iron or coffee rock (Baddock, 1995) that is widely developed in the Guildford Formation, around the zone of fluctuations of the water table. This ferruginisation of the Guildford Formation has a variable thickness and is laterally discontinuous, which means it doesn't form a large scale barrier to the vertical seepage of groundwater. However, at a fine scale the precipitation of iron changes the physical properties of the Guildford Formation, which can increase moisture retention where the average water table is below the base of the formation. The ferruginisation of the Guildford Formation is not thought to prevent, or limit, discharge from the Leederville and Yarragadee aquifers recharging the superficial aquifer. Where water tables are at, or below the base of the superficial aquifer, the rate of vertical and lateral groundwater flow will be lower where the Leederville Formation is the underlying aquifer, in comparison to the Yarragadee aquifer. This difference in behaviour is due to the Leederville aquifer being comprised of a higher percentage of lower permeability materials, such as shales, siltstones and clays, commonly referred to as confining layers.

The ferruginisation of the Guildford Formation and the physical properties of the underlying geology are both considered important in local moisture retention that sustains the plant assemblages of the Scott River Ironstone.

Shallow groundwater levels fluctuate naturally due to seasonal conditions, and have been altered locally due to changes in land use and groundwater abstraction. The clearing of native vegetation has increased surface water runoff and groundwater recharge, and these increases have been countered by groundwater abstraction to irrigate annual crops and pastures that have replaced the native vegetation. However, higher volumes of groundwater are abstracted from the Yarragadee aquifer, and where groundwater abstraction occurs through pumping this is most easily achieved with homogeneous aquifers characterised by materials with high porosities and permeability, such as sands. The heterogeneity of the ferruginised Guildford

Formation (Scott River Ironstone) and the underlying Leederville and Yarragadee aquifers complicates reliably quantifying the impacts of abstraction.

When water is pumped from deeper aquifers, vertical leakage can be difficult to predict. Groundwater use from deeper aquifers is less likely to impact the community due to the presence of confining layers, particularly within the Leederville Aquifer and the Scott River Ironstone itself (GCS 2007). Water levels near major production bores to supply irrigated agriculture in the area in the western part of the Scott Coastal Plain have decreased by 0.5 to 2m in 10 years. Water levels in bores on the eastern part of the plain are stable (Department of Environment 2003). In the western area the Leederville aquifer underlies the Scott River Ironstone Association and this may be reducing, or slowing recharge from rainfall compared with the eastern area where the Yarragadee aquifer underlies the communities. The volume and timing of groundwater abstracted can both influence water level observations and this must be taken into account when determining impacts to the water table. Any groundwater use that has the potential to lower the summer minimum groundwater levels at the water table by more than 0.3m should be considered a potential threat (GCS 2007).

Table 3: Bores within 1000m of occurrences: depth to groundwater - static level (m) below ground when drilled.

Occurrence Number	Depth to groundwater (static m below ground)*
1	-0.6m on 05/11/1998 (bore located 600m north east) Site_Id-20004391
3	-1.68m on 19/05/2000 (bore located 160m east) Site_Id-23001608 -2.74m on 30/06/1979 (bore located 458m south) Site_Id-20004395 -2.15m on 28/05/2009 (bore located 600m north) Site_Id-8532253 -4.30m on 28/05/2009 (bore located 657m north) Site_Id-8532246
4	-1.2m on 19/5/2000 (bore located at site) Site_Id-23001164
5	-0.64m on 04/11/1998 Dennis Road Site_Id-20004376
10	-1.3m on 19/05/2000 (bore located 1000m north east) Site_Id-23001611
11	-2.15m on 28/05/2009 (bore located 657m north west) Site_Id-8532253 -4.30m on 28/05/2009 (bore located 657m north west) Site_Id-8532246 -1.68m on 19/05/2000 (bore located 250m west) Site_Id-23001608 -4.27m on 15/04/1977 (bore located 300m east) Site_Id-20004393
17	-1.2m on 19/05/2000 (bore located 300m south east) Site_Id-23001164
19	-0.9m on 04/05/2005 (bore located 333m east) Site_Id-23020199 -2.15m on 28/5/2009 (bore located 900m west) Site_Id-8532253 -4.30m on 28/5/2009 (bore located 900m west) Site_Id-8532246
24	-1.7m on 23/06/2003 (bore located 500m north) Site_Id-23020005 -1.000 on 19/04/2005 (bore located 600m south) Site_Id-23020187

*Data obtained from Department of Water – Groundwater sites. Water INformation (WIN) database

1.5 Soils and Landform

Ironstone appears to occur as a relatively continuous layer beneath the Scott Coastal Plain. This is supported by the geological records in Mohsenzadeh (1999), in which "coffee rock" to about 2m thickness was observed in most drill-holes (GCS 1997).

Tille and Lantzke (1990 b, c, d and e) mapped the soils and landforms on private land in the Busselton-Margaret River-Augusta area, as follows. The majority of occurrences of the community are located within the Scott River Plain land system, consisting of 'Scott Wet Ironstone Flats' (Swi) described as poorly drained flats and depressions with lateritic boulders and outcrop and bog iron ore soils. Three occurrences (17, 5 and 1) occur on patches of 'Scott Deep Sandy Flats' (Sd) (extensively poorly drained flats with bleached sands), 'Scott Deep Sandy Wet Flats' (Swd) (extensive flats and depressions with very poor drainage and wet sands),

and 'Scott Deep Sandy Gentle Rises' (Sd2) (small sandy rises or dunes with bleached sands). Occurrences 2 and 6 are located on 'Scott Ironstone Rises' (Si) described as small raised knolls with laterite outcrop and shallow reddish sands.

1.6 Habitat critical to survival

The habitat critical for survival of the Scott River Ironstone Association comprises:

- the area of occupancy of known occurrences;
- areas of similar habitat within 200 metres of known occurrences, i.e. sandy ironstone soils or grey sands over ironstone, and around winter wet areas near the coast (these provide potential habitat for natural range extension);
- 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 groundwater that maintain the winter-wet habitat of the community (the plant community would be dependent on maintenance of the local hydrological conditions).

1.7 Important occurrences

Occurrences with comparatively large intact areas of the community that are in relatively good condition are considered important. Occurrences that provide for representation of the community across its geographic range and those that can be managed for conservation and/or with conservation included in their purpose are also considered important.

Comparatively large intact areas of the community that are in good condition or better are considered important occurrences. Occurrences that provide for representation of the community across its geographic range and include representative sub types, and that can be managed for conservation and/or with conservation included in their purpose are also considered important. Important sites include Gingilup Nature Reserve, other Crown reserves, and freehold sites that are being managed by the Department of Parks and Wildlife. Occurrence 10 is considered to be highest priority for acquisition or an alternative mechanism of pursuing conservation management.

1.8 Related biodiversity benefits

Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community. Declared rare and priority flora occur within many occurrences and include *Lambertia orbifolia* subsp. Scott River Plains (ranked EN in WA and the EPBC Act*), Darwinia ferricola* Keighery and *Banksia nivea* subsp. *uliginosa* (both ranked EN in WA and EPBC Act), *Grevillea brachystylis* subsp. *australis* (ranked EN in WA, and VU under EPBC Act), *Calothamnus lateralis* var. *crassus* (Priority 3), *Loxocarya magna* (Priority 3), *Grevillea manglesioides* subsp. *ferricola* (Priority 3) and *Melaleuca incana* subsp. Gingilup (Priority 2). Records of threatened and priority fauna that occur within the Scott Ironstone Association or within the surrounding buffer are listed in Appendix 3. Recovery actions implemented to improve the quality or security of the community are likely to also benefit threatened and priority flora and fauna populations.

1.9 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 Scott River Ironstone Association is not specifically listed under any international

agreement, the implementation of other international environmental responsibilities is not affected by this plan.

1.10 Affected interests

Occurrences of the community are located on land managed by Parks and Wildlife, Shire of Augusta Margaret River, Shire of Nannup and private land holders. Land owners and managers may be affected by actions in this plan, in particular where land is not managed primarily for conservation.

1.11 Indigenous interests

According to the Department of Aboriginal Affairs Register of Aboriginal sites, investigation into the Aboriginal significance of wetlands and rivers in the Busselton-Walpole Region (O'Connor *et al*. 1995), there are a number of registered sites including Scott River Road ochre deposit and Scott River, which are known in the vicinity of occurrences of the Scott River Ironstone Association. Implementation of recovery actions under this plan includes consideration of the role and interests of indigenous communities in the region.

1.12 Social and economic impacts and benefits

The implementation of this recovery plan has the potential to have some social and economic impact as some occurrences are located on private property and other lands not managed specifically for conservation. Areas on private land that are considered to be 'habitat critical' may be regarded as having potential for uses other than conservation by landholders. Approaches that may minimise this potential impact could include conservation covenants, management agreements or land acquisition. There are mineral exploration and extraction leases over the areas of land containing most occurrences of the community. Recovery actions refer to continued liaison between stakeholders with regard to these areas.

1.13 Historical and current threatening processes

Dieback disease

A number of plant taxa that occur in the community, particularly members of the families Proteaceae and Ericaceae (Epacridaceae), are highly susceptible to dieback caused by *Phytophthora* species. Most occurrences are thought to be infected with the disease. After a number of deaths of species in occurrence 12, testing confirmed the presence of the disease. Dieback has the potential to seriously impact species diversity and the community in general, through loss of remaining populations of some taxa. In particular, areas that contain low scrub on very shallow, often inundated soils over ironstone are considered to be extremely favourable for the spread of the disease (Obbens and Coates 1997). As yet no sites have been sprayed with phosphite to control the disease.

Recent research has resulted in the discovery of two new dieback species in the Scott River area; *Phytophthora gibbosa* and *Phytophthora gregata*. These two species are closely related. *P. gibbosa* is known only from a very limited area in the southwest of Western Australia around Scott River where it has been found to be associated with dying native vegetation on seasonally wet sites. *P. gregata* occurs within but is not restricted to the Scott River area, and is also found to occur in native vegetation on permanently or seasonally wet sites. It has a scattered distribution in WA and is known to occur in eastern Australia. It is a successful species with a high genetic variability. Both of these *Phytophthora* species appear to be opportunistic pathogens that are associated with sporadic but severe mortality on wet sites or after episodic favourable conditions such as heavy rain or flooding (Jung *et al*. 2011).

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

Myrtle rust

Myrtle Rust (*Puccinia psidii s.l. syn. Uredo rangelii*) is a fungal disease that has the potential to infect many species of plants belonging to the family Myrtaceae (Department of Agriculture and Food 2013). It was first detected in a commercial nursery in eastern Australia in 2010. Dispersal of rust spores through wind, honey bees, and via contaminated clothing, infected plant material and insect movement. Myrtle rust has the potential to spread into south Western Australia and many plant species occurring in the Scott Ironstone community are potentially vulnerable to infection by this disease if introduced into the State.

Clearing and physical disturbance

The Scott River Plain has recently been extensively cleared for agriculture, although large areas of remnant vegetation still remain. Most of the remaining occurrences of the TEC are on private property and not in secure conservation reserves (Gibson *et al*. 2000). Since the original mapping of the community in 1993, a number of occurrences consisting of 77.3 hectares, of the Scott Ironstone community have been cleared. These occurrences were cleared for mining and agriculture and have not regenerated.

The presence of threatened ecological communities is considered by the Department of Environment Regulation (DER) when evaluating the impact of any proposed development. As a result of 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 and any clearing proposals in a threatened ecological community are to be undertaken under a specific permit unless exempted by a law.

Road, track and firebreak maintenance activities 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, can threaten the integrity of the community. These disturbance events often encourage weed invasion into the adjacent habitat, as well as causing damage to vegetation, and may spread dieback.

The Shire of Augusta-Margaret River and other relevant authorities, such as utility providers, have been officially informed of the location of the occurrences so that appropriate protective measures can be implemented. Landowners have been informed of the presence of the community to prevent possible damage due to grazing, crop maintenance, firebreak maintenance or other activities that may threaten the occurrences.

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. Weeds suppress early plant growth by competing for soil moisture, nutrients and light. They also exacerbate grazing pressure and increase the fire hazard due to the easy ignition of high fuel loads, which are produced annually by many weed species.

Grazing of areas on private property has led to the extensive introduction of pasture weeds in most private property occurrences. Major weeds include annual pasture grasses and herbaceous weeds, including *Lotus* species that have invaded to varying extent along tracks and firebreaks. In some roadside occurrences weeds of most concern include kikuyu (*Cenchrus clandestinus)* and wild gladiolous (*Gladiolus undulatus)*. Weeds not

documented in Scott Ironstone occurrences, but have recently been located in damp areas along the Scott River and tributaries include cape tulip (*Moraea flaccida)* and arum lily (*Zantedeschia aethiopica)*.

A weed control program will be necessary to maintain or improve the condition of occurrences of the community in the long term. Brown and Brooks (2002) state that the generic 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 generic weed control program would involve the following steps (adapted from Brown and Brooks 2002):

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

Grazing and trampling

Grazing of plant communities causes alterations to species composition by the selective removal of edible species and the introduction and encouragement of weeds by the addition of dung, and through trampling and general disturbance. The Scott River Plain has been cleared extensively for stock grazing, despite the ironstone flats having poor drainage, and hence providing poor grazing (Tille and Lantzke 1990a). Grazing of the community is believed to have caused extensive alteration to species composition through the selective grazing of edible species, the introduction of weeds and nutrients, trampling, and general disturbance. Most occurrences on private land (7, 8, 9, 10, 13, 14, 15 and 25) are currently grazed, or have been grazed historically, and in some instances only larger shrubs and trees remain. Recent inspections have not observed evidence of stock movement along occurrences on Governor Broome Road, but this may occasionally occur.

High kangaroo numbers are also a threat to a number of occurrences, particularly 5, 6, 8, 9, 10, 11, 12, 17 and 19. Most occurrences are surrounded by cleared paddocks, therefore kangaroos impact greatly on the vegetation through grazing, trampling and breaking foliage when moving through the area. Grazing would also have an impact on the establishment of young plants through limiting natural recruitment.

Altered fire regimes

Mediterranean ecosystems are usually fire responsive and may require a particular fire regime to assist regeneration (Abbot and Burrows 2003). If an appropriate fire frequency 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 senesce and be unable to regenerate. Many of the taxa, in particular declared rare and priority flora, that occur in this community are obligate seeders. Therefore, wildfires or prescribed burns must occur at appropriate intervals, and possibly at the appropriate season and intensity, to sustain the integrity of plant assemblages.

Too frequent fire can increase the risk of invasive weeds establishing within small bushland remnants (Abbot and Burrows 2003). It is likely that the burning regime in remnants that contain the community has been modified to one of more frequent fires, especially hot burns, since European settlement.

Different ecosystems may require particular fire regimes to assist regeneration. There are few data available with which to elucidate which fire regimes enhance/protect the composition of the Scott River Ironstone Association, so what actually constitutes an appropriate fire regime requires investigation. It seems likely that fire regimes such as long periods of fire exclusion and sustained frequent burns, and factors such as post-fire grazing (e.g. by kangaroos and rabbits) and weed invasion, will be detrimental to the 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. A number of occurrences, in particular those along road reserves; have been frequently burnt in the past. Too frequent fires cause increased weed invasion, especially in smaller remnants such as those along roads. Fire response plans were formulated in 2002, for Occurrence 12; Camping Reserve A12591 (Occurrences 3, 12, 17); and Gingilup Nature Reserve (Occurrence 1) and require updating.

Burrows (2008) notes that there is no single optimum fire regime that will meet all management objectives, but that there are fire regimes that can be applied based on available evidence. Burrows (2008), recommends fire regimes based on vital attributes, regimes that provide for diversity of frequency, season and intensity, and provide habitat diversity, and a fine-grain mosaic of habitats. Burrows notes that if fire regimes are implemented in an adaptive management framework they provide good data and can lead to better fire management.

The juvenile period of many species that occur in the community is listed in Appendix 2. Although the juvenile periods of many taxa are not known, the data included in Appendix 2 can be used as a guide. Burrows *et al.* (2008) recommend a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. That is, the juvenile period of plant taxa that are killed by fire and only reproduce from seed can be used as a guide to determine minimum inter-fire intervals. In fire sensitive habitats, this may be increased to 3-4 times the juvenile period for fire sensitive species (Barrett *et al.* 2009). In this case, *Patersonia occidentalis* is a serotinous species that is killed by fire and reproduces only from seed. The juvenile period is 36 months. Therefore, an absolute minimum inter-fire period of six years and up to 12 years would be recommended for occurrences that contain this species. Other taxa in this community also have long juvenile periods; 32 months for *Velleia trinervis* and 24 months for *Acacia pulchella, Cassytha racemosa, Conostylis setigera, Eutaxia virgata, Hakea varia, Hemiandra pungens, Kunzea recurva, Opercularia vaginata* and *Sphenotoma capitata*.

Drying climate needs to be taken into consideration in designing appropriate fire regimes. It is likely that reduced rainfall will cause diminishing growth rates, and plant maturation times will also therefore increase. The interaction of the impacts of *Phytophthora* disease and more frequent fire also needs to be considered in determining inter-fire intervals, as this disease will be an additional source of stress in plant assemblages regenerating from fire. In this case it is known that the Scott River Ironstone Association contains many species that are *Phytophthora* susceptible, and many occurrences are thought to be infected. In addition, juvenile periods for many species that occur in the community are not known, and may be longer than those for which data are available. For all of these reasons, a precautionary approach is required, and longer inter-fire intervals than those suggested only from examining juvenile periods of some species that occur in the Scott River Ironstone Association is therefore advised. An initial absolute minimum inter-fire period of ten years is therefore recommended for the life of this plan unless new information becomes available. Post fire monitoring of recovery of the community is also recommended.

Alterations to water levels

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. Ponding occurs in low-lying areas during the winter because vertical drainage of rainfall and run-off is prevented by shallow groundwater (GCS 2007) or by the presence of impeding layers such as rock or clay.

Some ironstone species are sensitive to rapid groundwater level decline, however in general the ability of the ironstone species to respond to gradually falling water levels is not known. If the groundwater level is to be lowered to a certain depth, the more slowly the water level falls, the more able the plants are likely to be to extend their root systems to follow the groundwater, example in Froend *et al.* 2002. It is also likely that the vascular systems of some plants will have a limiting depth, below which they cannot draw groundwater (GCS 2007).

Production of timber in extensive tree-farms may result in both increased groundwater use and reduced rainfall recharge. Localised lowering of the groundwater table is likely to occur within and down-gradient of established plantations. The effects are unlikely to extend up-gradient by more than 100m or so at most, but local assessment is required (GCS 2007).

URS (2003) state 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.

Acid sulphate soils

A study of acid sulphate soils on the Scott Coastal Plain established that extensive areas of the plain pose a potential acid sulphate soil hazard (Degens & Wallace-Bell 2009) and mineral exploration and extraction leases exist over the land on which most occurrences of the Scott River Ironstone Association occur. Acid sulphate soil is a naturally occurring soil or sediment that contains iron sulfides that occur over extensive low lying areas under waterlogged or anaerobic conditions. Projects such as mineral sands mining that require excavations in areas where these soils are present, lowering the water table or compacting saturated soils or sediments resulting in groundwater extrusion and aeration of soils, may result in soil, groundwater and/or surface water acidity and the release of metals and precipitates. When exposed to air, oxidation takes place and when the soil's capacity to neutralise the acidity is exceeded, sulfuric acid is produced (Appleyard *et al*. 2003). Any proposals to mine are required to be referred to the Department of Mines and Petroleum. The Beenup mineral sands mine on the Scott Coastal Plain was closed in the recent past due to difficulties in managing acid leachate in the tailings (GCS 2007).

In addition to excavation, drainage or dewatering can also lead to the generation of substantial amounts of sulfuric acid. The Water Corporation project entitled 'the South West Yarragadee Blackwood Groundwater Area Project' proposed to abstract 45 GL per year from the southern flowing portion of the Yarragadee aquifer. The eastern part of the Scott Coastal Plain, where the superficial aquifer is in direct connection with the Yarragadee aquifer, would potentially be threatened by acidification as a consequence of any such abstraction (URS 2003).

Changes to nutrient status

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. Nutrient status at surface water sampling sites in the vicinity of the Scott River Ironstone Association occurrences has been measured at some sites for over 30 years. Brennan's Ford sampling site (within 400m of Occurrences 1 and 3), was sampled during the mid 1980s and early 1990s. Data from this longer-term monitoring indicate high levels of nutrient enrichment as agricultural uses in the catchment have expanded and intensified. There has been a noticeable increase in the median total phosphate (TP) concentrations. During the mid 1980s total phosphate and total nitrogen (TN) concentrations were well below the ANZECC guidelines. Less frequent sampling occurred over the following 10 years, but a small number of samples collected in the early 1990s showed TP concentrations approaching or just over the ANZECC guideline. By 2002-04 TP concentrations were over double the ANZECC guideline (White 2010). Nutrient levels in the groundwater are quite high, with a mean level of 8.5mg/L (Mohsenzadeh and Diamond 2000). Despite this, the Scott River shows few and occasional physical symptoms of eutrophication. This could be due to the dark colour of the water which is caused by a high level of tannin, which limits light penetration and algal plant growth (Department of Agriculture 2001). Tannin colouration of the river water is largely derived from the formation of humic acid that occurs when groundwater flows through ironstone deposits within the catchment soil profile (R. Pickett[1] personal communication).

[1] R. Pickett, Department of Water

Current low intensity land-uses are probably not cause for concern with regard nutrients, however new ventures with high nutrient demands up-gradient of the community would require assessment and potentially control measures. Intensive land use or chemical applications up-gradient to the community is a potential threat because surface water and groundwater can carry excess nutrients and pesticides/herbicides from agricultural lands. However, contaminant concentrations in groundwater will reduce as it travels away from the source as a result of dilution, dispersion, adsorption and degradation (GCS 2007).

One of the initiatives of the Hardy Inlet water quality improvement plan (Department of Water 2012) is to reduce nutrient output from the Scott River catchment. Excess runoff of nutrients into the Hardy Inlet has led to algal blooms near the Augusta town site. Initiatives will include effluent, fertiliser, drainage and riparian management.

Salinisation

The salinity of the superficial formations range from 60 to 690mg/L Total Dissolved Solids (TDS), with most falling between 200 and 500mg/L TDS, which is fresh. Higher salinities can be recorded where evaporative concentration of salts occurs. There is no indication in the available groundwater monitoring record of significant salinisation due to land clearing or rising groundwater. Plant species that dominate the ironstone community have a reliance on low salinity groundwater that occurs beneath or within the ironstone during summer and autumn when superficial soil moisture is likely to be exhausted (GCS 2007).

Hydrological changes such as increased groundwater levels, depth or period of inundation may cause salt accumulation near the ground surface. The Scott River area has been identified in the Australian Dryland Salinity Assessment 2000 as an area being at the highest risk from dryland salinity based on groundwater depth and soil system (National Land and Water Resources Audit 2001).

The levels of salinity in the community will need to be monitored to determine the level of threat, and the major sources of the problem 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 significant issue.

1.14 Guide for Decision-Makers

Section 1.13 above provides details of historical and current threats. Impacts on the surface or groundwater that lead to significant changes in water quality or levels would be expected to have a significant impact on the community. Proposed developments in the vicinity of the Scott River Ironstone Association should not be supported unless the proponent can demonstrate that they will have no significant impact on occurrences of the community.

1.15 Conservation status

Assessed 18 July 1996 as Endangered in Western Australia. The community meets criterion B (i) and (iii) as follows, for endangered:

Current distribution is limited and geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); There may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

The Scott River Ironstone Association is also listed as Endangered under the EPBC Act.

1.16 Strategies 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(s): To conserve the ecological and conservation values of the Scott River Ironstone Association through:

- Conservation management of representative samples of each of the identified sub communities of the Scott River Ironstone Association; and
- Minimising the loss and maximising the conservation of all remaining community occurrences as far as practicable, including recovering degraded occurrences where it is cost-effective and practical to do so.

Criteria for success:

- an increase in the number of occurrences of this community managed for conservation and/or with conservation included in their purpose
- an increase in the representation of the sub communities of the community in reserves managed for conservation;
- the total area of the community remains above 300ha
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales)
- increased knowledge about hydrological processes such that there is a comprehensive description of the maximum and minimum water levels that will maintain the community.

Criteria for failure:

- all occurrences of an identified sub-community are cleared, or decline to degraded or completely degraded condition
- the total area covered by the community falls below 300ha
- 10% or more of the known extent of occurrences fall into a lower category of condition (Bush Forever 2000 scales).

3. Recovery Actions

The responsible authority is frequently listed as the relevant Departmental district. This refers largely to initiating and guiding actions. In general however the relevant district, Species and Communities Branch (SCB) and the recovery team share responsibility for securing resources for recovery actions.

Completed Actions

The following actions were implemented as part of the previous interim recovery plan during 2004-2011.

- A report was completed on the hydrology of the ironstone communities, and this information has been included in this plan (GCS 2007).
- The land containing Occurrence 12 (MY4264NTH) (MY4264STH) was transferred to the State to be managed for conservation.
- All land managers were officially notified of the presence of the community on land they own or manage.

- A survey was completed and boundaries determined for the majority of occurrences on private land and data were entered into the Department's Threatened Ecological Communities Database and GIS systems.
- An 'Endangered' article on the 'Scott River Ironstone Association' was published in the Department's *Landscope* magazine and the article was used as an information poster.
- Roadside markers were installed at Gingilup Nature Reserve (Occurrence 1) and along Governor Broome Road.
- Dieback gates were replaced at Gingilup Nature Reserve in 2011.
- Both Governor Broome Road and Scott River Road were declared 'Flora Roads' by the Roadside Conservation committee in recognition of their high flora conservation values.
- The status of Gingilup Nature Reserve 30626 (Occurrence 1), Scott River Banks Nature Reserve 42942 (Occurrence 5) and Nature Reserve 42377 (Occurrence 17) were amended from C Class to A Class reserves.
- Occurrence 12 was fenced with a 1.8m herbivore exclusion fence in the summer of 2011-2012, using the Australian Government's Caring for our Country (CfoC) program funds.
- In 2013 the Lower Blackwood Land Conservation District Committee, in partnership with the South West Catchments Council, initiated the Scott River Project aimed at protecting environmentally sensitive areas including the Scott Ironstone TEC. Funding was provided for fencing of remnant vegetation through CfoC and the Government of Western Australia. Occurrence 7 on private property and Occurrence 6, adjacent to the river, were fenced in 2013 through this project.

Recommended Recovery Actions

1. Coordinate recovery actions

The South West Region Threatened Flora and Communities Recovery Team (SWRTFCRT) and Warren Region Threatened Flora and Communities Recovery Team (WRTF&CRT) will consider issues that relate to all threatened ecological communities and flora in the Department's South West Region and Warren Region. The recovery teams will continue to coordinate recovery actions for the Scott River Ironstone Association and other declared rare flora and threatened ecological communities in their region. They will include information on progress in their annual reports to the Department's Corporate Executive and funding bodies. Occurrence 24 is the only representation of the Scott River Ironstone Association that occurs within the Department's Donnelly District, Warren Region.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Estimated cost:	$2,000 per year
Completion date:	Ongoing

2. Continue liaison with stakeholders to implement this plan

Most of the occurrences of the community are managed by authorities other than the Department, or are privately owned. The involvement of land managers, local landholders, local government agencies, other government departments, and industry in management of the community is therefore essential to the recovery process. In particular the Shire of Augusta-Margaret River's involvement in the recovery of the community will be highly encouraged. Input and involvement will also be sought from any indigenous groups that have an active interest in areas of the Scott River Ironstone Association. Mining companies also hold mining tenements over areas that contain the community and will be encouraged to have greater involvement in conservation of the community.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$2,000 per year for all liaison (not including vehicle costs)
Completion date:	Ongoing

3. Seek long term protection of areas of the community

If suitable areas that contain the community become available, Parks and Wildlife will negotiate to have the remnants that contain the community, and adequate buffer areas where required, protected through reservation as conservation reserves vested with the Conservation Commission of WA or perpetual protection agreements such conservation covenants. The highest priorities for acquisition are the largest areas in good condition on private or public land.

Occurrence 10 is considered to be the highest priority for acquisition, or alternative mechanism of achieving conservation management such as a conservation covenant. High priority areas for conservation vesting on public land include Occurrence 3, 11 and 19 (currently managed by the local government for camping and recreation) and part Occurrence 3 on Camping Reserve A12951. Land containing Occurrence 12 has been ceded to the State and is now managed by the Department.

Responsibility:	Parks and Wildlife (Blackwood District), Landgate, with assistance from the SWRTFCRT, in liaison with landholders and managers
Cost:	Market price of land at time of purchase (private lands)
Completion date:	When resources available

4 Fence remnants that contain the community as required

Fencing is necessary to prevent further degradation by stock grazing where occurrences are in high usage areas. Almost all occurrences on private land would require fencing.

Responsibility:	Parks and Wildlife (Blackwood District) with assistance from the SWRTFCRT, in liaison with landholders
Cost:	Costs of liaison included in recovery action 3; fencing costs $100,000 (perimeter of Occurrences 8, 13, 15 and 10, that require fencing is 4803m and cost of fencing estimated at between $13 and $25/m
Completion date:	Year 1

5. Monitor dieback disease, treat and prevent further spread

The ironstone habitat is inundated over the winter months, and this favours the establishment and spread of *Phytophthora* species. Many plant species in the ironstone community are presumed to be susceptible to this disease. Dieback hygiene (outlined in CALM 2003) will therefore be applied during activities such as installation and maintenance of firebreaks and walking into the population in wet soil conditions. This will involve wash down of any equipment used adjacent to the community, restricting access by vehicles and machinery to dry soil conditions, and disinfecting footwear and other equipment used during foot access.

The presence of dieback disease will be confirmed through survey and mapping of affected areas, collection and testing of suspected soil and plant samples. Priority areas for dieback treatment in the community should be determined using the Dieback Protocol (Dieback Working Group 2000). Dieback fronts within, or very close to, the community will be mapped accurately, and photo monitoring points established. Dieback caused by *Phytophthora* species has been confirmed at Occurrence 12.

Priorities will be assigned for phosphite spraying as required. High priority areas will include sites that are highly susceptible to the disease, and at high risk of infection, and areas already infected and at risk of suffering high level impacts from the disease. The Department will then implement treatments recommended in Dieback Management Guidelines (CALM 1999) for infected areas, commencing with highest priority sites.

Such a strategy should initially be implemented in the community on Departmental 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.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$15,000 in year 1 for dieback mapping; $30,000 in year 3 and 5 for phosphate spraying
Completion date:	Ongoing

6. Develop and implement fire management strategy

Burrows *et al.* (2008) recommends minimum period between fires of at least twice the juvenile period of the slowest maturing species. Information in Appendix 2 indicates that an inter-fire interval of at least six years is likely to be required retain the full species composition of the community. It is essential to have a conservative approach to determining inter-fire intervals however as the juvenile period of many key taxa is not known, the assemblage is a sensitive wetland, drying climate will lengthen the time species take to mature, and as the added stress of dieback disease is impacting at least some occurrences of the community.

As a start point it is recommended that a minimum inter-fire interval of ten years, (and up to 20 years) be implemented for this community, and be applied in a variety of seasons, and intensities. For example 60-80% of the community in one occurrence to be burnt in a low intensity spring burn. This will be interspersed with much longer inter-fire intervals such as 3-4 times the juvenile period of the slowest maturing species, which on currently available information for taxa in the community would be at least 9-12 years. The outcomes of implementation of this regime on the composition and structure of the community need to be quantitatively monitored and results and data analysis incorporated into an adaptive management framework.

A fire management strategy will also include recommendations on fire intensity, season, and control measures. Fire response plans have been developed for Occurrences 1, 3, 12, and 17 and now require updating. In particular, Occurrence 1 in Gingilup Swamps Nature Reserve requires specific guidelines as any further widening of the firebreak is likely to spread disease and weeds within the occurrence. Fire response plans will be developed for all occurrences of this community, using the existing plans as a guide. For those occurrences surrounded by paddocks, a policy of no prescribed or planned burns should be considered unless accompanied by detailed post-fire weed control grazing management plans that can be implemented over a number of years. These plans will be incorporated into the fire management strategy.

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. Where firebreaks are not deemed strategically necessary, for example Occurrence 1, consideration will be given to closure and allowing the community to rehabilitate naturally. Firebreak maintenance should not increase the size of firebreaks and the careful use of herbicides is the preferred method for maintenance because it minimises soil movement and the spread of dieback in the community. There is no current necessity to construct any new firebreaks in occurrences.

It is recommended that Departmental personnel are consulted with regard planning firebreak construction and maintenance for all occurrences of the community and ideally should be present during wildfires and controlled burns to provide advice on protecting the conservation values of the community.

Close liaison will be required between stakeholders to develop and implement the fire management strategy.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT, in consultation with all stakeholders
Cost:	$5,000 in year 2 to prepare of strategy; firebreak maintenance $3,000 pa
Completion date:	Ongoing

7. Survey and describe known and potential occurrences

Currently identified and potential new occurrences need to be surveyed, described and attributed, where possible, to a sub-community as per Gibson *et al.* (2000). Those already attributed to a sub-community need to be confirmed due to the potential inaccuracy of location data of sub-communities surveyed by Gibson *et al.* (2000).

Areas of ironstone have been located along the Scott River, D'Entracasteaux National Park, Adelaide and Snake Springs, and near Black Point. It is not known if these areas are occurrences of the Scott River Ironstone Association sub-communities as described in Gibson *et al.* (2000) or if they represent a new level of variation in the floristic composition in the Scott River Ironstone Association. Quadrats will need to be installed (as per methods used in Gibson *et al.* 2000) and analysis undertaken to ascribe the community types. Additional occurrences will be entered onto the Threatened Ecological Communities Database, including boundary information, condition and threatening processes.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts; Science and Conservation Division) with assistance from the SWRTFCRT WRTF&CRT
Cost:	$6,000 per year
Completion date:	Year 4

8. Monitor extent, boundaries and condition of occurrences

Occurrences will ideally be monitored every five years. This will be dependent on access to occurrences with regards private land. Accurate on-ground GPS mapping of community boundaries has been undertaken within the last six years for all occurrences, excluding Occurrence 1 and 3. Condition mapping has been completed for Occurrences 2, 5, 6, 7, 8, 10, 13 and 17. Changes to extent, boundary and condition information will be added to the Threatened Ecological Community Database.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$5,000 to set up monitoring, then $5000 every fifth year
Completion date:	Ongoing

9. 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 this is required. If any additional occurrences are located, then this will also be determined and mapped for new locations.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts and Science and Conservation with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$10,000 in first year
Completion date:	Year 1

10. Monitor water quality and levels

The Department will seek to have a monitoring program established to provide detailed information about the groundwater regime of the Scott River Ironstone Association. Current high levels of water abstraction in the Scott River Plains may already be impacting the community. Long-term monitoring with a network of bores including some existing bores installed by the Department of Water, would allow measurement of water at different depths in suitable locations. This would assist in determining the likely impacts of any future developments that have the potential to cause further drawdown of major aquifers, or to alter water quality in the vicinity of the community.

The current distribution of bores in the vicinity of the Scott River Ironstone Association is sufficient to monitor regional affects, such as the effect of climate or regional scale groundwater pumping, but is unsuitable to monitor threats specific to the community. Priority should be given to establishing a dedicated monitoring network, in occurrences under the greatest perceived threat (GCS 2007).

Background/long term monitoring should comprise:

- installation of nests of monitoring bores (each nest to comprise three monitoring bores, at different depths). This would enable horizontal groundwater flow directions and vertical groundwater pressure changes to be assessed and monitored;
- installation of staff gauge for measurement of surface water levels where appropriate;
- monthly water level measurement (or data loggers for remote sites) at each monitoring bore and for surface water concurrent with site inspections;
- quarterly testing for basic groundwater chemistry (including electrical conductivity and pH);
- annual testing for nutrients, pesticides or herbicides as appropriate for the local situation; and
- determining the ability of vegetation to respond to falling groundwater levels through establishing the maximum rate of fall that can be matched by root growth, and the maximum depth from which plants can draw water.

Short term/specific threat monitoring should comprise:

- reviewing the likely changes to the groundwater regime that may be induced by a threat;
- establishing groundwater bores both within and outside the community such that the pre-existing groundwater flow patterns and fluctuations can be recorded; and
- undertaking water level and quality monitoring to suit any perceived threat and to ensure that there is sufficient time to respond to the threat in a timely manner.

If a specific threat is to be assessed in relation to the community, it may be appropriate to amend the monitoring programme (GCS 2007).

The Scott River area has been identified as an area being under highest risk from dryland salinity, therefore monitoring salinity levels and ponding in a number of northern and southern occurrences is required to indicate whether remedial action is necessary within the catchment. The depth and timing of inundation will ideally be measured at specific intervals (for example weekly during winter, and monthly thereafter), and data loggers may be appropriate for this task.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT, in liaison with Water Corporation
Cost:	$2,500 pa for depth monitoring. Costs of bore network installation approximately $30,000 in first year; other resources required for long-term groundwater monitoring to be determined.
Completion date:	Ongoing

11. Develop and implement a weed control strategy

A system of monitoring and adaptive management will be developed to maintain and improve the habitat by controlling weeds in occurrences of the community.

Weed control plans will be developed for all bushland that contains the community and will be based on information from weed mapping. Plans will identify priority weeds that pose the greatest threat to the community, in the early stages of invasion where possible. Appropriate methods of weed control are found in Brown and Brooks (2002) and may include hand weeding or localised application of herbicide. 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.

Ongoing monitoring will determine success of weed control measures. Weed maps will continue to be

updated to determine priority areas for weed control. Vegetation condition maps together with weed maps will guide priorities, with intact areas being a priority for weed control. Occurrence 2 is degraded by weed invasion, and weed control is a priority.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$10,000 per year
Completion date:	Ongoing

12. Design and implement flora monitoring program

Occurrences will be monitored every five to ten years. This information will be added to the Threatened Ecological Community Database. A series of quadrats have been established as per methods in Gibson *et al*. (2000). These are considered suitable for long-term broad scale examination of compositional and structural change. In addition, a Threatened Ecological Community Report Form will be completed for occurrences at least every five years, and this includes an evaluation of the threats and condition rank as per Bush Forever (2000) scales.

Data from the report forms and quadrats will be entered onto the Threatened Ecological Community Database. Following the second monitoring period, data will be analysed and compared as part of the full recovery plan, if required.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$8,000 every second year for field survey, specimen identification, and database entry for one monitoring period
Completion date:	Ongoing

13. Develop strategy for ex-situ propagation

Occurrences cleared historically could be utilised as seed orchards for threatened flora such as *Lambertia orbifolia* subsp. Scott River Plains, *Darwinia ferricola* Keighery and *Banksia nivea* subsp. *uliginosa* that occur in the community. A translocation was initiated by BHP Billiton in 2003 in conjunction with Botanic Gardens and Parks Authority at a previously cleared area of ironstone. Seed from individual occurrences only should be used to establish seed orchards, and then seed reintroduced into the original sites. A strategy for use of degraded areas of the ironstone community for ex-situ propagation of endangered ironstone taxa will continue to be developed and implemented.

Responsibility:	Parks and Wildlife (Blackwood District; Science and Conservation Division); BGPA with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$15,000 in years one, two and three to grow plants
Completion date:	Ongoing

14. Install roadside markers

To reduce the likelihood of accidental destruction, the Department will mark, or encourage the appropriate authorities to mark, roadside occurrences of threatened ecological communities, and occurrences located on roads, tracks or firebreaks, with the same pegs as used to mark threatened flora. Pegs are already in place alongside some occurrences, as they mark the location of threatened flora. Where these pegs are located on the boundary of the community there is no need to put additional pegs in place, but additional pegs will be installed 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. Markers have been installed along Governor Broome Road and at Gingilup Swamps Nature Reserve.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$1000 in the first year
Completion date:	Year 1

15. Report on success of management strategies

Reporting will be part of annual reports prepared by the Recovery Teams for Parks and Wildlife's Corporate Executive, and will include results of analysis of monitoring within an adaptive management framework. A final report will be presented as part of the next review and update of the recovery plan, if deemed necessary.

Responsibility:	Parks and Wildlife (Blackwood and Donnelly Districts) with assistance from the SWRTFCRT and WRTF&CRT
Cost:	$2000 per year
Completion date:	Ongoing

Table 3: 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
Continue liaison with land stakeholders to implement this plan	$2,000	$2,000	$2,000	$2,000	$2,000
Seek to acquire occurrences if not being successfully managed for conservation, or if they become available	TBD	TBD	TBD	TBD	TBD
Fence remnants that contain the community,	$100,000	-	-	-	-
Monitor dieback disease, treat	$15,000	-	$30,000	-	$30,000
Develop and implement fire management strategy	$3,000	$8,000	$3,000	$3,000	$3,000
Survey and describe occurrences	$6,000	$6,000	$6,000	$6,000	$6,000
Monitor extent, boundaries and condition	$5,000	-	-	-	-
Map habitat critical to survival	$10,000	-	-	-	-
Monitor water quality and levels	$32,500	$2,500	$2,500	$2,500	$2,500
Develop and implement a weed control strategy	$10,000	$10,000	$10,000	$10,000	$10,000
Design and implement flora monitoring program	-	$8,000	-	$8,000	-
Develop strategy for ex-situ propagation	$15,000	$15,000	$15,000	-	-
Install roadside markers	$1,000	-	-	-	-
Report on success of management strategies	$2,000	$2,000	$2,000	$2,000	$2,000
Total	$203,500	$55,500	$72,500	$35,500	$57,500

Total of all costs over five years: $424,500 (not including costs not yet determined (TBD) actions)

4. TERM OF PLAN

This plan will operate from April 2015 to March 2020 but will remain in force until withdrawn or replaced. After five years, the need to review this plan or to replace it with a full recovery plan will be determined.

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Appendix 1

Species occurrence by community type in the Scott River Ironstone Association. Only taxa that occurred in at least two sites are included. Adapted from Gibson *et al.* (2000):

Species	Sub-Community				
	4	5	6	8	9
Species Group A					
Acacia extensa	*				
Darwinia oederoides	*				
Philotheca spicata	*	*			
Xanthosia huegelii	*	*			
Austrodanthonia setacea	*				
Thysanotus tenellus	*				
Stylidium glaucifolium	*				
Caesia micrantha	*			*	
Chamaescilla corymbosa	*				
Burchardia multiflora	*				
Homalosciadium homalocarpum	*		*		
Patersonia juncea	*				
Species Group B					
Acacia pulchella	*				
Aira caryophyllea	*				
Hyalosperma cotula	*			*	
Siloxerus humifusus	*			*	
Patersonia occidentalis	*	*		*	
Podolepis gracilis	*			*	
Briza minor	*			*	
Desmocladus fasciculatus	*			*	
Opercularia vaginata	*		*	*	
Xanthorrhoea preissii	*			*	
Aphelia cyperoides	*	*	*	*	
Centrolepis aristata	*			*	
Philydrella pygmaea	*			*	
Lepidosperma squamatum	*		*	*	
Schoenus odontocarpus	*				
Kunzea aff. *micrantha* (BJK&NG 40)	*			*	
Drosera glanduligera	*				
Hemiandra pungens	*		*		
Hypochaeris glabra	*	*	*		
Phyllangium paradoxum	*	*	*	*	
Cyperus tenellus	*			*	
Lepyrodia aff. *macra* (BJK&NG 1026)	*			*	
Tremulina tremula	*			*	
Loxocarya magna	*			*	
Pericalymma ellipticum	*	*		*	*
Stylidium ecorne	*			*	
Thelymitra flexuosa	*			*	
Viminaria juncea	*		*	*	
Drosera macrantha subsp. m*acrantha*	*				
Stylidium perpusillum	*				
Hakea sp. (BJK&NG 226)	*				
Stylidium bulbiferum	*		*		
Species Group C					

Desmocladus flexuosus			*	
Goodenia eatoniana			*	
Dryandra nivea subsp. *uliginosa*			*	
Vulpia bromoides	*			
Stylidium repens	*			
Levenhookia pusilla	*			
Species Group D				
Astartea aff. *fascicularis*	*		*	
Juncus bufonius	*		*	
Cyathochaeta avenacea	*		*	*
Melaleuca preissiana	*			*
Meeboldina roycei ms	*			*
Melaleuca aff. *incana* (NG&ML 593)	*			*
Eriochilus dilatatus	*			
Lolium rigidum	*			
Lepidosperma longitudinale	*			
Melaleuca polygaloides	*			
Poa poiformis	*			
Grevillea manglesioides	*			*
Stylidium inundatum	*		*	
Hydrocotyle alata	*			
Tribonanthes australis	*			
Species Group E				
Centrolepis glabra	*			
Trithuria bibracteata	*			
Triglochin centrocarpa	*			
Monopsis debilis	*		*	
Thysanotus multiflorus	*			
Hypolaena fastigiata	*			
Juncus articulatus	*			
Lotus suaveolens	*			
Isolepis cyperoides	*			
Leucopogon carinatus	*			
Species Group F				
Agonis flexuosa	*	*		
Boronia spathulata		*		
Hakea tuberculata	*	*	*	
Kunzea recurva	*	*		
Sowerbaea laxiflora	*	*		
Ornithopus compressus		*		
Sonchus oleraceus		*		
Parentucellia viscosa	*	*		
Species Group G				
Amphipogon debilis	*		*	
Cassytha racemosa	*		*	
Isotoma hypocrateriformis	*			
Bartsia trixago	*			
Schoenus bifidus	*			
Stylidium calcaratum	*			
Thelymitra crinita	*			
Thysanotus manglesianus	*			
Austrostipa compressa	*			
Epilobium billardiereanum	*			
Trichocline sp. (BJK&NG 564)	*			
Conostylis setigera	*			
Neurachne alopecuroidea	*			

Selaginella gracillima	*					
Stylidium crassifolium	*					
Species Group H						
Acacia myrtifolia	*			*		
Calothamnus aff. *crassus* (R.D.Royce 84)	*	*		*		
Velleia trinervis	*			*		
Boronia anceps				*		
Grevillea aff. *manglesioides* (GJK 15158)				*		
Stenotalis ramosissima	*			*	*	
Adenanthos detmoldii				*		
Chordifex isomorphus	*			*		
Melaleuca incana				*		
Caesia occidentalis			*	*		
Mesomelaena tetragona	*		*	*		
Vellereophyton dealbatum	*		*	*		
Stylidium spathulatum	*	*		*		
Xanthorrhoea platyphylla				*		
Species Group I						
Eutaxia virgata	*			*		
Schoenus rigens				*		
Hakea ceratophylla				*	*	
Schoenus asperocarpus				*		
Sphenotoma capitata		*		*		
Ornduffia parnassifolia	*			*		
Species Group J						
Actinodium cunninghamii		*				
Schoenus curvifolius		*				
Cytogonidium leptocarpoides		*				
Euchilopsis linearis		*				
Dasypogon bromeliifolius	*	*		*		
Darwinia ferricola ms		*		*		
Cassytha glabella	*	*				
Drosera pallida	*	*				
Dampiera linearis	*	*		*		
Baxteria australis	*	*				
Leucopogon pendulus	*					
Sphenotoma gracile	*					
Species Group K						
Conostylis aculeata	*					
Patersonia occidentalis (swamp form)				*		
Briza maxima	*	*	*	*		
Romulea rosea			*			
Haloragis tenuifolia	*					
Hypolaena pubescens	*			*		
Microtis media	*			*		
Species Group L						
Caladenia marginata	*					
Drosera menziesii subsp. *menziesii*	*					
Isolepis marginata	*					
Utricularia multifida	*					
Elythranthera brunonis	*					
Hakea sulcata	*			*		
Stylidium guttatum				*		
Hypolaena exsulca		*				
Lyginia barbata				*		

Species Group M			
Hakea varia	*		*
Stylidium pulchellum		*	*
Chamaescilla corymbosa var. *latifolia*			*
Hibbertia stellaris	*		*
Nuytsia floribunda			*
Species Group N			
Centrolepis alepyroides			*
Hydrocotyle callicarpa	*		
Vulpia myuros			*
Centrolepis mutica	*		
Verticordia plumosa	*		
Cicendia filiformis	*		
Juncus capitatus	*		
Schoenus discifer	*		
Calothamnus lateralis	*		

Appendix 2

Vascular Plants recorded in the Scott River Ironstone Association. Only taxa which occur in at least two sites are included.

Scott Ironstone species (Gibson *et al.* 2000)	**Fire response**	**Months to 1st flowering**	**Months to peak flowering**	**Months to flowering decline**	**Longevity**	**Dieback response**
Acacia extensa	100% scorch kills, in soil seed storage	19	40	72	Perennial	Some evidence of resistance
Acacia myrtifolia	100% scorch kills, in soil seed storage	21	48	72	Perennial	Inferred moderate susceptibility
Acacia pulchella	100% scorch kills, in soil seed storage	24	48	60	Perennial	Some evidence of resistance
Actinodium cunninghamii	-					
Adenanthos detmoldii	-					
Agonis flexuosa	Survives 100% scorch, basal sprouts	30			Perennial	
Aira caryophyllea	100% scorch kills, in soil seed storage	12			Annual	Inferred evidence of resistance
Amphipogon debilis	Survives 100% scorch, basal sprouts	12	12		Perennial	
Aphelia cyperoides	Killed by 100% scorch (any 1,2,3)	6			Annual	
Astartea aff. *fascicularis*	Survives 100% scorch, basal sprouts	24			Perennial	Inferred evidence of resistance
Austrodanthonia setacea	-				Perennial	
Austrostipa compressa	100% scorch kills, in soil seed storage	6			Annual	Good evidence of resistance
Bartsia trixago	Killed by 100% scorch (any 1,2,3)	12			Annual	
Baxteria australis	Survives 100% scorch, soil suckers	6			Perennial	
Boronia anceps	-				Perennial	
Boronia spathulata	100% scorch kills, in soil seed storage	22			Perennial	Some evidence of resistance
Briza maxima	Killed by 100% scorch (any	6			Annual	Inferred evidence of

	1,2,3)					resistance
Briza minor	Killed by 100% scorch (any 1,2,3)	6			Annual	
Burchardia multiflora	Geophyte (Survives 100% scorch)	12			Perennial	Good evidence of resistance
Caesia micrantha	-				Perennial	
Caesia occidentalis	-					
Caladenia marginata	-				Perennial	
Calothamnus lateralis var. *crassus* (Benth.) A.S.George	-					
Calothamnus lateralis		24			Perennial	
Cassytha glabella	-				Perennial	
Cassytha racemosa	100% scorch kills, in soil seed storage	24			Perennial	
Centrolepis alepyroides	-				Annual	
Centrolepis aristata	-				Annual	
Centrolepis glabra	-				Annual	
Centrolepis mutica	-				Annual	
Chamaescilla corymbosa	Geophyte (Survives 100% scorch)	7			Perennial	
Chamaescilla versicolor (Lindl.) Ostenf.	-				Perennial	
Chordifex isomorphus	-				Perennial	
Cicendia filiformis	-				Annual	
Conostylis aculeata	Survives 100% scorch, basal sprouts	32			Perennial	Inferred evidence of resistance
Conostylis setigera	100% scorch kills, in soil seed storage	24			Perennial	Good evidence of resistance
Cyathochaeta avenacea	Survives 100% scorch, basal sprouts	6			Perennial	Good evidence of resistance
Cyperus tenellus	-				Annual	
Cytogonidium leptocarpoides	-					
Dampiera linearis	Survives 100% scorch, soil suckers	24			Perennial	Good evidence of resistance
Darwinia ferricola Keighery	-					
Darwinia oederoides	-					
Dasypogon bromeliifolius	Survives 100% scorch, large apical bud	6			Perennial	Some evidence of variable susceptibility

Desmocladus fasciculatus	-				Perennial	
Desmocladus flexuosus	-				Perennial	
Drosera glanduligera	Geophyte (Survives 100% scorch)	12			Annual	
Drosera macrantha subsp. *macrantha*					Perennial	
Drosera menziesii subsp. *menziesii*					Perennial	
Drosera pallida	Geophyte (Survives 100% scorch)	12			Perennial	Good evidence of resistance
Dryandra nivea subsp. *uliginosa*						
Elythranthera brunonis	Geophyte (Survives 100% scorch)	24			Perennial	Inferred evidence of resistance
Epilobium billardiereanum	-				Perennial	
Eriochilus dilatatus	Geophyte (Survives 100% scorch)	12			Perennial	Inferred evidence of resistance
Euchilopsis linearis	-					
Eutaxia virgata	100% scorch kills, in soil seed storage	24			Perennial	
Goodenia eatoniana	Killed by 100% scorch (any 1,2,3)	14			Perennial	
Grevillea aff. *manglesioides (*GJK 15158)	-					
Grevillea manglesioides	-					
Hakea ceratophylla	Survives 100% scorch, basal sprouts	24			Perennial	Inferred variable susceptibility
Hakea sulcata	100% scorch kills, on plant seed storage				Perennial	
Hakea tuberculata	-					
Hakea varia	100% scorch kills, on plant seed storage	24			Perennial	Some evidence of moderate susceptibility
Hemiandra pungens	100% scorch kills, in soil seed storage	24			Perennial	
Hibbertia stellaris	-					
Homalosciadium homalocarpum	-				Annual	

Hyalosperma cotula	100% scorch kills, in soil seed storage	12			Annual	
Hydrocotyle alata	-				Annual	
Hydrocotyle callicarpa	-				Annual	
Hypochaeris glabra		24			Biennial	
Hypolaena exsulca	-				Perennial	
Hypolaena fastigiata	-				Perennial	
Hypolaena pubescens	-				Perennial	
Isolepis cyperoides	-				Annual or Perennial	
Isolepis marginata	Killed by 100% scorch (any 1,2,3)	6			Perennial	Inferred evidence of resistance
Isotoma hypocrateriformis	100% scorch kills, in soil seed storage	12			Annual	
Juncus articulatus	-				Perennial	
Juncus bufonius	-				Annual	
Juncus capitatus	-				Annual	
Kunzea aff. *micrantha* (BJK&NG 40)		36			Perennial	
Kunzea recurva	100% scorch kills, on plant seed storage	24			Perennial	Some evidence of resistance
Lepidosperma longitudinale	Survives 100% scorch, soil suckers	24			Perennial	
Lepidosperma squamatum	Survives 100% scorch, soil suckers	22			Perennial	
Lepyrodia aff. *macra* (BJK&NG 1026)	-				Perennial	
Leucopogon carinatus	-					
Leucopogon pendulus	-					
Levenhookia pusilla	Killed by 100% scorch (any 1,2,3)	10			Annual	
Lolium rigidum	-				Annual	
Lotus subbiflorus Lag.	-				Annual or Perennial	
Loxocarya magna	-				Perennial	
Lyginia barbata	Survives 100% scorch, basal sprouts	21			Perennial	Inferred evidence of resistance
Meeboldina roycei ms	-				Perennial	

Meionectes tenuifolia (Benth.) M.L.Moody & Les						
Melaleuca aff. *incana* (NG&ML 593)						
Melaleuca incana	Survives 100% scorch, basal sprouts	22			Perennial	
Melaleuca incana R.Br. subsp. *incana*						
Melaleuca preissiana	Survives 100% scorch, epicormics	24			Perennial	
Mesomelaena tetragona	Survives 100% scorch, soil suckers	22			Perennial	Good evidence of resistance
Microtis media	-				Perennial	
Monopsis debilis	-				Annual	
Neurachne alopecuroidea	Survives 100% scorch, soil suckers	13			Perennial	Inferred evidence of resistance
Nuytsia floribunda	Survives 100% scorch, epicormics	24			Perennial	
Opercularia vaginata	100% scorch kills, in soil seed storage	24			Perennial	
Ornduffia parnassifolia (Labill.) Tippery & Les						
Ornithopus compressus	-				Annual	
Parentucellia viscosa	100% scorch kills, in soil seed storage	13			Annual	
Patersonia juncea	Survives 100% scorch, soil suckers	12			Perennial	
Patersonia occidentalis	100% scorch kills, in soil seed storage	36			Perennial	Inferred moderate susceptibility
Patersonia occidentalis (swamp form)						
Pericalymma ellipticum	Survives 100% scorch, basal sprouts	22			Perennial	
Philotheca spicata	-					
Philydrella pygmaea	-				Perennial	
Phyllangium paradoxum	-				Annual	
Poa poiformis	Survives 100% scorch (any 4,5,6,7,11)	12			Perennial	

Podolepis gracilis	Killed by 100% scorch (any 1,2,3)	12			Annual	
Romulea rosea	-				Annual (leaves) Perennial (corms)	
Schoenus asperocarpus	-				Perennial	
Schoenus bifidus	-				Perennial	
Schoenus curvifolius	Survives 100% scorch, basal sprouts	24			Perennial	
Schoenus discifer	-				Annual	
Schoenus odontocarpus	-				Annual	
Schoenus rigens	-				Perennial	
Selaginella gracillima	-				Annual	
Siloxerus humifusus	-				Annual	
Sonchus oleraceus	100% scorch kills, no seed storage				Annual	
Sowerbaea laxiflora	Survives 100% scorch, soil suckers	7			Perennial	
Sphenotoma capitata	100% scorch kills, in soil seed storage	24			Perennial	
Sphenotoma gracile	100% scorch kills, in soil seed storage	21			Perennial	Good evidence of high susceptibility
Stenotalis ramosissima	-				Perennial	
Stylidium bulbiferum	-				Perennial	
Stylidium calcaratum	100% scorch kills, in soil seed storage	7			Ephemeral	
Stylidium crassifolium	-				Perennial	
Stylidium ecorne	-				Ephemeral	
Stylidium glaucifolium (Carlquist) Wege ms						
Stylidium guttatum	-				Perennial	
Stylidium inundatum	-				Ephemeral	
Stylidium perpusillum	-				Ephemeral	
Stylidium pulchellum	-				Perennial	
Stylidium repens	Survives 100% scorch, soil suckers	7			Perennial	Good evidence of resistance
Stylidium spathulatum	-				Perennial	

Thelymitra crinita	Geophyte (Survives 100% scorch)	6			Perennial	Inferred evidence of resistance
Thelymitra flexuosa	Geophyte (Survives 100% scorch)	12			Perennial	
Thysanotus manglesianus	Survives 100% scorch, soil suckers	6			Perennial	
Thysanotus multiflorus	Survives 100% scorch, soil suckers	12			Perennial	
Thysanotus tenellus	Survives 100% scorch, soil suckers	24			Perennial	
Tremulina tremula	-				Perennial	
Tribonanthes australis	-				Perennial	
Trichocline sp. (BJK&NG 564)					Perennial	
Triglochin centrocarpa	-					
Trithuria bibracteata	-				Annual	
Utricularia multifida R.Br.	-				Annual	
Velleia trinervis	100% scorch kills, in soil seed storage	32			Perennial	
Vellereophyton dealbatum	100% scorch kills, no seed storage	10			Annual	
Verticordia plumosa	-					
	-					
Viminaria juncea	100% scorch kills, in soil seed storage				Perennial	
Vulpia bromoides	-				Annual	
Vulpia myuros	-				Annual	
Xanthorrhoea platyphylla	Survives 100% scorch, large apical bud	9			Perennial	
Xanthorrhoea preissii	Survives 100% scorch, large apical bud	9			Perennial	Good evidence of high susceptibility
Xanthosia huegelii	Survives 100% scorch, basal sprouts	32			Perennial	

Data for juvenile periods, flowering, dieback response are from *Naturemap* (accessed 2011).

Appendix 3

Rare, Priority, Specially Protected fauna within buffer of Scott River Ironstone Association (including Scott River) (list not comprehensive).

Genus	Species	Common name	Conservation Code
Bettongia	*penicillata* subsp. *ogilbyi*	Woylie, Brush-tailed Bettong	T
Calyptorhynchus	*banksii* subsp. *naso*	Forest Red-tailed Black-Cockatoo	T
Calyptorhynchus	*baudinii*	Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo	T
Calyptorhynchus	*latirostris*	Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo	T
Dasyurus	*geoffroii*	Chuditch, Western Quoll	T
Geocrinia	*alba*	White-bellied Frog	T
Geocrinia	*vitellina*	Orange-bellied Frog	T
Leipoa	*ocellata*	Malleefowl	T
Nannatherina	*balstoni*	Balston's Pygmy Perch	T
Numenius	*madagascariensis*	Eastern Curlew	T
Pezoporus	*flaviventris*	Western Ground Parrot	T
Phascogale	*tapoatafa* subsp. *tapoatafa*	Southern Brush-tailed Phascogale, Wambenger	T
Pseudocheirus	*occidentalis*	Western Ringtail Possum	T
Setonix	*brachyurus*	Quokka	T
Westralunio	*carteri*	Carter's Freshwater Mussel	T
Cacatua	*pastinator* subsp. *pastinator*	Muir's Corella, (Western Corella SW WA)	S
Falco	*peregrinus*	Peregrine Falcon	S
Morelia	*spilota* subsp. *imbricata*	Carpet Python	S
Austroconops	*mcmillani*	biting midge	P2
Elapognathus	*minor*	Short-nosed Snake	P2
Galaxiella	*nigrostriata*	Black-stripe Minnow	P3
Tyto	*novaehollandiae* subsp. *novaehollandiae*	Masked Owl (southern subsp)	P3
Ardeotis	*australis*	Australian Bustard	P4
Hydromys	*chrysogaster*	Water-rat	P4
Macropus	*irma*	Western Brush Wallaby	P4
Isoodon	*obesulus* subsp. *fusciventer*	Quenda, Southern Brown Bandicoot	P5

T = threatened ; S = Specially Protected ; P1,2,3,4,5 = Priority species