***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (s266B)**
Approved Conservation Advice for SCOTT RIVER IRONSTONE ASSOCIATION

1. The Threatened Species Scientific Committee (the Committee) was established under the EPBC Act and has obligations to undertake assessments and present advice to the Minister for Sustainability, Environment, Water, Population and Communities (the Minister) in relation to the listing and conservation of threatened ecological communities, including under sections 189, 194N and 266B of the EPBC Act.
2. The Committee provided its advice on the Scott River Ironstone Association ecological community to the Minister as a draft of this approved conservation advice. In 2013, the Minister accepted the Committee's advice, adopting it as the approved conservation advice.
3. The Minister amended the list of threatened ecological communities under section 184 of the EPBC Act to include the Scott River Ironstone Association ecological community in the endangered category. It is noted that the ecological community is also listed as the Scott River Ironstone Association on the Western Australian list of threatened ecological communities endorsed by the Western Australia Minister for the Environment
4. A draft conservation advice for this ecological community was made available for expert and public comment for a minimum of 30 business days. The Committee and Minister had regard to all public and expert comment that was relevant to the consideration of the ecological community.
5. This approved conservation advice has been developed based on the best available information at the time it was approved; this includes scientific literature, advice from consultations, existing plans, records or management prescriptions for this ecological community.

Contents

1. Description

The ecological community is described as a low to tall seasonally inundated shrubland or heathland, occurring on patches of shallow soils over massive ironstone formations of the Scott Coastal Plain in south-west Western Australia (WA). The shallowness of the soils, the iron content, and seasonal inundation and waterlogging by winter rains are all thought to heavily influence the particular assemblage of plant species found in these patches both in terms of differences to other ironstone and non-ironstone vegetation associations in south west WA and among patches of the community itself. Patches of the ecological community may be dominated by *Melaleuca preissiana, Hakea tuberculata, Kunzea micrantha* or *Melaleuca incana* subsp. Gingilup (N.Gibson & M.Lyons 593) while *Loxocarya magna* typically dominates the understorey.

Name of the ecological community

The name of the ecological community is Scott River Ironstone Association. The name is consistent with the Western Australian name for the ecological community on the State's list of Threatened Ecological Communities. Throughout this document it is referred to as the Scott River Ironstone Association ecological community or simply the ecological community.

This ecological community was nominated for listing as *Plant communities on ferricrete-ironstone in South West Western Australia* by the WA Department of Environment and Conservation (DEC) as a threatened ecological community under the EPBC Act as part of a process to streamline the listing of state endemic ecological communities under federal and state processes.

Location and physical environment

The ecological community occurs as extremely restricted, disjunct patches within the Southwest Botanical Province of WA (Gibson et al., 2000). Within this Province, there are restricted areas of skeletal soils overlying ironstone, which are associated with unique plant communities, with in general only low levels of sharing of plant species among them. The Scott River Ironstone Association ecological community, is one of these unique plant communities and is found on the Scott Coastal Plain within the Warren IBRA Bioregion (Interim Biogeographic Regionalisation of Australia version 7). Known occurrences of the community are found in the Shires of Nannup and Augusta Margaret River.

Geology and landforms

On the coastal plain of south-west WA, impeding layers of iron-rich substrate are common, producing a variety of sumplands and damplands (Gibson et al., 2000). However, most of the soils overlying this geology are composed of deep layers of Quaternary sand deposits (Poot et al., 2008). Only in very few places, the ironstone rock occurs close to the soil surface giving rise to highly restricted ironstone plant communities. The soils of these plant communities, such as the Scott River Ironstone Association ecological community, are generally very shallow, ranging from 0–20cm and are derived mainly from weathering of the underlying ironstone rock (Poot et al., 2008). The ironstone substrate can occur as a mosaic with other substrates, resulting in pockets or patches of deeper soil. Outcropping of ironstone rocks in the ecological community is common.

The Scott River Ironstone Association ecological community occurs on very shallow, reddish, loamy sands over massive ironstone rock (Poot et al., 2008). Ironstone soils contain more than 60% of ironstone gravel throughout the profile and have a distinct red-brown colour (CSIRO,

1983). The ironstone is thought to have formed by the precipitation of ferric iron in the zone of water table fluctuation, to create a very hard stony habitat (Gibson et al., 2000).

Hydrology

South-west WA receives an average of 800–1500mm of rain per year, most of which falls between May and October (Wheeler, 2002). The substrate on which the plant communities occur produces a specific hydrological regime. The ironstone substrate impedes drainage, leading to inundation of the ecological community during heavy or prolonged rainfall (Lu and English 2004; Meissner and English, 2005a). During the winter months, the ecological community experiences numerous waterlogging events (Poot et al., 2008). The watertable is close to or above the surface for several months between May–October, but the soils dry out quickly at the end of spring or early summer (Smith and Ladd, 1994; Luu and English, 2004; Meissner and English, 2005a,b). The depth and length of inundation varies between occurrences of the ecological community, with some having very little or no standing water and others having obvious pools of water (Luu and English, 2004).

The Scott River Ironstone Association ecological community sits on top of a suite of aquifers including the Superficial formation, the Warnbro Group, Parmelia formation, Yarragadee formation, Cockleshell Gully formation, Lesueur formation and the Sabina sandstone and Sue Coal Measures (Luu and English, 2004). Because some species of the community show adaptations to inundation (Poot et al., 2008), it is thought that its species composition could be affected by fluctuation in the level of the underlying aquifers and connections among them (Luu and English, 2004).

Climate

The south-west of WA has a mild Mediterranean climate of warm, dry summers and cool, wet winters (Beard et al., 2000; Wheeler, 2002). The area of the Scott River Ironstone Association ecological community receives approximately 1000 mm per year (mean = 956 mm, median = 933 mm, n = 34 years), with more than two thirds of this falling between May and September (Bureau of Meteorology).

Vegetative components

The Southwest Botanical Province where the ecological community occurs is an internationally recognised biodiversity hotspot (Beard et al., 2000). The generally poor soils of the south-west WA region are thought to have produced plant species that are highly specialised including many species that are endemic (Beard et al., 2000).

The occurrences of Scott River Ironstone Association ecological community are highly variable in plant species composition, probably as a result of variation in soil type and depth (Luu and English, 2004) as well as length of the inundation period (Gibson et al., 2000).

The vegetation type is generally heathlands and low to tall shrublands, with dominant species depending on the degree of waterlogging (Luu and English, 2004). The occurrences are variously dominated by *Melaleuca preissiana* (moonah), *Hakea tuberculata*, *Kunzea micrantha* or *Melaleuca incana* subsp. Gingilup (N.Gibson & M.Lyons 593)(grey honey-myrtle). The understorey is generally dominated by *Loxocarya magna*. All occurrences (except the wetter/swampier or more closed shrublands patches) have a diverse annual flora of *Stylidium* spp. (trigger-plants), *Centrolepis* spp., *Schoenus* spp. (bog-rush) and *Aphelia* spp. (Luu and English, 2004). There may be some emergent tree species such as eucalypts. One study in WA

shows 167 plant species occur in the community across its various occurrences (see Appendix A.1) (DEC, 2012a). Of these species, four are listed by Gibson et al. (2000) as endemic to the ecological community (Table 1). In addition to these records recent information shows an additional 54 species, all of them orchids, found within the ecological community. This is almost 25% of the total recorded species richness (i.e., 54 species of orchids out of a new total of 221species of plants) (A. Brown pers, comm.)

Table 1. Taxa restricted or largely restricted to the ecological community on the Scott River Plain (Gibson et al., 2000).

Species	Common name	Location	Endemic
Darwinia ferricola	Scott River bell	Scott Coastal Plain	Yes
Grevillea manglesioides subsp. *ferricola*		Scott Coastal Plain	Yes
Lambertia orbifolia subsp. Scott River Plains (L.W. Sage 684)	roundleaf honeysuckle	Scott Coastal Plain	Yes
Melaleuca incana subsp. Gingilup (N.Gibson & M.Lyons 593)	grey honey-myrtle	Scott Coastal Plain	Yes

The duration and degree of seasonal waterlogging is also an important determinant of species composition in communities such as the Scott River Ironstone Association ecological community (Smith and Ladd, 1994). The water table can be at or above the surface at this time, meaning plant roots may be submerged for months at a time. The roots of many plant species are not able to survive in the anaerobic conditions created by waterlogging and many seedlings of sclerophyllous trees are not able to establish in areas that are waterlogged for several months of the year (Smith and Ladd, 1994). Ironstone *Hakea* species, including *H. tuberculata* from the Scott River Ironstone Association ecological community, were shown to be highly tolerant to winter waterlogging (Poot and Lambers, 2003), but were less affected by waterlogging on an ironstone soil than other *Hakea* species from surrounding winter-wet and dryland communities (Poot et al., 2008). This suggests that the specific chemistry of waterlogged ironstone soil and local adaptation to it may partially explain the uniqueness of these communities.

Fauna

No surveys have been conducted specifically on the fauna of this ecological community; therefore there is very limited information available. No fauna species are known to be exclusively restricted to the ecological community. However many vertebrate and invertebrate fauna are likely to be part of the ecological community. For example, pollinating birds are likely to be visitors during the dry flowering season (Oct–April) and other birds may be present in the wet season to exploit the temporary pooling of water and associated resources. Some fauna species are likely to be visitors to the ecological community, for food and shelter, or using patches as stepping-stones to preferred habitat. For example, parrots such as *Calyptorhynchus baudinii* (Baudin's black cockatoo) have been seen feeding within the ecological community (N. Burton pers. comm.). Macropus fuliginosus (western grey kangaroo) are frequent visitors, grazing on the grasses and resting in the ecological community (J. Pryde pers comm.). Lists of threatened flora and fauna are in Tables 3 and 4. A list of fauna is provided as Table A.2 of Appendix A.

Key diagnostic characteristics and condition classes

The ecological community no longer exists at many sites where it was formerly present. In many cases, the loss is irreversible because sites have been permanently cleared or have undergone some other substantial modification that has removed their natural hydrological and biological characteristics. In other cases, the ecological community now exists in a disturbed or degraded state, and may be so degraded that it is impractical to restore it.

National listing focuses legal protection on the remaining occurrences of the ecological community that are functional, relatively natural and in relatively good condition. Key diagnostic and condition classes help identify a patch of the threatened ecological community, determine when the EPBC Act is likely to apply to an ecological community, and to distinguish between patches of different quality. They provide guidance for when a patch of a threatened ecological community retains sufficient conservation values to be considered as a Matter of National Environmental Significance, as defined under the EPBC Act. This means that the protection provisions of the EPBC Act will be focussed on the most valuable elements of Australia's natural environment, while heavily degraded patches, which are not in the best condition classes, will be largely excluded from EPBC Act protection. The condition classes for the ecological community are based on those developed and used to assess condition by the WA Department of Environment and Conservation.

Although highly degraded patches will not be a part of the ecological community listed under the EPBC Act, it is recognised that patches that are not in the best condition classes may still retain important natural values. As such, these patches should not be excluded from recovery and other management actions (see also the *Surrounding environment and landscape context* below).

Step 1 Key diagnostic characteristics

The key defining attributes for the ecological community are:

- Known occurrences of the community are limited to the Warren Bioregion (IBRA vers 7)
- Soils are typically shallow, loamy sands above a substrate of ironstone;
- Sites are typically seasonally inundated in winter but some areas may only experience wet/damp soils in winter;
- Topsoils generally dry out quickly in late spring or summer;
- Vegetation is shrubland or heathland with an open to closed structure;
- Dominant species in the overstorey may be *Melaleuca preissiana* (moonah), *Hakea tuberculata*, *Kunzea micrantha* or *Melaleuca incana* subsp. Gingilup (N.Gibson & M.Lyons 593) (grey honey-myrtle);
- The understorey is generally dominated by *Loxocarya magna*; and
- An annual herbaceous layer is present in the dry season (Oct–April). All occurrences (except the wetter/swampier or more closed shrublands patches) have a diverse annual flora of *Stylidium* spp. (trigger-plants), *Centrolepis* spp., *Schoenus* spp. (bog-rush) and *Brizula (*now *Aphelia)* spp.

Step 2 Condition classes

The listed ecological community is limited to patches that meet the description, including key diagnostic characteristics, and the following condition classes.

A **patch** of the listed ecological community is defined as a discrete and intact area of the ecological community, as described, and does not include substantial elements of other ecological communities. As the ecological community is very limited in area overall and occurs in restricted locations that can be very small, **no minimum patch size is recommended** as long at the patch meets at least the Good Condition class (see below).. A patch of the listed ecological community may include small-scale disturbances, such as tracks or breaks, that do not alter its overall functionality, for instance the easy movement of wildlife or dispersal of plant propagules, and may also include small-scale variations in vegetation. In particular, there can be a mosaic of different soil types and depths within a patch that will produce differences in vegetation structure; however the whole patch should be considered part of the ecological community.

To be considered as part of the ecological community a patch should meet at least the **Good Condition** class of the WA ecological community condition criteria (Government of Western Australia, 2000).

The WA government assesses ecological community condition based on the following Vegetation Condition descriptions:

> ***Pristine*:** Pristine or nearly so, no obvious signs of disturbance.
>
> ***Excellent*:** Vegetation structure intact, disturbance is only affecting individual species and weeds are non-aggressive species.
>
> ***Very Good*:** Vegetation structure altered, with obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, and/or grazing.
>
> ***Good*:** Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or the ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and/or grazing.
>
> **The following represent patches that are not considered part of the ecological community:**
>
> ***Degraded*:** Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and/or grazing.
>
> ***Completely degraded:*** The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed and crop species with isolated native trees or shrubs.

The following information should also be taken into consideration when applying condition thresholds.

- Buffer zones around the ecological community are important for protection against further weed invasions and disruptions to hydrology. To assist in the preservation of the patch and persistence of the ecological community, it is recommended that **a buffer zone of at least 50 m** be maintained from the outer edge of the patch. However, the width of the buffer required may be greater, depending on the type of threat, the local hydrology, and other factors.
- **Timing** of surveys is an important consideration because the ecological community can be variable in its appearance between wet and dry seasons and between years depending on drought-rain cycles. Timing of surveys should also consider the detectability of plant species at different times of their life cycle, or their recovery after recent disturbances (natural or human-induced) to the ecological community.

Surrounding environment and landscape context

The Good condition category outlined above is the minimum level at which patches are to be considered under the EPBC Act for actions that may require referral to the Australian Government. The descriptions for Very Good and Excellent categories represent states closer to the ideal, Pristine state of the ecological community. In addition the larger or more diverse a patch is, the greater the likely biodiversity value and its sustainability. Patches that link native remnants in the landscape are also important as wildlife habitat and for the viability of the ecological community into the future, provided that threats are adequately managed.

Therefore, in the context of actions that may have significant impacts and require approval under the EPBC Act, it is important to consider the environment surrounding the listed patches that meet the Good, Very Good, Excellent and Pristine condition categories. Some patches that meet the condition thresholds above will occur in isolation and require protection, as well as priority actions, to link them with other native vegetation. Other patches will have additional conservation value through being connected to other intact native vegetation. In these instances, the following indicators should be considered when assessing the impacts of actions or proposed actions under the EPBC Act, or when considering recovery, management and funding priorities for a particular patch:

- Large size and/or with a large area to boundary ratio – larger area/boundary ratios are less exposed and more resilient to edge effect disturbances such as weed invasion and other anthropogenic impacts;
- Areas of minimal weeds and feral animals or where they can be easily managed;
- Connectivity to other, surrounding native vegetation remnants or proximity to other natural features or restoration works. In particular, a patch of the community in an important position between (or linking) other such patches in the landscape;
- Patches that occur in those areas in which the ecological community has been most heavily cleared and degraded, or that are at the natural edge of its range, and components of the ecological community that are the least protected in conservation reserves; and/or
- Patches that contain listed threatened species (state or national) or key functional species such as the presence of key pollinator and dispersal animals; evidence of recruitment of key native plant species or the presence of a range of age cohorts (including through successful assisted regeneration);

- Good faunal habitat as indicated by patches providing cover, refuge, and that contribute to movement corridors;
- Patches that occur in areas where the ecological community has been most heavily cleared and degraded, or that are at the natural edge of its range.
- High species richness as shown by the variety of native flora and fauna species that are present

Area critical to the survival of the ecological community

All areas that meet the condition classes and the buffer zone (page 7) are considered critical to the survival of this ecological community. Abiotic features including the soil type, substrate and the surface, groundwater and groundwater catchment hydrology that maintains the vegetation of the ecological community are also considered critical to the ecological community's survival. Additional areas such as adjoining native vegetation and areas that meet the description of the ecological community but not the condition classes may be critical to the survival of the ecological community depending on factors such as presence of key functional, threatened, or rare species, their size and shape, linkages to other patches and landscape position. It is also important to consider the surrounding environment and landscape context as outlined on page 9.

Geographic extent and patch distribution

The ecological community occurs naturally as isolated patches due to the restricted nature of patches of shallow soils overlying the ironstone substrate. However, it has undergone a decline in distribution, in part as a result of extensive clearing of the Scott River Plain for agriculture (Luu and English, 2004).

Based on information provided by the WA government (2012b) the community is estimated to currently occupy 276–404 ha.

The remaining known patches of the ecological community occur on a variety of tenures from private, freehold land to Nature Reserves managed by the WA government. The available patch size data provided by the WA government (2012b) and presented in Table 2 indicate a high degree of fragmentation across the range of the ecological community with most patches (89%) less than 50 ha, and the majority (74%) less than 10 ha.

Table 2. Patch data for the ecological community

Patch size (ha)	Number of patches	Percentage of total patches	Cumulative percentage
<1	7*	26	26
1– 10	13	48	74
10– 20	3	11	85
20–50	1	4	89
>50	3	11	100
Total	**27**	**100**	**100**

The WA government indicates that there are 16 patches of less than 1 ha in their database but that nine of these are "are no longer extant".

National context and existing protection

Distribution

The Scott River Ironstone Association ecological community occurs as extremely restricted, disjunct patches within the Southwest Botanical Province of Western Australia (Gibson et al., 2000; Luu and Meissner, 2004). Within this Province, there are restricted areas of ironstone soils which are associated with a particular assemblage of plants. The ecological community is only known to occur in Warren IBRA Bioregion (Interim Biogeographic Regionalisation of Australia version 7) and in the South West Catchments Natural Resource Management Area within the Shire of Augusta-Margaret River and the Shire of Nannup.

There may be other occurrences of the ecological community in other locations within the Warren IBRA Bioregion. However, these have not been adequately documented and would be expected to be small. Patches which meet the *Description,* including the *Key Diagnostic Characteristics* and *Condition Classes* are considered to be part of the listed ecological community.

Landuse history

The ecological community is generally unsuitable for agriculture due to the shallow soils which overlie the ironstone substrate. However, the surrounding landscape in which occurrences are found is generally productive and much of the vegetation has been removed since European settlement for grazing and cropping. In some cases, the ironstone substrate has been dug up and removed to make the soil more productive. In these cases, the ecological community is irretrievable. As many of the patches of the ecological community are surrounded by grazing and cropping, these patches are subject to edge effects which exacerbate threatening processes, such as weed invasion.

Relationships to State-listed ecological communities

The Scott River Ironstone Association is listed as an endangered ecological community on the state's list of threatened ecological communities endorsed by the Western Australia Minister for the Environment. The state-listed ecological community corresponds with the description and known distribution of the national ecological community, named Scott River Ironstone Association and described in this conservation advice. Under the Western Australian *Wildlife Conservation Act 1950,* individual species of plants and animals are also protected.

Relationships to other vegetation classifications

The ecological community falls within the National Vegetation Information System (NVIS) equivalents of:

- Major vegetation group 17 Other shrublands
- Major vegetation group 18 Heathlands

Differences to similar ecological communities

A number of plant communities occur on iron-rich substrates (e.g. ironstone, ferricrete in south-west Western Australia. Two such communities are already listed as separate national ecological communities. These are *Shrublands and woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain* and *Shrublands on southern*

Swan Coastal Plain ironstones. Both of these communities are also State-listed threatened ecological communities, however neither occurs in the Warren IBRA Bioregion.

Level of protection in reserves

Based on information contained in the interim recovery plan, 126 ha of the ecological community is on public land. Of this amount 82 ha is in Nature Reserves and only an estimated 2 ha in State Forests and National Parks, with the remaining approximately 42 ha under the control of Local Government Authorities (Luu and English, 2004). A conservative estimate of the area in some type of reserve is then around 84 ha or 21–30 % of the extant area (276–404 ha) of the ecological community.

Listed threatened species

Table 3 below provides a list of flora species protected under state and/or national legislation.

Table 3. Threatened plant species known to occur in the ecological community.

Scientific Name	**Common name**	**WA**	**National**
Banksia nivea subsp. *uliginosa*	Swamp Honeypot	DRF - E	E
Darwinia ferricola	Scott River Darwinia	DRF - E	E
Lambertia orbifolia subsp. Scott River Plains (L.W.Sage 684)	Scott River Roundleaf Honeysuckle	DRF - E	E

Legend: WA= *Wildlife Conservation Act 1990;* National= EPBC Act; DRF= Declared Rare Flora; E= endangered.

The following nationally-listed fauna species have been recorded within the extent of occurrence (the minimum area enclosing all known occurrences of the ecological community).

Table 4 Threatened animal species that may occur in the ecological community.

Scientific Name	**Common name**	**National**
Calyptorhynchus banksia naso	Forest Red-tailed Black-Cockatoo	VU
Calyyptorhynchus baudinii	Baudin's Black-Cockatoo	VU
Calyyptorhynchus latirostris	Carnaby's Black-Cockatoo , Short-billed Black-Cockatoo	E
Dasyurus geoffroi	Chuditch, Western Quoll	VU

2. Summary of threats

The ongoing threats to the ecological community are:

- Land clearing;
- Road, track, and firebreak maintenance;
- Weed invasion;
- Acid sulphate soils;
- Grazing by native and non-native animals; and
- *Phytophthora* dieback disease caused by the root-rot pathogen *Phytophthora cinnamomi*;

The ecological community is potentially threatened by:

- Altered fire regimes;
- Hydrological changes;
- Changes to nutrient status (from surface water runoff on agricultural land) and;
- Climate change.

Further details about the threats to the ecological community can be found at Appendix B.

3. Summary of eligibility for listing against EPBC Act criteria

Criterion 1: Decline in geographic distribution

Estimates of pre-European extent and current extent are based on information provided by the WA government (DEC, 2012b)

Based on available data for the known occurrences, the ecological community has declined in extent from approximately 1100–1700ha to occupy between 276–404 ha. This represents a substantial decline in the order of 63–84%. It is important to note that some patches of the ecological community that are included in the data above may not meet the condition classes, such as patches with a high degree of disturbance, so the decline may actually be more than is estimated.

The Committee considers that the ecological community has undergone a substantial decline in geographic distribution. Therefore the ecological community has been demonstrated to have met the relevant elements of Criterion 1 to make it **eligible** for listing as **vulnerable**.

Criterion 2: Small geographic distribution coupled with demonstrable threat

This criterion aims to identify ecological communities that are geographically restricted to some extent. Three indicative measures apply: 1) extent of occurrence (i.e. the total geographic range of the ecological community); 2) area of occupancy (i.e. the area actually occupied by the ecological community within its natural range); and 3) patch size distribution (an indicator of the degree of fragmentation). It is recognised that an ecological community with a distribution that is small, either naturally or that has become so through modification, has an inherently higher risk of extinction if it continues to be subject to ongoing threats that may cause it to be lost in the future.

The ecological community is subject to a range of demonstrable threats, as outlined in Appendix B. Many of these threats will continue to operate, or even intensify and compound each other, rather than diminish, particularly without further coordinated recovery and management effort.

The ecological community occurs in highly restricted patches. The extent of occurrence (the minimum area that encloses all known occurrences of the community) is approximately 11 734 ha, which is indicative of a ***restricted*** geographic distribution, i.e. less than 100 000 ha.

The remaining area of occupancy for the ecological community is approximately 276–404 ha. This is indicative of a ***very restricted*** geographic distribution (i.e. total area of occupancy < 1000 ha). An analysis of patch size based on WA government data indicates that there are 27 patches of the ecological community remaining (Table 2). Of the patches remaining, 74% are less than 10 ha and all are less than 100 ha. The available patch size data indicate a high degree of fragmentation across the range of the ecological community consistent with a ***very restricted*** geographic distribution (i.e. patch size is typically less than 10 ha).

The Committee notes that the ecological community has a very restricted geographic distribution, based on its area of occupancy and the generally small and fragmented size distribution of patches. Furthermore, the Committee considers that the demonstrable ongoing threats detailed previously are not likely to cause the ecological community to become lost in the **immediate** future (consistent with *critically endangered*) but could cause the community to be lost in the **near** future. Therefore, the Committee considers that the ecological community has been demonstrated to have met the relevant elements of Criterion 2 to make it **eligible** for listing as **endangered** under this criterion.

Criterion 3: Loss or decline of functionally important species

The ecological community has variable composition and it is not possible to identify a single species or suite of species that has critical functions. The functional roles of many species in the ecological community are unknown.

There is no information available to judge if the ecological community has undergone a loss or decline in functionally important species. Therefore, as the ecological community has not been demonstrated to have met any of the required elements of Criterion 3, it is **not eligible** for listing in any category under this Criterion.

Criterion 4: Reduction in ecological community integrity

There are a number of threatening processes that may lead to a reduction in the integrity of the ecological community.

Incursion of weeds changes the structure of the ecological community and out-competes native species.

Phytophthora dieback disease caused by the root-rot pathogen *Phytophthora cinnamomi* is known to have infected patches of the ecological community. As many of the plant species in the ecological community are susceptible to this fungus, it has the potential to have a significant impact on the integrity of the ecological community through change in structure, function and species composition.

Hydrological regimes are important to the ecological community as they provide the conditions in which the substrate is formed and maintained. They also influence species composition due to wetting and drying cycles throughout the year. Changes to hydrological regimes and/or increased salinity would have a severe impact on the ecological community.

Weed incursion, dieback disease and changes to hydrological regimes all have the potential to reduce the integrity of the ecological community by disruption of important community processes and to degrade the ecological community. However, the nature of their impacts can only be surmised in general and there is not enough evidence to determine what impact these factors are having on the ecological community as a whole. Therefore, as the ecological community has not been demonstrated to have met any of the required elements of Criterion 4, it is **not eligible** for listing in any category under this Criterion.

Criterion 5: Rate of continuing detrimental change

The ecological community is suspected to be undergoing continuing detrimental change (through clearing, weed incursions, grazing and changes to hydrological regimes) over the immediate past.

Data from the interim WA recovery plan indicate a rate of loss of 12.3% of the known area of occurrence over the period 1993–2004. However, there are no more recent data available to the Committee to judge the rate of continuing detrimental change experienced by the ecological community. Therefore, as the ecological community has not been demonstrated to have met any of the required elements of Criterion 5, it is **not eligible** for listing in any category under this Criterion.

Criterion 6: Quantitative analysis showing probability of extinction

There are no quantitative data available to assess this ecological community under this criterion. Therefore, it is **not eligible** for listing under this Criterion.

4. Priority research and conservation actions

Research priorities

Research priorities that would inform future regional and local priority actions include:

- Investigate the natural hydrological processes that maintain the ecological community, especially the water levels, quality and seasonal patterns of inundation. Use these data to help design buffers to protect hydrological processes.
- Develop better understanding of the impact of *Phytophthora* dieback, weeds, and fire on the ecological community.
- Study key biological processes (e.g. pollination biology, time to maturity) for key plant species and the role of disturbance in community regeneration
- Undertake seed germination and/or vegetative propagation trials including *in situ* programs, to determine the requirements for successful establishment of native species in revegetation works.
- Design and implement a monitoring program of the extent and condition of known occurrences or, if appropriate, support and enhance existing programs.
- More precisely assess the current distribution of the community.
- Undertake survey work in suitable habitat and potential habitat to locate any additional remnants. Also identify any threatened flora and fauna that require specific conservation measures at particular sites.
- Determine the resilience and responses of the ecological community to variations in climate (very wet seasons as well as prolonged droughts).
- Develop a more characteristic list of fauna that occur in the ecological community and determine their ecological roles.
- Investigate landscape scale gene flow and its implications for management of remnants, associated flora and fauna interactions and longer-term ecological function. This includes research into optimal distances between remnants and remnant sizes for a range of flora and fauna refugia and movements.

Priority recovery and threat abatement actions

The following priority recovery and threat abatement actions can be done to support the recovery of the Scott River Ironstone Association ecological community.

Habitat Loss, Disturbance and Modification

- Avoid clearance of native vegetation within the ecological community and its surrounds (at least within a buffer zone of 50 metres from the edge of a given patch)
- Protect and conserve all remnants of the ecological community.

- Monitor the progress of recovery, through improved mapping, estimates of extent and condition assessments of the ecological community, and effective adaptive management actions.
- Monitor flora, fauna at the ecological community boundaries and identify key threats.
- Avoid any changes to hydrology that may result in changes to the natural hydrological regime of patches of the community, groundwater water table levels and subsequent increase or decrease in run-off, salinity, or pollution.
- Minimise disruptions to the local landscape that would influence the pattern of winter rain inundation, such as smoothing out depressions or creating banks/levees to store water.
- Ensure road or track widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance in areas where the ecological community occurs do not adversely impact on known patches.
- Ensure that development activities minimise direct impacts to the ecological community and indirect effects on its ecological function.
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate inclusion in reserve tenure if possible.
- Develop and implement best practice standards and regimes for management of remnants on private and public lands to maintain the biodiversity, including threatened species, of the ecological community.
- Recognise and implement appropriate management regimes to maintain distinctive biodiversity elements, such as threatened species as identified in national and state recovery plans and the connected landscapes and focal areas as identified through recovery planning processes.
- Ensure that networks of patches of the community that serve as refugia or linkages for wildlife and their habitat are maintained across the landscape.

Diseases and Fungi

- Develop and implement suitable hygiene protocols to protect known sites from further outbreaks of dieback caused by *Phytophthora cinnamomi*.
- Use control methods to control identified patches infected with dieback caused by *Phytophthora* spp.
- Identify *Phytophthora*-resistant individuals in keystone and threatened plant taxa susceptible to *Phytophthora cinnamomi* for future functional regeneration of infested areas using seed developed from selected resistant clones.

Trampling, Browsing or Grazing

- Develop and implement a management plan, or support existing management plans for roadside verges, and other public land remnants, which may be adversely impacted by inappropriate stock grazing.
- Ensure that an appropriate management regime that is not detrimental to the ecological community, is in place where stock access patches of the ecological community,

Invasive Weeds

- Manage sites to prevent introduction or further spread of invasive exotic weeds, and targeted control of existing key weeds which threaten the ecological community, using appropriate methods.

- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on native ironstone species.

Fire

- Determine and implement a suitable fire management strategy specific to the Scott River Ironstone Association ecological community.
- Identify appropriate intensity and interval of fire to promote seed germination and vegetation regeneration, focussing on fire-sensitive and rarer taxa.
- Where appropriate provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plan(s), risk register and/or operation maps.
- Negotiate appropriate standing procedures with local fire brigades in relation to establishing fire control lines in native vegetation areas, to avoid unnecessary destruction of the ecological community.
- Develop fire response plans and maintain strategic fire breaks for occurrences on Department of Environment and Conservation (WA government) managed land.

Conservation Information

- Raise awareness of the Scott River Ironstone Association ecological community within local communities utilising a range of media/methods such as fact sheets/information brochures/field days in conjunction with known industry or community interest groups.
- Liaise with planning authorities to ensure that planning for growth zones in urban and peri-urban areas takes the protected remnants into account, with due regard to principles for long-term conservation.
- Liaise with local councils and State authorities to ensure new development, road widening, maintenance activities or other activities involving substrate or vegetation disturbance in areas where the Scott River Ironstone Association ecological community occurs do not adversely impact on known remnants.
- Establish and maintain liaison with private landholders and managers of land on which remnants of the ecological community occur.
- Install interpretive signage at occurrences, especially in sites utilised heavily by members of the public.
- Notify relevant organisations of roadside, rail and power easement locations and how to protect them during construction and maintenance activities.

This list does not necessarily encompass all actions that may be of benefit to the Scott River Ironstone Association ecological community, but highlights those that are considered to be high priority at the time of preparing the Conservation Advice.

Existing plans/management prescriptions

Luu, R and English, V (2004). Scott River ironstone Association. Interim Recovery Plan 2004–2009. Department of Conservation and Land Management, Wanneroo. WA. Available on the internet at: http://www.dec.wa.gov.au/pdf/plants_animals/threatened_species/irps/tec/scott_ironstone_irp217.pdf

Management prescriptions in the form of recovery plans are known to exist for some plant species occurring in the ecological community. These are:

Luu, R. and Brown A. (2008) Swamp Honeypot (*Banksia nivea subsp. uliginosa*) Interim Recovery Plan 2008–2013. Department of Conservation and Land Management, Wanneroo, WA.

Available on the internet at: http://www.dec.wa.gov.au/pdf/plants_animals/threatened_species/irps/flora/dry_niv_uli_irp255.pdf

Luu, R. And English, V. (2009) Scott River Darwinia (*Darwinia ferricola* ms) Interim Recovery Plan 2004–2009. Department of Conservation and Land Management, Wanneroo, WA.

Available on the internet at: http://www.dec.wa.gov.au/pdf/plants_animals/threatened_species/irps/flora/dar_fer_irp176.pdf

These prescriptions were current at the time of publishing; please refer to the relevant agency's website for any updated versions.

Recovery plan recommendation

Recovery of the community is expected to be complex and benefit from the development of a national plan. The complexity arises primarily because the ecological community occurs on a variety of tenures with the majority occurring on private land. Accordingly, there will be a high degree of stakeholder support necessary to effect successful recovery. In addition, there are a range of threats that may vary from patch to patch of the ecological community. Moreover, knowledge is limited regarding the ways in which threats may develop across and impact the ecological community (e.g. *Phytophora*, ground water abstraction). The South West Region Threatened Flora and Communities Recovery Team (SWRTFC RT) already in place in the region would provide the structure to facilitate the necessary coordination, engagement, management, and research activities. The existence of an Interim Recovery Plan (2004-2009) provides a good basis for the development of a national recovery plan.

5. Appendices

Appendix A: Species lists

Table A.1: List of plant species occurring in Scott River Ironstone Association.

Acacia alata (Winged Wattle)	*Caladenia hirta subsp. hirta*
Acacia divergens	*Caladenia infundibularis*
Acacia extensa (Wiry Wattle)	*Caladenia latifolia*
Acacia myrtifolia	*Caladenia longiclavata*
Acacia pulchella (Prickly Moses)	*Caladenia marginata* (White Fairy Orchid)
Adenanthos detmoldii (Scott River Jugflower)	*Caladenia nana subsp. unita*
Agonis flexuosa (Peppermint)	*Caladenia reptans subsp. reptans*
Taxandria parviceps	*Caladenia serotina*
**Anagallis (*now *Lysimachia) arvensis* (Pimpernel)	*Caladenia* sp. Scott River (G. Brockman 830)
Anigozanthos flavidus (Tall Kangaroo Paw)	*Caladenia vulgata*
Anigozanthos humilis (Catspaw)	*Callistachys lanceolata* (Wonnich)
Aotus gracillima	*Calothamnus lateralis* var. *crassus*
Aotus intermedia	*Calothamnus lateralis*
Aphelia cyperoides	*Cassytha racemosa* (Dodder Laurel)
Astartea fascicularis	*Centrolepis aristata* (Pointed Centrolepis)
Astartea sp. Scott River (D. Blackshall 88233)	*Chaetanthus aristatus*
Astroloma pallidum (Kick Bush)	*Chamaescilla corymbosa* (Blue Squill)
Banksia grandis (Bull Banksia)	*Chordifex isomorphus*
Baumea juncea (Bare Twigrush)	*Comesperma virgatum* (Milkwort)
Baumea vaginalis (Sheath Twigrush)	*Corymbia calophylla* (Marri)
Baxteria australis	*Cryptostylis ovata*
Blennospora aff. drummondii (golden bracts) *scps BJK&NG20*	*Cyanicula gemmata*
	Cyathochaeta avenacea
Boronia dichotoma	*Cyathochaeta clandestina*
Boronia spathulata (Boronia)	*Cyrtostylis huegelii*
Bossiaea rufa	*Cyrtostylis tenuissima*
**Briza maxima* (Blowfly Grass)	*Dampiera heteroptera*
**Briza minor* (Shivery Grass)	*Dampiera linearis* (Common Dampiera)
Burchardia multiflora (Dwarf Burchardia)	*Darwinia ferricola*
Caesia micrantha (Pale Grass-lily)	*Darwinia oederoides*
Caladenia attingens subsp. attingens	*Dasypogon bromeliifolius* (Pineapple Bush)
Caladenia brownii	*Desmocladus fasciculatus*
Caladenia cairnsiana	*Desmocladus flexuosus*
Caladenia corynephora	**Disa bracteata*
Caladenia flava subsp. flava	*Diuris corymbosa*

Diuris emarginata
Diuris heberlei
Diuris laxiflora
Diuris longifolia
Drosera glanduligera (Pimpernel Sundew)
Drosera menziesii subsp. *menziesii*
Banksia nivea subsp. *uliginosa* (Honeypot Dryandra)
**Ehrharta calycina* (Perennial Veldt Grass)
Elythranthera brunonis
Elythranthera emarginata
Eriochilus helonomos
Eriochilus scaber subsp. scaber
Eucalyptus diversicolor (Karri)
Eucalyptus marginata (Jarrah)
Eucalyptus patens (Swan River Blackbutt)
Eutaxia virgata
Gastrolobium formosum
Gompholobium aristatum
Gompholobium capitatum
Gompholobium tomentosum (Hairy Yellow Pea)
Goodenia micrantha
Grevillea manglesioides
Grevillea manglesioides subsp. *ferricola*
Grevillea papillosa
Haemodorum simplex
Haemodorum spicatum (Mardja)
Hakea ceratophylla (Horned Leaf Hakea)
Hakea linearis
Hakea oleifolia (Dungyn)
Hakea prostrata (Harsh Hakea)
Hakea sp. Scott River (B.J. Lepschi *1883)*
Hakea sulcata (Furrowed Hakea)
Hakea tuberculata
Hakea varia (Variable-leaved Hakea)
Hardenbergia comptoniana (Native Wisteria)
Hibbertia cunninghamii
Hibbertia stowardii
Homalosciadium homalocarpum
Hyalosperma cotula

Hyalosperma simplex
Hydrocotyle alata
Hypocalymma cordifolium subsp. *minus*
**Hypochaeris glabra* (Smooth Catsear)
**Hypochaeris radicata* (Flat Weed)
Hypolaena exsulca
Hypolaena pubescens
Isolepis cyperoides
Isopogon axillaris
Isotoma hypocrateriformis (Woodbridge Poison)
**Juncus bufonius* (Toad Rush)
**Juncus capitatus* (Capitate Rush)
**Juncus microcephalus*
Juncus pallidus (Pale Rush)
Juncus planifolius (Broadleaf Rush)
Kunzea aff. micrantha
Kunzea micrantha
Kunzea recurva
**Lagurus ovatus* (Hare's Tail Grass)
Lambertia orbifolia subsp. Scott River Plains (L.W. Sage 684)
Laxmannia ramosa (Branching Lily)
Lechenaultia expansa
Lepidosperma angustatum
Lepidosperma effusum (Spreading Sword-sedge)
Lepidosperma gladiatum (Coast Sword-sedge)
Lepidosperma longitudinale (Pithy Sword-sedge)
Lepidosperma squamatum
Leporella fimbriata
Leptoceras menziesii
Leptomeria scrobiculata
Lepyrodia macra (Large Scale Rush)
Leucopogon carinatus
Leucopogon propinquus
Leucopogon striatus
Levenhookia pusilla (Midget Stylewort)
Lobelia heterophylla (Wing-seeded Lobelia)
Lomandra suaveolens
Loxocarya magna
Lyperanthus serratus

Meeboldina roycei
Meeboldina scariosa
Meeboldina tephrina ms
Meionectes tenuifolia
Melaleuca incana (Grey Honeymyrtle)
Melaleuca incana subsp. Gingilup (N. Gibson & M. Lyons 593)
Melaleuca incana subsp. *incana*
Melaleuca pauciflora
Melaleuca preissiana (Moonah)
Melaleuca rhaphiophylla (Swamp Paperbark)
**Mentha pulegium* (Pennyroyal)
Mesomelaena tetragona (Semaphore Sedge)
Microlaena stipoides (Weeping Grass)
Microtis alboviridis
Microtis atrata
Microtis brownii
Microtis media subsp. media
Microtis orbicularis
Nuytsia floribunda (Christmas Tree)
Opercularia hispidula (Hispid Stinkweed)
**Parentucellia viscosa* (Sticky Bartsia)
Patersonia juncea (Rush Leaved Patersonia)
Patersonia occidentalis (Purple Flag)
Patersonia occidentalis var. *angustifolia*
Pericalymma ellipticum (Swamp Teatree)
Petrophile serruriae
**Phalaris paradoxa* (Paradoxa Grass)
Pheladenia deformis
Philotheca spicata (Pepper and Salt)
Philydrella pygmaea (Butterfly Flowers)
Phyllangium paradoxum
Pimelea ferruginea
Pimelea longiflora
Pimelea rosea (Rose Banjine)
Platychorda applanata
Poa poiformis (Coastal Poa)
Podolepis gracilis (Slender Podolepis)
Prasophyllum brownii
Prasophyllum drummondii
Prasophyllum gibbosum
Prasophyllum gracile
Prasophyllum hians
Prasophyllum macrostachyum
Prasophyllum regium
Pterostylis recurva
Pterostylis vittata
Rytidosperma setaceum
Schoenus odontocarpus
Schoenus tenellus
Siloxerus humifusus (Procumbent Siloxerus)
Sowerbaea laxiflora (Purple Tassels)
Sporadanthus strictus
Spyridium spadiceum
Stenotalis ramosissima
Stylidium calcaratum (Book Triggerplant)
Stylidium crassifolium (Thick-leaved Triggerplant)
Stylidium inundatum (Hundreds and Thousands)
Stylidium angustifolium subsp. *glaucifolium*
Stylidium repens (Matted Triggerplant)
Taxandria juniperina
Taxandria linearifolia
Taxandria parviceps
Thelymitra antennifera
Thelymitra benthamiana
Thelymitra crinita
Thelymitra flexuosa
Thelymitra fuscolutea
Thelymitrasp. Plain Sun Orchid (A. R Annels 512)
Thelymitra uliginosa
Thelymitra vulgaris
Thysanotus glaucus
Thysanotus gracilis
Thysanotus multiflorus (Many-flowered Fringe Lily)
Thysanotus tenellus
Thysanotus triandrus
Tremulina tremula
Tribonanthes australis
**Trifolium campestre* (Hop Clover)

Trymalium ledifolium	**Vulpia bromoides* (Squirrel Tail Fescue)
Tyrbastes glaucescens	*Xanthorrhoea preissii* (Grass tree)
**Ursinia anthemoides* (Ursinia)	*Xanthosia huegelii*
Utricularia multifida	
Velleia trinervis	
Verticordia plumosa (Plumed Featherflower)	
Liparophyllum capitatum	
Viminaria juncea (Swishbush)	

indicates exotic species

Table A.2 Faunal species recorded within the area* of the ecological community

***Scientific name* – (Common name)**
Birds
Acanthiza (Acanthiza) apicalis (Inland Thornbill)
Acanthiza (Geobasileus) chrysorrhoa (Yellow-rumped Thornbill)
Acanthiza (Geobasileus) inornata (Western Thornbill)
Acanthorhynchus superciliosus (Western Spinebill)
Accipiter (Leucospiza) fasciatus (Brown Goshawk)
Accipiter (Paraspizias) cirrocephalus (Collared Sparrowhawk)
Acrocephalus (Acrocephalus) australis (Australian Reed-warbler)
Anthochaera (Anellobia) lunulata (Western Wattlebird)
Anthochaera (Anthochaera) carunculata (Red Wattlebird)
Anthus (Anthus) novaeseelandiae (Australasian Pipit)
Aquila (Uroaetus) audax (Wedge-tailed Eagle)
Ardea (Ardea) pacifica (White-necked Heron)
Artamus (Angroyan) cinereus (Black-faced Woodswallow)
Artamus (Angroyan) cyanopterus (Dusky Woodswallow)
Aythya (Nyroca) australis (Hardhead)
Barnardius zonarius (Australian Ringneck)
Cacomantis (Vidgenia) flabelliformis (Fan-tailed Cuckoo)
Cacomantis (Vidgenia) pallidus (Pallid Cuckoo)
Calyptorhynchus (Calyptorhynchus) banksii (Red-tailed Black-cockatoo)
Calyptorhynchus (Zanda) baudinii (Baudin's Black-cockatoo)
Chalcites (Chalcites) lucidus (Shining Bronze-cuckoo)
Cincloramphus (Maclennania) mathewsi (Rufous Songlark)
Circus approximans (Swamp Harrier)
Climacteris (Climacteris) rufa (Rufous Treecreeper)
Colluricincla (Colluricincla) harmonica (Grey Shrike-thrush)
Coracina (Coracina) novaehollandiae (Black-faced Cuckoo-shrike)
Corvus coronoides (Australian Raven)
Coturnix (Coturnix) pectoralis (Stubble Quail)
Coturnix (Synoicus) ypsilophora (Brown Quail)
Cracticus tibicen (Australian Magpie)

Cracticus torquatus (Grey Butcherbird)
Dacelo (Dacelo) novaeguineae (Laughing Kookaburra)
Daphoenositta (Neositta) chrysoptera (Varied Sittella)
Dromaius novaehollandiae (Emu)
Elseyornis melanops (Black-fronted Dotterel)
Eopsaltria (Eopsaltria) griseogularis (Western Yellow Robin)
Eopsaltria (Quoyornis) georgiana (White-breasted Robin)
Epthianura (Epthianura) albifrons (White-fronted Chat)
Falco (Falco) longipennis (Australian Hobby)
Falco (Hierofalco) peregrinus (Peregrine Falcon)
Falco (Ieracidea) berigora (Brown Falcon)
Falco (Tinnunculus) cenchroides (Nankeen Kestrel)
Falcunculus frontatus (Crested Shrike-tit)
Fulica atra (Eurasian Coot)
Gerygone fusca (Western Gerygone)
Gliciphila melanops (Tawny-crowned Honeyeater)
*Glossopsitta porphyrocephala (*Purple-crowned Lorikeet)
Grallina cyanoleuca (Magpie-lark)
Haliastur sphenurus (Whistling Kite)
Hirundo (Hirundo) neoxena (Welcome Swallow)
Lalage (Lalage) sueurii (White-winged Triller)
Gavicalis virescens (Singing Honeyeater)
Ptilotula ornatus (Yellow-plumed Honeyeater)
Lichmera (Lichmera) indistincta (Brown Honeyeater)
Malurus (Leggeornis) elegans (Red-winged Fairy-wren)
Malurus (Malurus) splendens (Splendid Fairy-wren)
Megalurus gramineus (Little Grassbird)
Melanodryas (Melanodryas) cucullata (Hooded Robin)
Melithreptus (Melithreptus) lunatus (White-naped Honeyeater)
Milvus migrans (Black Kite)
Myiagra (Seisura) inquieta (Restless Flycatcher)
*Neophema (Neonanodes) elegans (*Elegant Parrot)
Neophema (Neonanodes) petrophila (Rock Parrot)
Ninox (Ninox) novaeseelandiae (Southern Boobook)
Pachycephala (Alisterornis) rufiventris (Rufous Whistler)
Pachycephala (Pachycephala) pectoralis (Golden Whistler)
Pandion cristatus (Eastern Osprey)
Pardalotus (Pardalotinus) striatus (Striated Pardalote)
Pardalotus (Pardalotus) punctatus (Spotted Pardalote)
Petrochelidon (Hylochelidon) nigricans (Tree Martin)
Petroica (Petroica) boodang (Scarlet Robin)
Phaps (Phaps) chalcoptera (Common Bronzewing)
Phaps (Phaps) elegans (Brush Bronzewing)
Phylidonyris (Meliornis) niger (White-cheeked Honeyeater)
Phylidonyris (Meliornis) novaehollandiae (New Holland Honeyeater)

Platycercus (Violania) icterotis (Western Rosella)
Pluvialis fulva (Pacific Golden Plover)
Podargus strigoides (Tawny Frogmouth)
Porphyrio (Porphyrio) porphyrio (Purple Swamphen)
Purpureicephalus spurius (Red-capped Parrot)
Recurvirostra novaehollandiae (Red-necked Avocet)
Rhipidura (Rhipidura) albiscapa (Grey Fantail)
Rhipidura (Sauloprocta) leucophrys (Willie Wagtail)
Sericornis (Sericornis) frontalis (White-browed Scrubwren)
Smicrornis brevirostris (Weebill)
Stagonopleura (Zonaeginthus) oculata (Red-eared Firetail)
Stipiturus malachurus (Southern Emu-wren)
Strepera (Neostrepera) versicolor (Grey Currawong)
Todiramphus (Todiramphus) sanctus (Sacred Kingfisher)
Tyto (Tyto) javanica (Eastern Barn Owl)
Vanellus (Lobivanellus) tricolor (Banded Lapwing)
Zosterops lateralis (Silvereye)
Mammals
Isoodon obesulus fusciventer (Quenda)
Macropus fuliginosus (Western Grey Kangaroo)
Rattus fuscipes (Bush Rat)
Sminthopsis gilberti (Gilbert's Dunnart)
Tarsipes rostratus (Honey Possum)
Reptiles and Amphibians
Aprasia pulchella (Pretty Worm-lizard)
Egernia kingii (King's Skink)
Egernia napoleonis (South-western Crevice-skink)
Elapognathus minor (Little Brown Snake)
Hemiergis gracilipes (South-western Mulch-skink)
Lerista microtis microtis
Parasuta nigriceps (Mitchell's Short-tailed Snake)
Ramphotyphlops australis (Southern Blind Snake)
Tiliqua rugosa rugosa
Varanus rosenbergi (Heath Monitor)
Crinia georgiana (Tschudi's Froglet)
Geocrinia leai (Lea's Frog)
Invertebrates
Allothereua maculata (House Centipede)
Archiargiolestes pusillissimus
Archiargiolestes pusillus
Chledocyon marmoratus
Chledocyon semiopacus
Onthophagus evanidus
Onthophagus haagi
Sauvagesinella becki

Arachnura higginsi (Scorpion Tailed Spider)
Austrochthonius australis
Cercophonius sulcatus
Geogarypus taylori
Oratemnus curtus
Raveniella peckorum
Westrarchaea pusilla

* There are no faunal data specifically attributed to the ecological community. The above fauna list corresponds to records from the Atlas of Living Australia (2013) occurring in the Warren IBRA Bioregion. These records were filtered to include only those falling within a rectangular area bounded by the maximum and minimum longitudes and latitudes of the known occurrences of the ecological community. Species such as seabirds or birds typical or estuaries or coasts were also removed from the list.

Appendix B – Detailed description of threats

The main threats are clearing, grazing, and dieback disease caused by *Phytophthora* spp. The ecological community occurs as isolated patches within a largely agricultural landscape and is therefore subject to threats from grazing and weed invasion. Threats which have the potential to significantly impact the ecological community are altered fire regimes, changes to hydrological regimes and climate change.

Clearing and fragmentation

The ecological community occurs in the south-west of WA, where the main cause of habitat loss has been agricultural expansion (Conservation International, 2007). The plants that make up the foundation of the ecological community are naturally restricted in the landscape due to the restricted nature of the ironstone substrate and the associated hydrological regime. Although clearing has occurred in the past it remains a threat. The shallow soils associated with the ironstone are not ideal for agriculture as it is hard for many crop species to establish. Therefore the vegetation on deeper soils surrounding the ecological community has been more extensively cleared. However in some cases, the ecological community has been removed and the ironstone substrate dug up to allow more suitable plant species for grazing and cropping to grow. Where the substrate has been removed, the ecological community is irretrievable. Based on available data for the known occurrences, the ecological community has declined in extent from approximately 1100–1700 ha to occupy between 276–404 ha. (DEC, 2012b)

Where patches of the ecological community have not been cleared, they generally occur as small isolated patches within a cleared landscape. These patches are therefore subject to a range of associated threatening process including increased runoff and other changes in hydrological regimes, weed invasion, and grazing.

Phytophthora dieback

This disease is caused by the pathogen *Phytophthora cinnamomi*; a water mould which was inadvertently introduced from south-east Asia and impacts a number of native flora across Australia. Propagules of the mould are spread over large distances through root systems, movement of people and vehicles that have come into contact with infested soil, and in water flowing in surface and near-surface drainage systems (Shearer et al., 2007). WA is thought to be the most impacted state due to favourable climate, soil and susceptible plant species (dieback.org.au, 2012). It is estimated that 800 plant species in the south-west of WA, including the families Proteaceae and Epacridaceae (now subsumed in Ericaceae), are highly susceptible to the disease (Lu and English, 2004; Shearer et al., 2004). The ecological community has several genera in the Proteaceae (*Banksia, Hakea, Grevillea*) and two in the Ericaceae (*Astroloma, Leucopogon*) accounting for around 11% of species recorded from known occurrences of the community.

The disease causes the plant roots to rot, resulting in death from drought stress (Hamilton-Brown et al., 2004). Rare species such as the endangered *Banksia nivea* subsp. *uliginosa* (swamp honeypot) are highly susceptible (Meissner and English, 2005b). Dieback disease has the potential to significantly impact on the ecological community through loss of plant species and changes in community structure. Two occurrences of the ecological community have already recorded the presence of the disease. Loss of plant species is also likely to increase the chance of weed invasion which would lead to further impacts on the ecological community.

Grazing

Grazing is known to impact the ecological community. Remaining patches are subject to varying degrees of grazing by both native and non-native species. As many patches are isolated in agricultural landscapes, they are currently being grazed or have been grazed in the past by sheep (*Ovis aries*) and cattle (*Bos taurus*). Many patches are also grazed by *Macropus fuliginosus* (western grey kangaroo) and rabbits (*Oryctolagus cuniculus*). High densities of kangaroos have a large impact on the vegetation of the ecological community through grazing, as well as trampling and breaking foliage (Luu and English, 2004). Grazing in areas of the ecological community can assist weed invasion through soil disturbance, altered soil fertility and spread of weed propagules. Preferential browsing of the understorey, particularly on herbaceous species, may impact the structure and diversity of the ecological community. Species composition in the ecological community has been altered by selective grazing of edible species, introduction of weeds and nutrients and trampling (Luu and English, 2004).

Weeds

The extent and impact of weed invasion is variable across the ecological community due to differences in the level of disturbance and surrounding landscape use. Weed invasions are usually assisted by disturbance to the soil, along with increased soil fertility. If weed propagules are present in a patch then fire, grazing, nutrient enrichment, mowing and spraying of chemicals can all predispose areas to weed invasion. The creation of tracks through patches of the ecological community is known to facilitate weed spread (Lu and English, 2004; Meissner and English, 2005b). When weeds are present in the ecological community they have significant impacts through competition with native species, by competing for soil moisture, nutrients and light. The presence of weed species can also lead to altered fire regimes through easy ignition of high fuel loads produced by annuals (Luu and English, 2004).

Inappropriate fire regimes

The fire regime requirements of the ecological community are not fully understood, however, the impact of too frequent fires or exclusion of fire can be deduced. Impacts from altered fire regimes are noted in the Interim Recovery Plan (Luu and English, 2004). Many plant species in the ecological community are obligate-seeding and require heat from fires and smoke for their seeds to germinate. If fires are too frequent, there will not be enough time for these plants to flower and set seed. Alternatively, if the time between fires is too long, these plants or their seed bank may senesce and be unable to reproduce. The disturbance created by fire can create increased nutrient levels and niche gaps which allow weed species to become established. Some weeds (e.g. grasses) are highly flammable and can increase the intensity and frequency of fires.

Hydrological changes

A potential threat to the functional integrity of the ecological community is a change in hydrological regimes. A defining characteristic of the ecological community is seasonal inundation or wet/damp soils from winter rainfall and groundwater. Changes to the regular hydrological regime could therefore have a significant impact. A number of occurrences are located on the boundary of areas that are highly cleared which can lead to increases in surface flow and groundwater recharge (Lu and English, 2004). Alternatively, abstraction from bores may lower groundwater levels. Changes to groundwater levels may also lead to salt accumulating near the surface (Luu and English, 2004).

Changes to the period or depth of ponding could affect structure and composition through changes in the timing of growth of annuals which could then favour different plant species including weeds (Luu and English, 2004).

Climate change

There has been an observed significant change in rainfall in south-west WA. A sharp drop in rainfall occurred in south-west WA since the mid-1970s, with some of the driest years on record occurring since 1975. This drop in rainfall is most apparent in late autumn and winter, with fewer storms and less rainfall per storm. The driest winter on record was recorded in 2010 (Western Australia Climate Sciences Centre, 2010). South-west WA's significant drying trend is forecast to worsen under climate change. If current climate trends continue, there will be up to 80 per cent more droughts in south-western WA by 2070 (CSIRO, 2007).

As inundation or damp/wet soils following winter rainfall is a defining characteristic of this ecological community, any changes to the timing or degree of rainfall is likely to have an impact through altered species composition and structure. The annual herbs that rely on winter rainfall to flower are unlikely to persist.

Key threatening processes

Key Threatening Processes are listed under the EPBC Act. A threatening process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

Key Threatening Processes that operate in the ecological community include:

- *Phytophthora* dieback caused by the root-rot pathogen *Phytophthora cinnamomi*
- Land clearing
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants.
- Loss of habitat caused by climate change linked to anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity

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