Biodiversity Sub-Strategy for the South West Catchments Council

Prepared for

South West Catchments Council

by

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Executive Summary

Background

One of the most significant challenges confronting the South West Catchment Council and other NRM regions within Australia is the conservation of its biodiversity. This pressure is intensified within SWCC as it is fully contained within one of the global biodiversity hot spots, the only such designated area in Australia. Approximately 3,500 plant species have been recorded within the region, of which 50% are not found in any other region in the world. The region has a rich fauna with high species diversity. There are 49 species of terrestrial mammals, 8 endemic native fish species, 135 species of reptiles and amphibians, and more than 330 species of birds.

Growth pressures within the region are among the highest in Australia. This places additional stress on the biota and their habitats. The successful management of biodiversity (the components and their ecological processes) depends on the development of a coordinated, strategic current approach to the management of the whole landscape.

The Biodiversity Sub-Strategy

The Biodiversity Sub-Strategy presents a systematic, logical and strategic approach to the prioritisation of biodiversity assets and processes that threaten them, to enable defendable and transparent conservation investment decisions to be made across the whole of the SWCC region.

The SWCC Biodiversity Sub-Strategy aims to:

- Provide a regional context for long term conservation of biodiversity;
- Provide a strategic, systematic and objective approach to identifying and prioritising projects that require funding to protect, enhance or restore biodiversity;
- Outline broad management responses at biogeographical and regional scales that conserve biodiversity;
- Increase the SWCC community's understanding of biodiversity and its values and threats within the South West NRM region; and
- Facilitate the integration of biodiversity conservation objectives within other natural resource themes and issues.

Biodiversity Planning Process

This strategy focuses on biodiversity assets and their relative values.

A defined list of biodiversity assts and the threats to them were compiled from an analysis of higher level strategies at the State and National level. This ensured that SWCC's targeted assets and threats were able to be compatible with broader strategic processes for conservation.

Within the strategy, an expert panel was approached to allocate discrete values to the suite of biodiversity assets and the severity and impact of the threats upon them. This enabled the list of assets to be ranked in order of its perceived value from significant to low. The panel were also used to assign a relative values against a number of attributes that make up the threats to the biodiversity assets and their impacts on a bioregional scale. This resulted in a prioritised list of biodiversity assets and threats and a broad determination of the impacts of those threats within each of the bioregions of SWCC.

Targeted BioLandscapes

Consistent with the landscape approach adopted within the strategy, these values were transferred onto a 5km by 5km scale grid that covered the whole of the region. Each of the resulting 25 km^2 areas was considered a "landscape" with the various biodiversity assets considered as discrete values within each landscape. This enabled a "biodiversity" score to be determined for each landscape unit. These areas are referred to as BioLandscapes.

From this analysis a total of 19 priority landscape areas were able to be determined within the SWCC region. These are landscapes that have the highest concentrations of biodiversity value within the region and where management actions need to be considered first, in order to achieve as high a conservation return for actions, as possible.

Regional Guidelines

An ecosystem driven approach is adopted for this strategy. The strategic priority for actions on biodiversity is based on a three-tiered structure that ranks actions based on their relative costs and on the likelihood of achieving positive outcomes. The highest priority is to **Retain** the existing biodiversity values. The second priority is to **Restore** those areas or assets that still have values and the final priority is to **Revegetation** or rebuild areas of degraded habitat.

A synopsis of general features, landscape design elements and areas of focus are provided for a range of landscape types ranging from those landscapes with less that 10 % of their native vegetation remaining, up to landscape with more than 50% of their native vegetation remaining.

A brief discussion of regional monitoring and evaluation is provided, including some suggested biodiversity indicators to prompt further discussion.

Integrated Decision Support System

The strategic framework provides a process in which future biodiversity projects can be objectively assessed from a biological and ecological perspective. Biases in perceptions, expertise and philosophy, however, interplay within any scientific based investment decision process. Other considerations such as political focus and will, social acceptance, available skills and knowledge, funding availability and delivery methods also influence the final investment decision. A vast array of decision support tools has evolved to provide a formal and objective way of structuring problems and presenting the information to increase the likelihood of good decisions (e.g. CIAT, 1999).

A separate project for Waterways, Wetland and Estuaries has developed a spatially based multi-criteria analysis Investment Decision Support System (IDSS). The strategic framework developed for Biodiversity within this strategy is compatible with the logic in this IDSS. The principles and data developed for this strategy will be integrated with the Water IDSS. This will allow detailed analysis of potential projects from both a spatial context as well as from a discrete asset or class of asset perspective. This IDSS will be run using GIS technology and owned and managed by SWCC, thus given the organisation the flexibility to adapt, modify and update the systems as new information, science and funding programmes are developed.

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THE ONE PROCESS ON-GOING IN THE 1990S THAT WILL TAKE MILLION OF YEARS TO CORRECT IS THE LOSS OF GENETIC AND SPECIES DIVERSITY BY THE DESTRUCTION OF NATURAL HABITATS. THIS IS THE FOLLY THAT OUR DESCENDANTS ARE LEAST LIKELY TO FORGIVE US.

E.O. Wilson (1992).

1. Introduction

The South West region is one of 56 Natural Resource Management (NRM) regions across Australia and one of six within Western Australia (Australian Government 2007). The boundaries of each region have been established by agreement between Commonwealth and State/Territory governments (Commonwealth of Australia 2005). The region covers approximately 5.2 million hectares (SWCC. 2005). The boundaries of the region are primarily based on surface water catchments and include the sub regions of Peel-Harvey, Leschenault, Blackwood, Geographe, Warren and the Cape to Cape catchment.

Each of the NRM regions has at least one “regional body” formed to undertake or coordinate the management of its region’s natural resources. The recognised regional body for the south west of Western Australia is the South West Catchments Council (SWCC). It is funded by State and Australian Government initiatives; the Natural Heritage Trust (NHT), the National Action Plan for Salinity and Water Quality (NAP) (SWCC. Undated), and the recently announced “Caring for our Country” Program.

The South West Catchments Council (SWCC) is a community representative body that coordinates NRM within the south west region (SWCC. Undated). SWCC’s role is to:

- Provide guidance on NRM issues in the region;
- Support priority regional opportunities for NRM in partnership with the sub-regions;
- Coordinate partnerships between the community and all levels of government to share responsibility for NRM; and

- Coordinate implementation of State and Commonwealth NRM policy and programs relevant to the SW region. (SWCC. Undated).

The present document provides a regional context for the strategic conservation of biodiversity within SWCC. It aims to present a systematic and logical approach to highlight the priority biodiversity assets and to enable defendable and transparent conservation investment into the future.

The strategic approach draws out eight key landscape areas where the highest biodiversity values exist and where targeted actions can return significant conservation returns for the region's biota.

Finally, the strategy establishes a framework for conservation that can be adapted as new information is obtained or developed and upon which a consistent NRM based Investment Decision Support System (IDSS) can be based.

1.1. Human Dimensions

The SWCC Region covers 33 local government areas and has a population of approximately 193,000, with some of the coastal areas experiencing growth levels amongst the highest in Australia (SWCC. 2005).

The major industries in the south west are resource-based, such as agriculture, mining, forestry and plantation industries. Tourism and recreational activities are growth industries.

The indigenous people in the south west, collectively known as Nyungars, have a 38,000 year association with the environment and landscape. They have strong familial ties to the country and share a common culture, language, history and affiliation with the land (SWCC. 2005)

European settlement in the region began in 1829 with land in the Swan and Peel Harvey areas initially, then into the Vasse and Augusta areas in the 1830s. The Blackwood Valley was settled around 1857 and by the late 1860s settlement had spread along the Blackwood River's fertile valleys.

1.2. Biophysical Characteristics.

The climate of the south west region is characterised by cool, wet winters and warm to hot, dry summers. The average rainfall ranges from 900 to 1400 mm on the coast to approximately 350mm in the inland parts. Most of the rainfall

occurs from May to September. The evaporation gradient follows a reversed direction to rainfall, with 800-1200 mm average annual evaporation in coastal areas , increasing to over 2000 mm in the inland areas (SWCC. 2005).

The soils of the south west are among the oldest on the planet, making them remarkably infertile and frequently laterised. The region spans five broad geological regions, within which a number of soil-landscapes zones are represented (Tille, Mathwin et al. 2001).

The vegetation of the south west has evolved alongside these poor soils giving the region plant species diversity not found in many other parts of the world. The region lies at the heart of the South West Botanical Province, which is documented as Australia's only area recognised internationally as a Global Biodiversity Hotspot (Myers 1988; Myers 1990; Mittermeier *et al*. 1998; Myers 2003). A large variety of vegetation formations and associations exist across the region, as well as flora species themselves. Approximately 3,500 species have been recorded, of which 50% are endemic to the region (SWCC. 2005). About 2.7 million hectares (52%) of the region have been cleared of native vegetation (SWCC. 2005). There is not, however, a uniform pattern of remnant vegetation and clearing. A large contiguous portion of jarrah forest region remains, which contrasts with the highly cleared areas further east, as dictated by agricultural development needs over the last 150 years.

The region has a rich fauna with high species diversity. There are 49 species of terrestrial mammals, 8 native fish species, 135 species of reptiles and amphibians, and more than 330 species of birds known to occur within the region (SWCC. 2005).

1.3. Biodiversity in the South West

Rapidly escalating human demands for natural resources are causing genes, species and natural ecosystems to disappear at an unprecedented rate. Conservation is becoming a crisis discipline. Extinction is a fact of life. Sooner or later, every species meets its fate; it may be overwhelmed by environmental change or by the debut of a new species. Conservative estimates indicate human activity has increased the extinction rate of plants and vertebrates to between 10–100 times the normal "background" rate. This figure is likely to be much higher for invertebrates (Wilson 1992).

The term biodiversity is a contraction of the terms “biological” and “diversity” and has emerged over the past 20 years to mean different things to different people, and to be used to drive different agendas.

Biological is derived from the word biology – meaning “science of life.” It refers to the living components of earth and associated processes. In the context of biodiversity it is often viewed at three levels of organisation: genes, species, and ecosystems. Some definitions, however, often include one or more additional levels such as “communities” and “landscapes.”

Diversity suggests many varieties (multiplicity) and dissimilarity (i.e. not being the same). Therefore there are two aspects implied by diversity. One is the number of different varieties, or aggregate variability; the other is concerned with comparing variation within and between the different entities, which implies a degree of pattern caused by these differences of the physical way elements are arranged or structured (Claymore 2003).

Biodiversity, therefore, suggests an underlying complexity and dynamism that varies over time. While the biological components (particularly species) are often the primary focus, the notion of Biodiversity is greater than the sum of its parts. It is more than the number of genes, species and ecosystems in a given area. It refers to a complex system of interacting living entities that form ecological patterns and processes, and evolve over time.

The Australian Government’s definition of biodiversity is:

“….. *the variety of all life forms – the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part”* (Commonwealth of Australia 1996).

While this definition is the one most commonly used in Australia, it doesn’t highlight the dynamic nature of the concept of biodiversity in the combination and arrangement of its component parts. Therefore the following definition is preferred as the reference point of this document.

Biodiversity is:

“*The sum of the total variety of life – the diversity of what it’s made of (the components), plus the diversity of how it’s arranged (the patterns), plus the diversity of what it does (its functions), at a range of scales both geographical and over time*” (Claymore 2003).

Figure 1 shows the attributes and components of biodiversity.

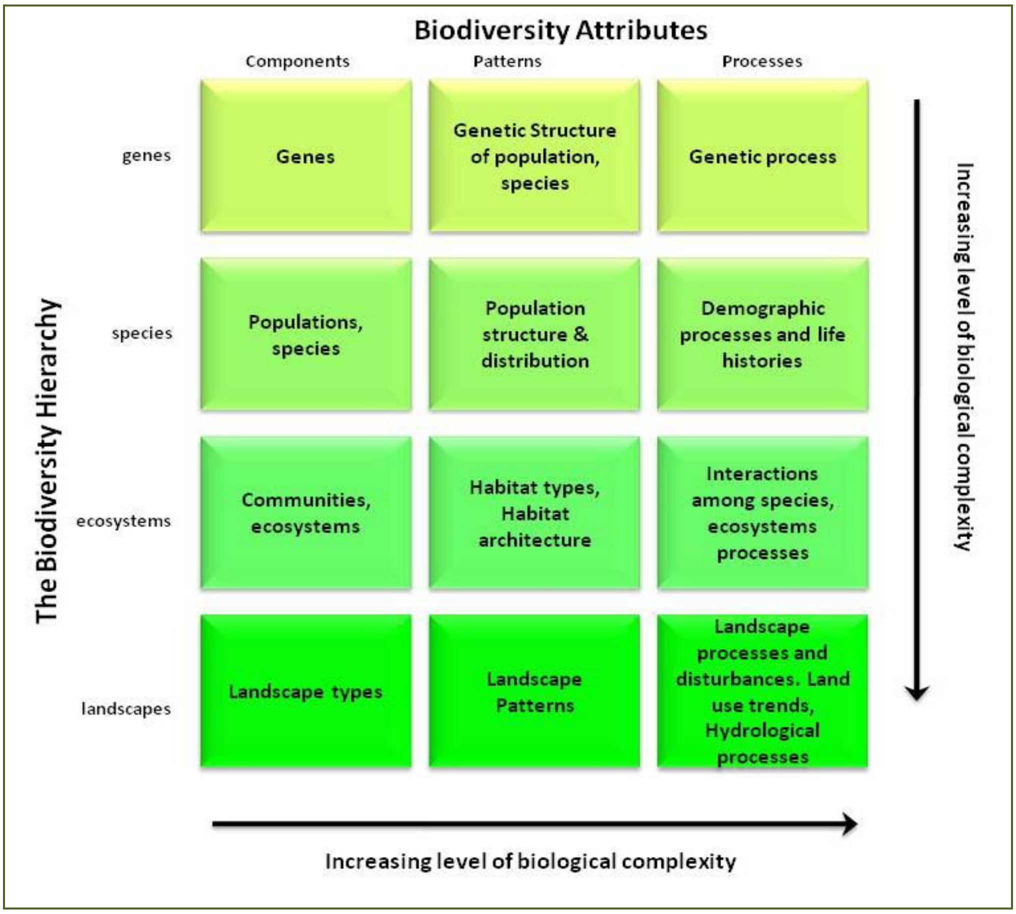

Figure 1: Attributes of the biodiversity hierarchy (D.E.H, 2007 adapted from Peck 1998)

Biodiversity is considered essential (Croft *et al*. 1999):

- To maintain the health and function of the environment;
- For agricultural productivity, societal and cultural well being; and
- For the ecologically sustainable use of natural resources.

1.3.1. Bioregions

The Interim Biogeographical Regionalisation for Australia (IBRA) is an interim framework for planning and management developed for conservation over the Australian Continent. The basis for bioregionalisation is that "key physical processes drive ecological processes, which in turn are responsible for driving the observed patterns of biological productivity and associated patterns of biodiversity" (Thackway and Creswell 1995; Department of Environment and Heritage 2005). Assigning areas to IBRA regions has been based on specialist ecological knowledge, as well as regional and continental scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna. The latest

version identified 85 bioregions within Australia (Department of Environment and Heritage 2005). The system also provides a sub-regional classification, and in 2003, 354 sub-regions were recognised (Department of Environment and Heritage 2005).

Five bioregions and six sub-regions (Warren is not split into sub-regions) are within the SWCC region (Figure 2). The codes listed in the brackets are the recognised codes under IBRA (Thackway and Creswell 1995)

- Swan Coastal Plain (SWA);
    - Perth (SWA2);
- Jarrah Forest (JF);
    - Northern Jarrah Forest (JF1);
    - Southern Jarrah Forest (JF2);
- Warren (WAR);
- Avon Wheatbelt (AW);
    - Avon Wheatbelt P2 (AW2)
- Mallee (MAL)
    - Western Mallee (MAL2).

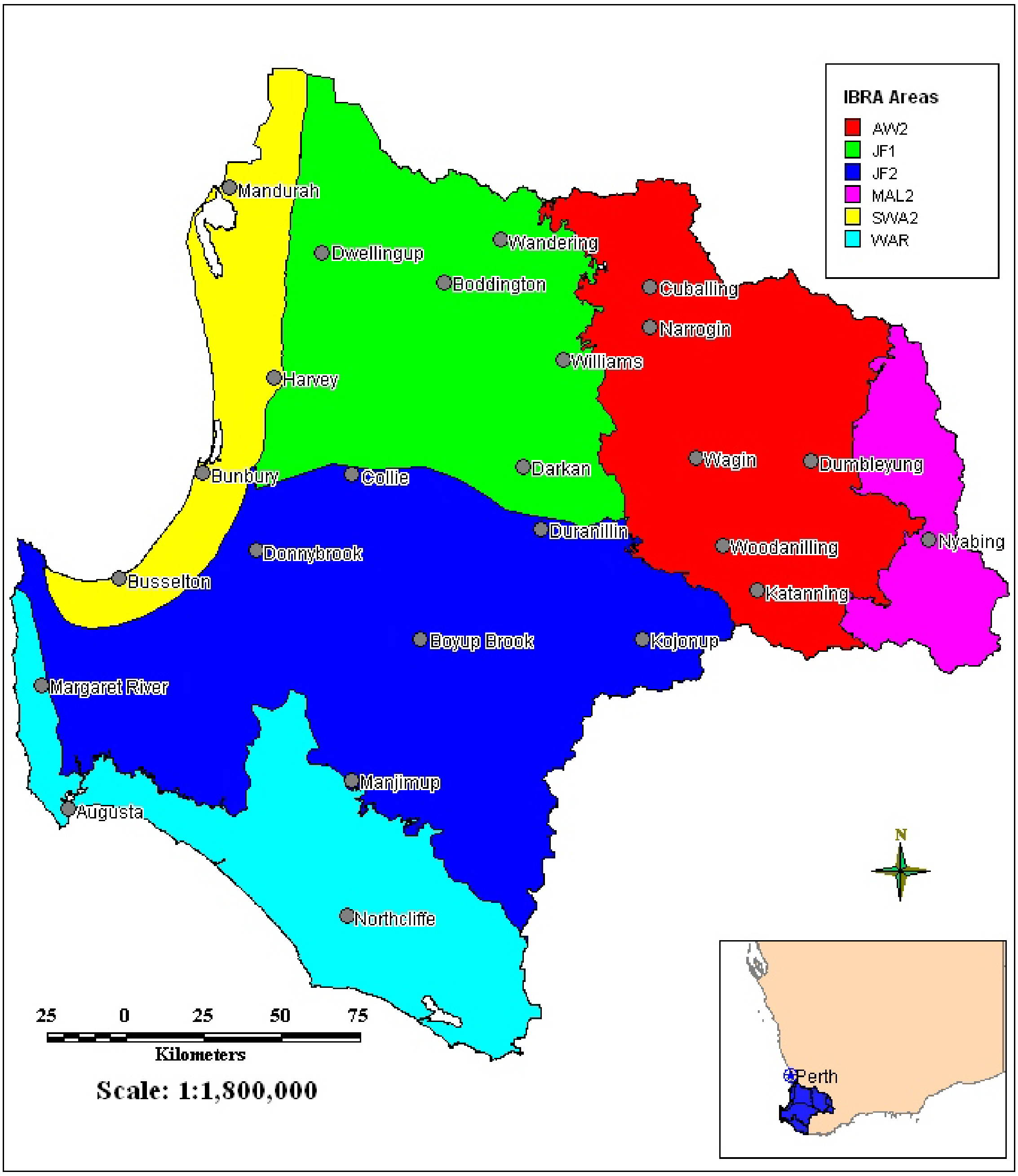

Figure 2: IBRA Areas within SWCC

This strategy focuses on sub-IBRA boundaries (i.e. bioregions) as the spatial area within the region, because biodiversity elements within a bioregion usually co-occur within a similar landscape, share common ecological processes and share similar critical threats. Hence a defining area such as bioregion (or sub-bioregion) provides a more useful boundary for strategic planning and prioritisation than other boundaries, such as catchments. Descriptions of the bioregions within SWCC are included in Appendix A (CALM 2002).

1.3.2. Broad Condition and Trends

The following tables (1-6) summarise the current status and conservation trends of the major biodiversity assets within each sub-IBRA area of SWCC. These assets include endangered flora, fauna and communities and native vegetation. The information is a synopsis of the data contained in the publication *A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions (*Department of Conservation and Land Management 20*02)*. The condition ranks are based on the perceived likelihood of recovery based upon the degree of management intervention:

- Degraded: Recovery is unlikely in the medium term;
- Fair: Recovery requires significant management intervention; and
- Good: Recovery would likely occur in the short term with minimal intervention.

Table 1: Swan Coastal Plain 2 - Biodiversity Condition and Trend

Swan Coastal Plain 2 (within SWCC's Boundary)			
Dominant Land use	Urban, Rural Residential, Cultivation-horticulture, Some conservation.		
Diversity	Very High degree of species diversity		
Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 0 DRF = 35 Priority = 128	Fair	Condition Declining
Fauna	Extinct = 0 Threatened = 25 Priority = 19	Degraded	Condition Declining
Ecological Communities	Number = 16 Occurrences = 226	Fair	Condition Declining

Vegetation Associations				
% Remaining	<10%	10-<30%	30-<50%	>50%
Number	13	17	4	8

Area remaining	<10ha	10-<100ha	100-<1,000 ha	1000- <10,000ha	>10,000ha
Number	4	8	18	10	2

General trend:	Quality	Amount

Table 2: Jarrah Forest 1 - Biodiversity Condition and Trend

Jarrah Forest 1 (within SWCC's Boundary)			
Dominant land use	Forestry (native forests), Conservation, Grazing, Cultivation, Forestry (plantations)		
Diversity	Moderate species diversity		
Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 0 DRF = 16 Priority = 122	Fair-Good	Condition Declining
Fauna	Extinct = 0 Threatened = 14 Priority = 19	Fair	Condition Declining
Ecological Communities	Number = 2 Occurrences = 6	Fair	Condition Declining

Vegetation Associations				
% Remaining	<10%	10-<30%	30-<50%	>50%
Number	1	21	5	12

Area remaining	<10ha	10-<100ha	100-<1,000 ha	1000- <10,000ha	>10,000ha
Number	0	1	12	15	11

General trend:	Quality	Amount

Table 3: Jarrah Forest 2 - Biodiversity Condition and Trend

Jarrah Forest 2 (within SWCC's Boundary)	
Dominant land use	Grazing, Agriculture, Forestry (native), Conservation
Diversity	Moderate to High Species Diversity (taxa dependant)

Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 0 DRF = 43 Priority = 197	Fair	Condition Declining
Fauna	Extinct = 2 Threatened =23 Priority = 26	Good	Condition Static
Ecological Communities	Number = 5 Occurrences = 23	Degraded-Fair	Condition Static

Vegetation Associations				
% Remaining	**<10%**	**10-<30%**	**30-<50%**	**>50%**
Number	6	23	16	32

Area remaining	**<10ha**	**10-<100ha**	**100-<1,000 ha**	**1000- <10,000ha**	**>10,000ha**
Number	3	11	27	29	7

General trend:	Quality	Amount

Table 4: Warren - Biodiversity Condition and Trend

Warren (within SWCC's Boundary)	
Dominant land use	Grazing, Horticulture, Conservation, Forestry (Native and Plantations)
Diversity	High degree of species diversity

Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 2 DRF = 23 Priority = 137	Fair	Condition Declining
Fauna	Extinct = 1 Threatened = 26 Priority = 27	Good	Condition Static
Ecological Communities	Number = 9 Occurrences = 84	Degraded-Fair	Condition Declining

Vegetation Associations				
% Remaining	**<10%**	**10-<30%**	**30-<50%**	**>50%**
Number	1	3	7	75

Area remaining	**<10ha**	**10-<100ha**	**100-<1,000 ha**	**1000- <10,000ha**	**>10,000ha**
Number	5	15	33	23	10

General trend:	Quality	Amount

Table 5: Avon Wheatbelt 2 - Biodiversity Condition and Trend

Avon Wheatbelt 2 (within SWCC's Boundary)			
Dominant land use	Dry-land agriculture, Grazing, Conservation, Crown Reserves		
Diversity	Very High Species Diversity		
Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 2 DRF = 19 Priority = 119	Fair	Condition Declining
Fauna	Extinct = 1 Threatened = 11 Priority = 16	Fair	Condition Declining
Ecological Communities	Number = 1 Occurrences = 3	Fair	Condition Declining

Vegetation Associations				
% Remaining	**<10%**	**10-<30%**	**30-<50%**	**>50%**
Number	22	20	13	7

Area remaining	**<10ha**	**10-<100ha**	**100-<1,000 ha**	**1000- <10,000ha**	**>10,000ha**
Number	4	13	29	13	3

General trend:	Quality	Amount

Table 6: Mallee 2 - Biodiversity Condition and Trend

Mallee 2 (within SWCC's Boundary)			
Dominant land use	Dry-land agriculture To a lesser extent – Crown reserves and Conservation		
Diversity	Very High Species Diversity		
Asset	**Status**		
	Numbers	**Condition**	**Trend**
Flora	Extinct = 0 DRF = 3 Priority = 59	Fair	Condition Declining
Fauna	Extinct = 0 Threatened = 6 Priority =	Fair	Condition Declining
Ecological Communities	Number = 0 Occurrences = 0	Fair	Condition Declining

Vegetation Associations				
% Remaining	**<10%**	**10-<30%**	**30-<50%**	**>50%**
Number	14	7	4	2

Area remaining	**<10ha**	**10-<100ha**	**100-<1,000 ha**	**1000- <10,000ha**	**>10,000ha**
Number	2	7	13	5	0

General trend:	Quality	Amount

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2. The Biodiversity Sub-Strategy Project

The successful management of biodiversity (the components and their ecological processes) depends on the development of a coordinated, strategic current approach to the management of the whole landscape.

The project was therefore initiated by SWCC in order to bring its management strategy for biodiversity up to date and develop an IDSS (see Section 4) to help guide future investment. This document, the Biodiversity Sub-Strategy, is the final product of the former.

As such it provides a regional context for long-term biodiversity conservation[1] of the South West Catchment Council region. The strategy is based on the concepts of useability (how readily can the strategy be used), transparency (how simply can the approach of the strategy be understood) and defendability (how clearly can SWCC defend decisions that are based on the strategy to invest or not invest in particular conservation projects). The basis of the strategy is the so-called asset-based approach to biodiversity, where priority is primarily based on rarity and irreplaceability, as well as the threat to that asset and the feasibility of success. Landscape ecology and conservation principles are then used to devise broad guidelines for management.

2.1. Project Objectives

The Biodiversity Sub-Strategy presents a systematic, logical and strategic approach to the prioritisation of biodiversity assets and processes that threaten them, to enable defendable and transparent conservation investment decisions to be made across the whole of the SWCC region.

2.2. Project Scope

The project focused on terrestrial biodiversity assets[2], as aquatic and riparian biodiversity assets of waterways, wetlands and estuaries in the South West are being reviewed as part of a separate SWCC project. There are obvious linkages between the two projects, with both projects considering native vegetation and fauna species, which allows for clear areas of commonality and integration. These are discussed in the document, where appropriate.

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[1] *The protection, maintenance, management, restoration and enhancement of the natural environment*. Department of Environment and Conservation (2006)

[2] Those biodiversity assets that are predominantly found in habitats on land.

2.3. Expected Outcomes

The SWCC Biodiversity Sub-Strategy aims to:

- Provide a regional context for long term conservation of biodiversity;
- Provide a strategic, systematic and objective approach to identifying and prioritising projects that require funding to protect, enhance or restore biodiversity;
- Outline broad management responses at biogeographical and regional scales that conserve biodiversity;
- Increase the SWCC community's understanding of biodiversity and its values and threats within the South West NRM region; and
- Facilitate the integration of biodiversity conservation objectives within other natural resource themes and issues.

The Biodiversity Sub-Strategy is closely linked to SWCC's development of an Investment Decision Support System (IDSS) for biodiversity projects that will be cooperatively developed by Spatial Vision Pty Ltd and Ecosystem Solutions Pty Ltd.

3. Terrestrial Biodiversity Sub-Strategy

3.1. Overview

The SWCC Terrestrial Biodiversity Sub-Strategy is an output of an overall Biodiversity project[3] managed by Ecosystem Solutions.

3.1.1. National and State Context

This strategy needs to be considered in the context of state and national policy, legislation and strategies. The following tables summarise the mechanisms within which this strategy needs to be situated. Table 7 outlines the primary mechanisms that are **solely** directed toward biodiversity conservation, while Table 8 highlights those mechanisms that **support** or **assist** in biodiversity conservation.

[3] The other outputs of the project include a review of the biodiversity NRM targets of SWCC, a situation statement on biodiversity (a snapshot of the biodiversity assets within the region) and the incorporation of this strategy into an Investment Decision Support System (IDSS).

Table 7: Primary mechanisms influencing or solely aimed at biodiversity conservation

Level	**Type of Mechanism**
International Conventions and agreements	• Convention on Biological Diversity (1992) • Local Agenda 21 (1992) • Convention on Wetlands of International Importance (Ramsar 1971) • Convention on the International Trade in Endangered Species of Wild Fauna and Flora (1975) • Asia-Pacific Migratory Waterbird Conservation Strategy:2001-2005 • Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1979) • Japan Australia Migratory Bird Agreement (JAMBA 1981) • China Australia Migratory Bird Agreement (CAMBA 1988) • International Convention for the Regulation of Whaling (1946)
National legislation and strategies	• *Environment Protection and Biodiversity Conservation Act 1999* • 2004-2007 National Biodiversity and Climate Change Action Plan • National Strategy for the Conservation of Australia's Biological Diversity (1996) • Strategic Plan of Action for the National Representative System • Marine Protected Areas: A Guide for Action by Australian Governments (1999) • Biodiversity Conservation Research: Australia's Priorities (1999) • National Objectives and Targets Biodiversity Conservation 2001- 2005 • Directions for the National Research System: A Partnership Approach (2004) • Nationally Agreed Framework for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Australia (1997) • Wetlands Policy of the Commonwealth Government of Australia (1997) • Australia's State of the Environment (2006) • The National Framework for the Management and Monitoring of Australia's Native Vegetation (2001)
State legislation, policies and strategies	• *Wildlife Conservation Act 1950* • *Conservation and Land Management Act 1984* • WA State of the Environment Report (2007) • Proposed Biodiversity Conservation Act • Wetlands Conservation Policy for Western Australia (1997) • Environmental Weeds Strategy (1999)

Table 8: Other mechanisms that support biodiversity conservation

Level	Type of Mechanism
International Conventions and agreements	• Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention 1972)
National legislation and strategies	• Australia's Oceans Policy (1998) • National Framework for Environmental Management Systems in Australian Agriculture (2002) • National Forest Policy Statement (1992) • National Principles and Guidelines for Rangeland Management (1999) • Commonwealth Coastal Policy (1995) • National Local Government Biodiversity Strategy (1998) • *Natural Heritage Trust of Australia Act 1997* • National Water Quality Management Strategy (1998) • National Action Plan for Salinity and Water Quality (WA signed 2003) • National Strategy for Ecologically Sustainable Development (1992) • National Weeds Strategy (1997) • Australian Weeds Strategy (2007)
State legislation, policies and strategies	• *Waterways Conservation Act 1976* • Waterways WA Strategy (draft) (2001) • *Planning and Development Act 2005* and Statements of Planning Policy • *Sandalwood Act 1929* • *Fish Resources Management Act 1994* • State Planning Strategy (1997) • State Coastal Planning Policy (2003) • *Environmental Protection Act 1986* and associated Environmental Protection policies and amendments • *Land Administration Act 1997* • Forest Management Plan (2004 - 2013) • WA Greenhouse Strategy (2004) • Hope for the Future: The WA State Sustainability Strategy (2003) • State Salinity Strategy (2000) • WA Salinity Investment Framework interim report (2003) • A Weed Plan for Western Australia (2001) • Nature Based Tourism Strategy (1997) • *Swan and Canning Rivers Management Act 2006* • *Agriculture and Related Resources Protection Act 1976* • Securing our Water Future: A State Water Policy for WA (2003) • State Water Plan: Draft Water Policy • Framework Discussion Paper (2006) • Network City - a milestone in metropolitan planning (2005) • Policy for the Implementation of Ecological Sustainable Development for Fisheries and Aquaculture within Western Australia (2002) • *Aboriginal Heritage Act 1972* • *Museum Act 1969* • Proposed Biosecurity and Agriculture Management Act • Bush Forever (2000)
Regional and local strategies and plans	• Regional NRM strategies and investment plans • WA Planning Commission Regional Strategies • Regional Development Commissions Strategies • Local Government biodiversity plans

Figure 3 shows how the SWCC Biodiversity Sub-Strategy nests within the key elements of the above mechanisms.

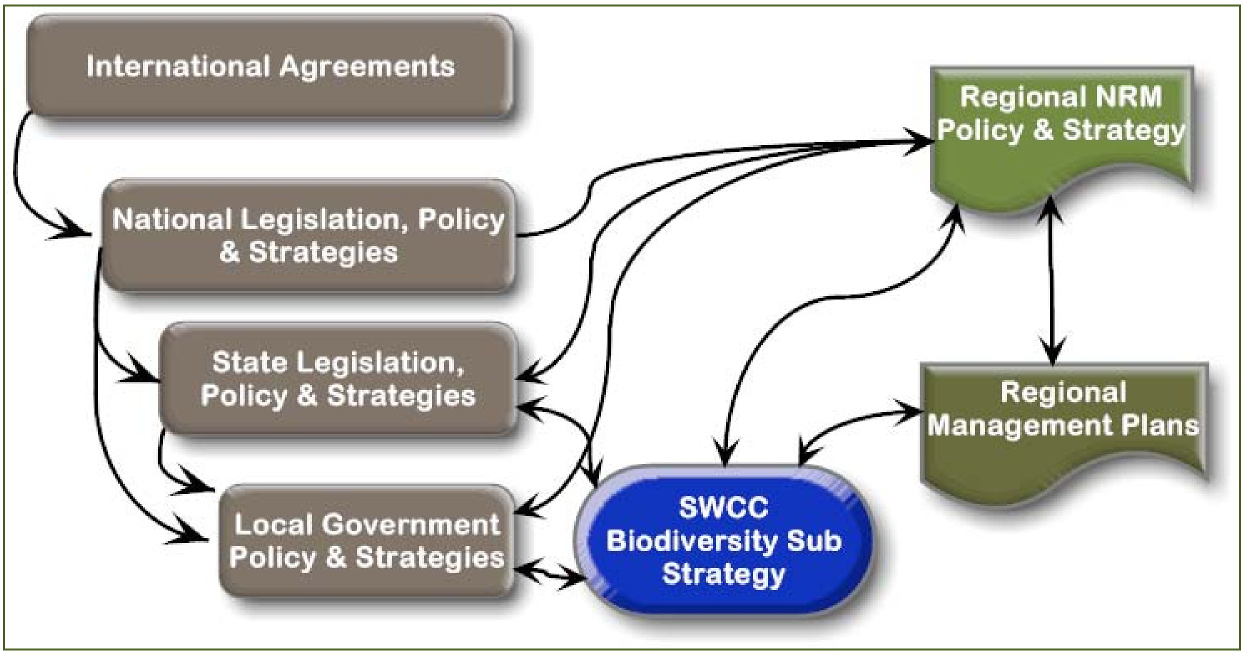

Figure 3: Sub-Strategy Context

3.1.2. Biodiversity Planning Overview

Biodiversity conservation planning seeks to address conservation problems by drawing upon our knowledge of natural ecosystems and our understanding of the human impacts on these systems. Many approaches have been adopted and have been used by organisations, such as The Nature Conservancy (TNC), World Wildlife Fund (WWF), as well as government agencies. The approach used within this strategy is a combination of approaches, but relies heavily on the strategic rationale outlined by The Nature Conservancy (Groves 2003).

It has long been recognised that biodiversity occurs at a variety of organisational levels from genes to ecosystems and landscapes (Noss 1990a; Noss 1990b). Theories about the hierarchical organisation of biodiversity suggests that the higher levels, such as landscape and ecosystems, constrain and affect what can happen at the lower levels, i.e. at species and population levels (O'Neill *et al*. 1986). Most of our experience and knowledge of how the natural world is organised suggests that a continuum of strategies that seeks to conserve biodiversity at all spatial scales and all levels of organisation is required (Noss 1996).

Biodiversity also occurs at a variety of spatial scales. For example, a population of the White-Bellied Frog, *Geocrinia alba*, which is found only within the SWCC region, may be distributed over just a few square metres (McMahon in press),

whereas Carnaby's White-tailed Black Cockatoo (*Calyptorhynchus latirostris*) may range over thousands of square kilometres (Cale 2003).

TNC scientists have developed a framework that enables conservation planners to account better for the influence of spatial or geographic scales in the conservation of biodiversity (Poiani *et al*. 2000). This is a useful tool for distinguishing the spatial scale of conservation assets and targets. It does not, however, provide much assistance in determining the level of biological organisation from which targets should be selected to ensure that the most effective and efficient conservation management is undertaken.

However, it is important for any strategic conservation approach to work both at a variety of spatial scales and levels of biological organisation[4]. And so the metaphor of a coarse and a fine filter for biodiversity conservation developed by TNC in the mid-1980s (Noss 1987; Hunter *et al*. 1988). In its simplest form, the main idea of a coarse filter is that by conserving representative examples of all the ecological communities within a given region, the vast majority of surviving species would also be conserved. This involves an explicit assumption that communities could serve as a surrogate (or a coarse filter) for conserving the majority of species within a region. To complete the metaphor, some species would fall through the gaps of this "coarse filter" and would need to be conserved through individual efforts (a "fine filter"). This would comprise some individual specialised species including rare or endangered taxa. Studies of remnant vegetation in agricultural areas in Tasmania have demonstrated that there is very little overlap between remnants in good condition and the presence of rare and endangered species (Kirkpatrick and Gilfedder 1995). This reinforces the notion that the two categories (coarse filter and fine filter) need to be considered separately and cannot be dealt with by one single approach, and that TNC's approach could be useful in an Australian context by utilising native vegetation associations as the coarse filter and threatened/rare taxa as the fine filter.

This is borne out by studies conducted in Victoria that tested the effectiveness of ecological vegetation classes (their vegetation mapping classification) as surrogates for a variety of classes of fauna. These show that this approach represented birds, mammals and tree species reasonably well, but did not work as well for reptiles and invertebrates (MacNally *et al*. 2002).

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[4] This refers to the varying levels of species, populations, communities, ecosystems, remnants, landscapes etc.

The coarse-fine filter approach therefore appears well suited for the large area within SWCC as a means to ensure that the most effective and efficient conservation measures are implemented. This strategy utilises the use of remnant native vegetation at a sub-bioregional level as the “coarse filter” and then focuses on specific rare, threatened or endangered species and communities that would represent the “fine filter.” The process is discussed in in more detail in the following section.

3.1.3. Biodiversity Planning in SWCC

Many of the early (i.e. pre NHT2) strategies for NRM were developed using a threat-based or “identifying a problem” paradigm, where problems were highlighted and actions on how to deal with them were the main management actions. This encouraged a culture where threats and problems are seen and addressed almost anywhere they occurred and consequently were not strategically targeted (G. Parkes, pers. comm.). As a result, the NRM paradigm has currently moved to focus on “Assets” as the primary strategic driver. An asset is the broad description of a biodiversity value or element which can include species, taxa, vegetation association or landscapes. Even where they remain threat-based, any rationale for actions is based on preserving, protecting, maintaining or restoring assets and their values.

This strategy, therefore, focuses on biodiversity assets and their relative values. The focus on a physical biological asset provides a more tangible target for conservation using the assumption that it is more practical to manage for a specific asset or suite of assets, rather than to manage for a process (i.e. an ecological process).

SWCC’s current strategy (SWCC 2005) was developed using scientific and technical data, extensive stakeholder consultation and reference to more than 20 management plans. It was endorsed by State and Commonwealth ministers in June 2005. This strategy follows this assets-based approach (as guided by the Australian Government), where the region’s assets are identified via themes of water, biodiversity, land, marine and coasts, air, climate and people.

Within the biodiversity section, regional assets and threats were identified and accompanying Resource Condition Targets (RCTs) and Management Action Targets (MATs) determined, embracing a number of guiding principles[5] and

[5] Refer to page 3 of the NRM Strategy for more information.

nationally agreed accreditation criteria. Throughout this document, the 2005 strategy is referred to as the Regional NRM Strategy.

While this document was useful in SWCC receiving accreditation and in the initial determination of regional priorities and projects, it still does not provide a completely transparent, systematic and defendable framework from which to allocate investments in biodiversity conservation.

The strategic approach developed for this Biodiversity Sub-Strategy overcomes this and provides a repeatable, simple, yet robust model from which biodiversity priorities and projects can be determined, and at the same time allows for a comparison among varying projects or investments so that any opportunities foregone by focusing on one project over another can be effectively evaluated.

3.2. Strategic Approach to Biodiversity Management

The focus on conserving landscapes, at a variety of scales, can improve both the efficiency and effectiveness of regional conservation actions for the following reasons:

- Capturing ecological systems, communities and species at multiple scales within a single intact landscape provides a more ecologically integrated conservation strategy (see coarse-fine filter discussion above);
- Functional landscapes may be more efficiently conserved than many widely dispersed sites;
- Functional landscapes, typically, provide more habitat, greater habitat diversity, and larger populations of known and unknown species;
- Because of their complex and comprehensive environmental gradient, functional landscapes offer greater protection against climate change effects (Poiani *et al*, 2000).

This strategy is based upon these premises and has been developed using a standardised procedure as outlined below.

3.2.1. Process used to rank values.

The process used to develop the strategy is based on the outline and workflow shown in Figure 4.

Figure 4: Strategic Process for the development of the Strategy

In order to achieve a systematic, consistent and transparent approach to the strategic determination of biodiversity conservation, the development of the asset and threat categories and their relative weighting or importance is critical.

Within this strategy, the list of assets and threats are mostly consistent with those identified in higher level strategies, such as the draft 100 Year Biodiversity Conservation Strategy for Western Australia (Department of Environment and Conservation 2006) and the Western Australian Salinity Investment Framework (Sparks *et al*. 2006). This is because it is vital that a regionally-based biodiversity strategy is at least consistent with conservation strategies utilised at a state and national level. This fulfils one of the aims of this strategy which is to ensure that it is able to nest comfortably within these broader strategic platforms.

The ranking of biodiversity values is a subjective activity, based primarily on one's perspective, experience and world-view, which brings with it the difficulty in determining relative values due to differing assessment methodologies in different contexts.

An “expert panel” approach was therefore taken in this strategy to surmount this difficulty. This “expert panel” was made up of a number of people with skills, knowledge and/or experience in biodiversity conservation. These specialists were sent questionnaires in which they were to allocate discrete “values” to the identified list of biodiversity assets and to the severity and impact of threats upon them. Ranking was to be done from a biological /ecological perspective, on a decreasing scale ranging from Significant to High to Moderate to Minor to Low. The specialists were also asked to assign a relative value against a number of attributes that contribute to a number of threatening processes that impact on biodiversity. Appendix B contains a copy of the questionnaire.

This “expert panel” approach aimed to develop a defensible methodology for prioritisation, while acknowledging the qualitative nature of the information.

This process was not set up to produce empirical and/or statistically valid data, but rather was intended to be a transparent and repeatable process by which biodiversity assets and threats can be prioritised for this strategy and in the future.

Experts, as defined here, are people with a good knowledge of the concepts and components of biodiversity within the region (or sub IBRA region) and who are familiar with the important factors that influence the spatial and temporal distribution of these biodiversity components. They included conservation managers, scientists, academics and practitioners. A total of 15 responses were received, of which two were the cumulative response of workshops held in the sub-regions, i.e. represent more than one person’s view.

Once the questionnaires were received, each category of asset was assigned with the modal ranking with “significant” rankings receiving a “5” and “low” a “1.” (see Table 11 for results).

Rather than focussing on the specific assets themselves, and in order to determine both the coarse and fine filter areas applicable within the region, the SWCC land area was broken up into landscape areas of 5 kms by 5 kms. Each 25km^2 area was considered as a separate “landscape,” within which the various components of biodiversity could be considered as values within that landscape. For example, if there was one population of a DRF species within an area (which would score a “5” as significant on the ranking scale), that 25km^2 would receive a ranking of 5, whereas if there were 4 populations within another area, that area would receive a ranking of 20, and so on.

Many of the attributes of the assets, however, could not be spatially represented with the current level of data. In order to maintain data integrity and consistency it was therefore decided to use the data maintained by the WA government as the primary data for prioritisation within this strategy, even though that meant that some attributes could not be included. This has a number of advantages:

- The state has protocols to maintain the integrity of the data;
- They are updated regularly with current information, as it becomes available;
- They are commonly used as the basis of other analyses and processes in NRM;
- The maintenance of the data is the state's responsibility, not SWCC's; and
- New data sets can simply replace old data sets used within this strategy to update its status.

The principal data sets used are therefore:

- The declared rare and priority flora lists;
- The declared rare and priority fauna lists;
- The threatened and priority threatened ecological communities list, all maintained by the Department of Environment and Conservation; and
- The pre-European and remaining vegetation data sets maintained by the Department of Agriculture and Food WA.

The use of this information is not intended to displace the finer scale data that is available within some catchments and landscapes within the region. It does, however, allow for a consistent and repeatable analysis at a whole-of-region scale. Once specific areas for potential projects or investment have been determined, finer scale, local information can be used to refine the prospective area.

The process used, while highly qualitative, provides a transparent, repeatable and defendable ranking system for SWCC and can be used until quantitative measures and an appropriate level of spatial data and representation are available.

3.2.2. Prioritisation

Priority is defined as something that has precedence or is established by order of importance or urgency. Importance implies that something of priority has great value or significance. Calling something a priority implies that its value or significance is greater than other things with which it is being compared. There

are no self-evident priorities; priorities cannot be chosen before the set of things being considered are assigned relative values. And this valuation is by its very nature relative, depending on the experience, objectivity and objectives of each valuer. These values can be biological, social, economic, cultural or any combination of these.

Given the complexity of biodiversity and the range of values, perspectives, and goals that influence how biodiversity is perceived, it is not surprising that there is no generally accepted universal scheme for establishing conservation priorities.

That said, establishing biodiversity conservation priorities should be a conscious effort to assign values to species, habitats and/or ecosystems, and then to evaluate other criteria in relation to those values in order to arrive at a set of temporal and spatial priorities. Priority setting is a complex process around which achieving consensus would be difficult if only one process existed. Hundreds of approaches have been developed, however, to support a range of conservation objectives, each one with its own strengths and weaknesses.

Criteria provide standards to judge whether a thing or a process has certain desired properties, characteristics, or values. Given the intricacy of biodiversity and the many ways in which it is valued, the number of criteria that could be used is enormous.

Biologically-defined criteria are used in virtually all priority-setting schemes and are utilised in the broad categorisation of assets used to determine strategic priorities within this strategy. Within the SWCC Biodiversity Sub-Strategy, only the biological criteria will be used in the initial prioritisation process.

While social and institutional criteria[6] are important, many of these are subjective and difficult to define and represent spatially. It is recommended that once the biodiversity priorities are defined, that continued discussion and debate be encouraged to address and weigh these additional criteria.

The broad biological criteria used to define assets within this strategy are listed in Table 9.

[6] These include elements such as equity, utility, heritage, ethical, historical and economic among others.

Table 9: Broad Asset Criteria

Richness
Species richness refers to the number of species in a given area; the more species, the greater the species richness. Use of this criterion alone (i.e. without additional criteria) implies that all species are of equivalent value, and that areas with more species are of greater value to conservation than areas with fewer species. In isolation, this criterion places no exceptional value on rare or endangered organisms.
Rarity
This criterion is used to assign higher conservation value to the least common genotypes, species, habitats or ecosystems. This criterion also has an advantage in that quantitative information can usually be used. It is common for this criterion to be linked to a threat matrix (as is the case with IUCN categories for rare and threatened taxa) to highlight those taxa or ecosystems that are not only limited in numbers or areas, but are likely to become more uncommon by impending threats. This adds a level of urgency into the prioritisation process, as those taxa or ecosystems that are rare and threatened require more immediate intervention to conserve them; consequently, they are usually ranked higher in any prioritisation scheme. In this instance, rarity tends to be a physical factor, while threat adds a temporal factor. It is important to realise that rarity, by itself, does not necessarily mandate conservation action, as there are rare species that are not threatened or vulnerable. However rare species, by the nature of their rarity, are more likely to become so.
Distinctiveness
In contrast to rarity, which simply measures the relative quantity of something, distinctiveness is a criterion used to assess the degree of separation of a population, species or ecosystem from its nearest comparable entity. A species, for example, may be numerically common (hence not rare), but could be exceedingly distinct in the sense that it has few, if any, closely related species – e.g. the Platypus. This category also includes aspects such as relictual species, species at the limit of their occurrence, outlying habitats, etc. Another example is the greater contribution to the conservation of biodiversity made by conserving a plant community with many endemic species (i.e., species found nowhere else in the world) than by conserving a community containing many widespread but only a few endemic species. It is important to note that the SW of WA has many species that are endemic to the region.

Representativeness
This criterion is used to ensure that conservation efforts in a given area include examples of all species, genotypes, habitats or ecosystems, depending upon the conservation objective. This category is commonly used to design reserve systems containing different biological communities, typical of the region's variety of ecosystems. This criterion may also be used to decide which of two sites within the same ecosystem has the most representative sample of species and ecosystem processes that characterise that ecosystem.
Naturalness
This criterion attempts to place a higher value on those biological assets that are least disturbed. In conservation biology, the term "natural" is used to define anything that has not been made or influenced by humans (Hunter 1996; Angermeirer 2000). If we assume "natural" as being the antonym of "artificial," the naturalness or quality of being natural would express the level at which something occurs without human influence. It is assumed that those assets that are more natural, have more ecological integrity (Hunter 2000; Pimatel *et al*. 2000). Within this strategy a broad assumption is used that a site over 40 ha, representing a level at which it is assumed that ecological process can maintain the "naturalness" of remnant native vegetation. Similarly, those areas or sites that have been used as reference sites which represent an "ideal" state of native vegetation structure, composition or function of a pre-1750 vegetation association are considered to have high "naturalness" This also includes any sites used for the comparison of vegetation condition as outlined in the "habitat hectares" approach (Parkes *et al*. 2003)

3.2.3. Biodiversity Assets

The types of asset classes defined within this strategy have been determined from a review of the literature and the state and national policy documents (Commonwealth of Australia 1996; Department of Environment and Conservation 2006; Sparks *et al*. 2006). These are shown in Table 10.

Table 10: Asset Categories by Criteria

Criteria	Category	Value
Rarity	Flora	Declared Rare
		Priority
	Fauna	Threatened
		Priority
	Communities	Threatened
		Priority
	Vegetation Type	<10% of Pre-European extent remaining Good Condition
		Poor Condition
		<30% of Pre-European extent remaining Good Condition
		Poor Condition
		<50% of Pre-European extent remaining Good Condition
		Poor Condition
		>50% of Pre-European extent remaining Good Condition
		Poor Condition
	Native Vegetation Extent	<10% over landscape
		Good Condition
		Poor Condition
		<30% over landscape
		Good Condition
		Poor Condition
		<50% over landscape
		Good Condition
		Poor Condition
		>50% over landscape
		Good Condition
		Poor Condition
Representative	Vegetation Type	<10% within conservation reserves
		<30% within conservation reserves
		<50% within conservation reserves
		>50% within conservation reserves
	Tenure	National Parks
		Nature Reserves
	Government	Natural Diversity Recovery Catchments
		Land for Wildlife sites
		Conservation Covenant sites
Richness	Species	High number of species within a landscape
		Areas of overlap of botanic and zoologic districts
Distinctiveness	Species	Areas of endemism
		Relictual/outlying species/populations
		Locally significant species
Naturalness	Vegetation	Areas greater than 40 ha
		Known research/reference sites

The expert panel's asset weightings are reflected in Table 11.

Table 11: Asset Value Weightings

Value	Ranking
Declared Rare Flora	Significant
<10% Native Vegetation over landscape Good Condition	Significant
<10% Native vegetation type within conservation reserves	Significant
<10% of Pre-European extent remaining Good Condition	Significant
<30% Native Vegetation over landscape Good Condition	Significant
<30% of Pre-European extent remaining Good Condition	Significant
Areas of Endemism	Significant
Areas of overlap of botanic and zoologic districts	Significant
High number of species within a landscape	Significant
National Parks	Significant
Threatened Communities	Significant
Threatened Fauna	Significant
Priority Flora	High
<30% Native vegetation type within conservation reserves	High
<50% Native Vegetation over landscape Good Condition	High
<50% of Pre-European extent remaining Good Condition	High
Areas greater than 40 ha	High
Conservation Covenant sites	High
Known research/reference sites	High
Natural Diversity Recovery Catchments	High
Nature Reserves	High
Priority Communities	High
Priority Fauna	High
Relictual/outlying species/populations	High
<10% of Pre-European extent remaining Poor Condition	Moderate
<10% Native Vegetation over landscape Poor Condition	Moderate
<30% of Pre-European extent remaining Poor Condition	Moderate
<50% Native vegetation type within conservation reserves	Moderate
>50% Native Vegetation over landscape Good Condition	Moderate
>50% of Pre-European extent remaining Good Condition	Moderate
Land for Wildlife sites	Moderate
Locally significant species	Moderate
<50% of Pre-European extent remaining Poor Condition	Minor
<30% Native Vegetation over landscape Poor Condition	Minor
<50% Native Vegetation over landscape Poor Condition	Minor
>50% Native vegetation type within conservation reserves	Minor
>50% of Pre-European extent remaining Poor Condition	Low
>50% Native Vegetation over landscape Poor Condition	Low

From this process, it can be seen that 32% of the asset categories were classified by the expert panel as being Significant, 32% as High, 21% as Moderate, 11% as Minor and 5% as Low. It also highlighted the significance the panel placed on highly threatened species and vegetation associations that are highly cleared. These are the initial asset results of the process undertaken in 2008 and are explored further in Section 3.3.

3.2.4. Biodiversity Threats

Both the draft 100 year Biodiversity Conservation Strategy for WA (Department of Environment and Conservation 2006) and the SIF (Sparks *et al*. 2006) list major threats to biodiversity. These were used as the basis for the questionnaire on threats which was used to rank the potential impacts of these processes on biodiversity within the SWCC region (Figure 6).

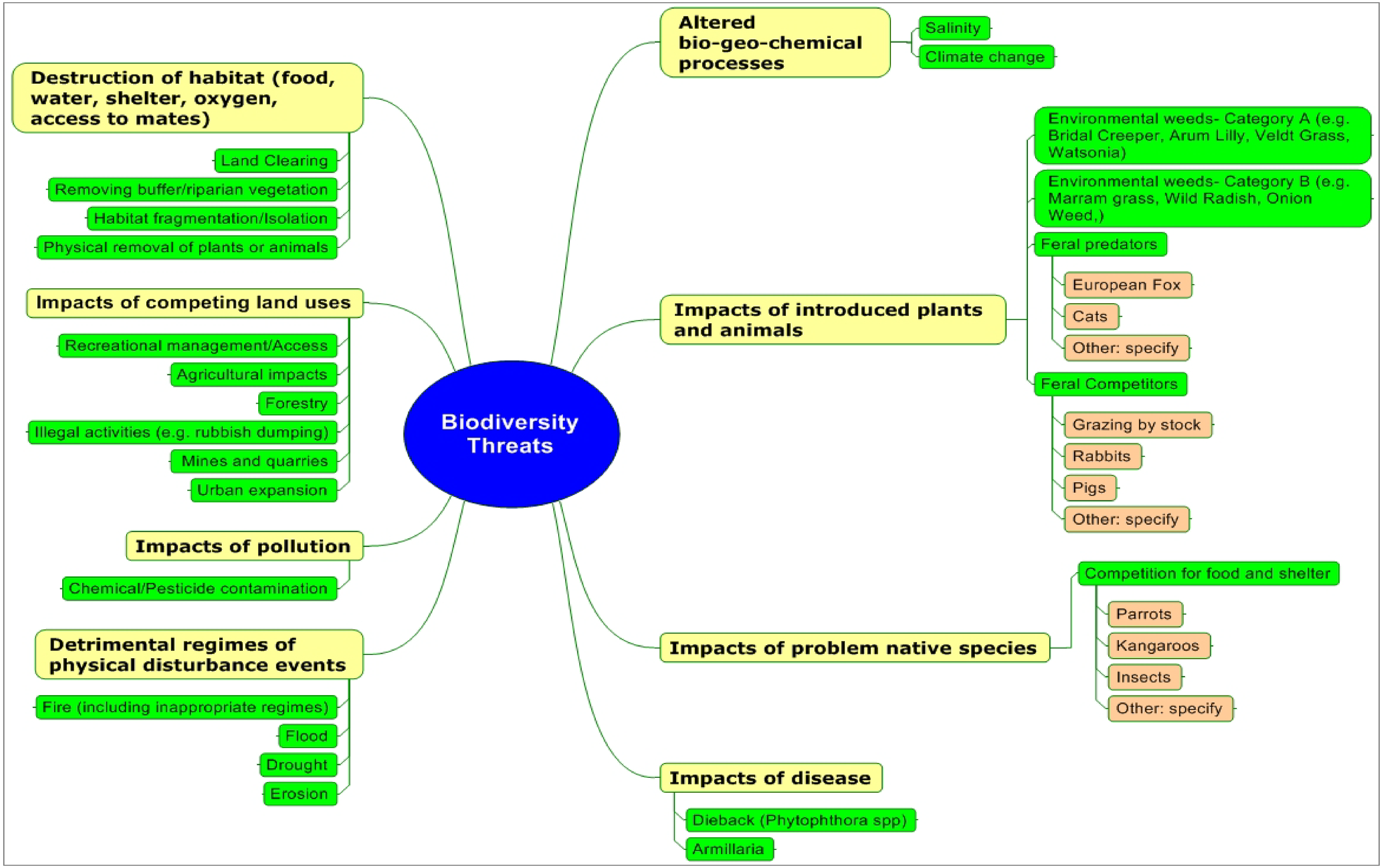

Figure 5: Biodiversity Threatening Processes

The expert panel was asked to rank each threatening process against six parameters:

- Asset Significance: a measure of the significance of the asset affected by the threatening process (not how much the asset is affected by the threat), based on the primary impacts of the threat;
- Occurrence: an indication of the relative distribution of the threat throughout the region;
- Rate of Spread: An indication of the relative speed of spread of the threat through the region (assuming no management input);
- Capacity to Degrade: an indication of the relative severity of the threat, or its capacity to degrade the resources it is impacting;
- Knowledge of the Threat: An assessment of the level of our current knowledge of the threat; and
- Feasibility: Estimation on the degree of feasibility of current techniques in preventing or mitigating the impacts of the threat, based on our current level of knowledge, skills and resources.

The first four parameters refer to the actual threatening process and its impacts, whereas the final two refer to our current ability to manage it.

Expert panel participants were also asked to highlight those sub-IBRA areas where the threatening processes are greater. As many of the threatening processes are not able to be consistently and adequately represented spatially throughout the region, this final question enables some degree of classification and prioritisation by sub-IBRA areas throughout SWCC.

Respondents were also asked to include additional threatening processes that they felt were missed within the original questionnaire. A threat was included if more than one response highlighted the same threat[7] and the technical working group determined that the threat was not just a sub-set of the original threats. The following changes were included as a result of this:

- Forestry was broken into two components:

[7] This prevented an abundance of threats that only focused on one particular area or sub region, instead of the intended whole-of-region focus.

  - Native Forestry; and
  - Non-native Plantations;
- Addition of European Honey Bee;
- Addition of Eucalyptus Dieback;
- Addition of a category for feral birds e.g. Kookaburras, Minahs, Galahs and Corellas;
- Water extraction and capture; and
- Inclusion of sedimentation[8].

To determine how to arrange each of the parameters for a combined regional weighting, the first four parameters associated with the severity and impacts of the threat were separated from the two management-based criteria and a set of rules were defined as to how these four threats were to be ranked (Table 12).

Table 12: Regional Threat Criteria

Regional Threat	Rule Set
High	Has a High significance of asset threatened, a high capacity to degrade **and** a High ranking in any other of the two categories
Medium	Has a High significance of asset threatened (and does not qualify as a High Regional Threat) **and** a High or Medium capacity to degrade.
Low	Has a High significance of asset threatened and a low capacity to degrade; **or** Has a Medium significance of asset threatened.

The rationale for this rule set is that the significance of the asset threatened was determined to be most important for an asset-based prioritisation process, followed closely by the capacity of the threat to degrade that asset. The other two parameters, occurrence and rate of spread, while important, are of lower consequence in the broad regional sense, although the weightings of these can be varied depending on the questions asked of it in the IDSS process.

[8] Although this strategy is terrestrially focused, these last two processes can have major impacts beyond that normally associated with the process in wetlands and waterways, hence its inclusion.

The other two parameters of knowledge and feasibility were not used in the initial ranking process as they relate more to the management of the threatening process rather than its inherent potential impact on biodiversity assts. These parameters need to be considered by SWCC within any project development or investment planning process. Assessments of knowledge and feasibility provide further discussion points for future biodiversity investment and could be used, for example, to decide if further investment in testing differing techniques or whether gaining additional knowledge is required, or as a sounding platform against which a new project's feasibility can be compared.

The results of the threat ranking process are summarised in Table 13.

Table 13: Regional Threats Rankings

Threat	Regional Ranking	Asset Significance	Capacity to degrade	Distribution	Rate of Spread	Feasibility	Knowledge
Climate change	High	High	High	High	High	Low	Medium
Cats	High	High	High	High	High	Low	Medium
Dieback (Phytophthora spp)	High	High	High	High	High	Low	High
Drought	High	High	High	High	High	Low	Medium
European Fox	High	High	High	High	High	Medium	High
Fire (including inappropriate regimes)	High	High	High	High	High	Medium	Medium
Kookaburrah/Minahs/Galahs/ Correllas	High	High	High	High	High	Medium	Medium
Rabbits	High	High	High	High	High	Medium	High
Water Extraction/capture	High	High	High	High	High	High	Medium
Environmental weeds- Category A	High	High	High	High	Medium	Medium	High
European Honey Bee	High	High	High	High	Medium	Medium	Medium
Habitat fragmentation/Isolation	High	High	High	High	Medium	High	High
Land Clearing	High	High	High	High	Medium	Medium	High
Removing buffer/riparian vegetation	High	High	High	High	Medium	Medium	High
Grazing by stock	High	High	High	High	Low	High	High
Salinity	Medium	High	High	Medium	Medium	Medium	High
Pigs	Medium	High	High	Medium	Medium	Medium	High
Armillaria	Medium	High	High	Medium	Medium	Low	Medium
Kangaroos	Medium	High	Medium	High	Low	Medium	High
Chemical/Pesticide contamination	Medium	High	Medium	Medium	Low	High	Low
Physical removal of plants or animals	Medium	High	Medium	Low	Low	Medium	Medium
Air Pollution	Low	High	Low	Medium	Medium	High	Low
Sedimentation	Low	Medium	High	High	High	Medium	Low
Insects	Low	Medium	Medium	High	Medium	Low	Low
Agricultural impacts	Low	Medium	Medium	High	Low	Medium	High
Recreational management/Access	Low	Medium	Medium	Medium	High	Medium	Medium
Non native plantations	Low	Medium	Medium	Medium	Medium	High	Low
Parrots	Low	Medium	Medium	Medium	Low	Medium	High
Illegal activities (e.g. rubbish dumping)	Low	Medium	Medium	Low	Low	Medium	Medium
Environmental weeds- Category B	Low	Medium	Low	High	Medium	Medium	High
Flood/Inundation	Low	Medium	Low	Low	Low	Low	Low
Erosion	Low	Medium	Low	Low	Low	Medium	High
Canals	Low	Medium	Low	Low	Low	Medium	Medium
Urban expansion	Low	Low	High	Medium	Medium	Medium	High
Mines and quarries	Low	Low	High	Low	Low	High	High
Native Forestry	Low	Low	Medium	Medium	Low	High	High

For each sub-IBRA area within SWCC, the threats were categorised by High, Medium and Low rankings, depending upon the responses. To determine their category, the lowest score was subtracted from the highest score and divided by three. This allowed the sub-IBRA scores to show their relative weighting, based on the expert panel's scores. Threats that received no ranking scores were not included. Threats by IBRA area and their rankings are summarised in Tables 14 to 19.

The threat information by IBRA area is combined with the asset rankings and becomes the foundation for the Investment Decision Support System (IDSS).

Table 14: Swan Bioregion Threat Ranking

Threat	Swan	Rank
Climate change	11	High
Urban expansion	11	
Environmental weeds- Category A	10	
Cats	10	
Fire (including inappropriate regimes)	10	
European Fox	9	
Recreational management/Access	9	
Illegal activities (e.g. rubbish dumping)	9	
Mines and quarries	9	
Environmental weeds- Category B	8	
Rabbits	8	
Dieback (Phytophthora spp)	8	
Chemical/Pesticide contamination	8	
Land Clearing	8	
Removing buffer/riparian vegetation	8	
Grazing by stock	7	Medium
Kangaroos	7	
Agricultural impacts	7	
Habitat fragmentation/Isolation	7	
Insects	6	
Armillaria	6	
Physical removal of plants or animals	6	
Parrots	5	
Drought	5	
Erosion	5	
Pigs	4	
Flood/Inundation	4	
Salinity	3	Low
European Honey Bee	3	
Kookaburrah/Minahs/Galahs/ Correllas	2	
Forestry	2	
Eucalyptus Dieback	1	
Air Pollution	1	
Canals	1	
Water Extraction/capture	1	

Table 15:Jarrah Forest 1 IBRA Threat Ranking

Threat	JF1	Rank
Climate change	12	High
Environmental weeds- Category A	10	
European Fox	10	
Cats	10	
Dieback (Phytophthora spp)	10	
Fire (including inappropriate regimes)	10	
Environmental weeds- Category B	8	Medium
Rabbits	8	
Drought	8	
Forestry	8	
Grazing by stock	7	
Pigs	7	
Kangaroos	7	
Insects	7	
Armillaria	7	
Agricultural impacts	7	
Illegal activities (e.g. rubbish dumping)	7	
Mines and quarries	7	
Chemical/Pesticide contamination	6	
Recreational management/Access	6	
Removing buffer/riparian vegetation	6	
Parrots	5	
Land Clearing	5	
Physical removal of plants or animals	5	
Flood/Inundation	4	Low
Erosion	4	
Urban expansion	4	
Habitat fragmentation/Isolation	4	
Salinity	3	
European Honey Bee	3	
Kookaburrah/Minahs/Galahs/ Correllas	2	
Non native plantations	2	
Water Extraction/capture	2	
Eucalyptus Dieback	1	
Air Pollution	1	

Table 16: Jarrah Forest 2 IBRA Threat Rankings

Threat	JF2	Rank
Climate change	11	High
European Fox	10	
Cats	10	
Fire (including inappropriate regimes)	10	
Environmental weeds- Category A	9	
Pigs	9	
Dieback (Phytophthora spp)	9	
Armillaria	9	
Forestry	9	
Environmental weeds- Category B	7	
Rabbits	7	
Grazing by stock	7	
Kangaroos	7	
Drought	7	
Illegal activities (e.g. rubbish dumping)	7	
Recreational management / Access	6	Medium
Agricultural impacts	6	
Mines and quarries	6	
Removing buffer / riparian vegetation	6	
Insects	5	
Chemical / Pesticide contamination	5	
Physical removal of plants or animals	5	
Parrots	4	
Erosion	4	
Urban expansion	4	
Land Clearing	4	
Habitat fragmentation / Isolation	4	
Salinity	3	Low
European Honey Bee	3	
Flood / Inundation	3	
Feral Fish / crayfish	1	
Kookaburrah / Minahs / Galahs / Correllas	1	
Non native plantations	1	
Water Extraction / capture	1	

Table 17: Warren IBRA Threat Ranking

Threat	WAR	Rank
Climate change	12	High
European Fox	10	
Environmental weeds- Category A	9	
Cats	9	
Dieback (Phytophthora spp)	9	
Fire (including inappropriate regimes)	9	
Pigs	8	Medium
Armillaria	8	
Agricultural impacts	8	
Environmental weeds- Category B	7	
Rabbits	7	
Grazing by stock	7	
Kangaroos	7	
Recreational management / Access	7	
Removing buffer / riparian vegetation	7	
Drought	6	
Forestry	6	
Illegal activities (e.g. rubbish dumping)	6	
Habitat fragmentation / Isolation	6	
Insects	5	
Chemical / Pesticide contamination	5	
Land Clearing	5	
Flood / Inundation	4	Low
Erosion	4	
Mines and quarries	4	
Urban expansion	4	
Physical removal of plants or animals	4	
European Honey Bee	3	
Parrots	3	
Salinity	1	
Feral Fish / crayfish	1	
Non native plantations	1	
Water Extraction / capture	1	

Table 18: Avon Wheatbelt 2 IBRA Threat Ranking

Threat	AW2	Rank
Salinity	15	High
Climate change	10	Medium
Environmental weeds- Category A	10	
Agricultural impacts	9	
Cats	8	
Rabbits	8	
Drought	8	
Habitat fragmentation / Isolation	8	
Environmental weeds- Category B	7	
Grazing by stock	7	
European Fox	6	
Kangaroos	6	
Fire (including inappropriate regimes)	6	
Erosion	6	
Insects	5	Low
Chemical / Pesticide contamination	5	
Illegal activities (e.g. rubbish dumping)	5	
Parrots	4	
Flood / Inundation	4	
Removing buffer / riparian vegetation	4	
Physical removal of plants or animals	4	
Recreational management / Access	3	
Land Clearing	3	
European Honey Bee	2	
Kookaburrah / Minahs / Galahs / Correllas	1	
Pigs	1	
Dieback (Phytophthora spp)	1	
Armillaria	1	
Eucalyptus Dieback	1	
Air Pollution	1	
Forestry	1	
Mines and quarries	1	
Non native plantations	1	

Table 19: Mallee IBRA Threat Ranking

Threat	Mal	Rank
Salinity	11	High
Climate change	9	
Cats	6	Medium
Rabbits	6	
Agricultural impacts	6	
Environmental weeds- Category A	5	
Habitat fragmentation / Isolation	5	
European Fox	4	
Grazing by stock	4	
Kangaroos	4	
Fire (including inappropriate regimes)	4	
Drought	4	
Chemical / Pesticide contamination	4	
Illegal activities (e.g. rubbish dumping)	4	
Environmental weeds- Category B	3	Low
Insects	3	
Erosion	3	
Recreational management / Access	3	
Physical removal of plants or animals	3	
European Honey Bee	2	
Land Clearing	2	
Removing buffer / riparian vegetation	2	
Parrots	1	
Armillaria	1	
Forestry	1	
Mines and quarries	1	

3.3. Strategic Priorities Analysis

3.3.1. Flora, Fauna and Communities

The prioritisation process outlined in section 3.2.1 was used to determine strategic areas within SWCC where conservation investment can return the most effective and efficient outcomes for biodiversity. Figures 7 to 10 show the SWCC region broken into these weighted landscapes for flora, fauna, communities and all of them combined.

3.3.2. Information Gaps

It is important to note that areas that have been assigned a ranking of 0 in these figures does not necessarily indicate that those areas have no biodiversity value as it may just be that no data are available for that area. Thus a biological survey has not been undertaken in these landscapes and this indicates where information “gaps” exist that warrant future investment in survey or information gathering.

The combined weighting grid (Figure 10) reveals a number of areas of high biological rarity within the SWCC region. This information can be used to highlight potential project areas. This can include targeting those areas with the high biodiversity value and developing or encouraging specific projects within them. It can also include instigating surveys or investigation in the areas with no data. When combined with vegetation rarity information, landscape scale projects would be designed to conserve areas of native vegetation and habitat, while targeting specific at-risk taxa or communities as part of the approach.

This allows for complementary conservation activities that benefit both approaches, from crisis management to proactive landscape management. This theme is expanded in the regional management approaches section.

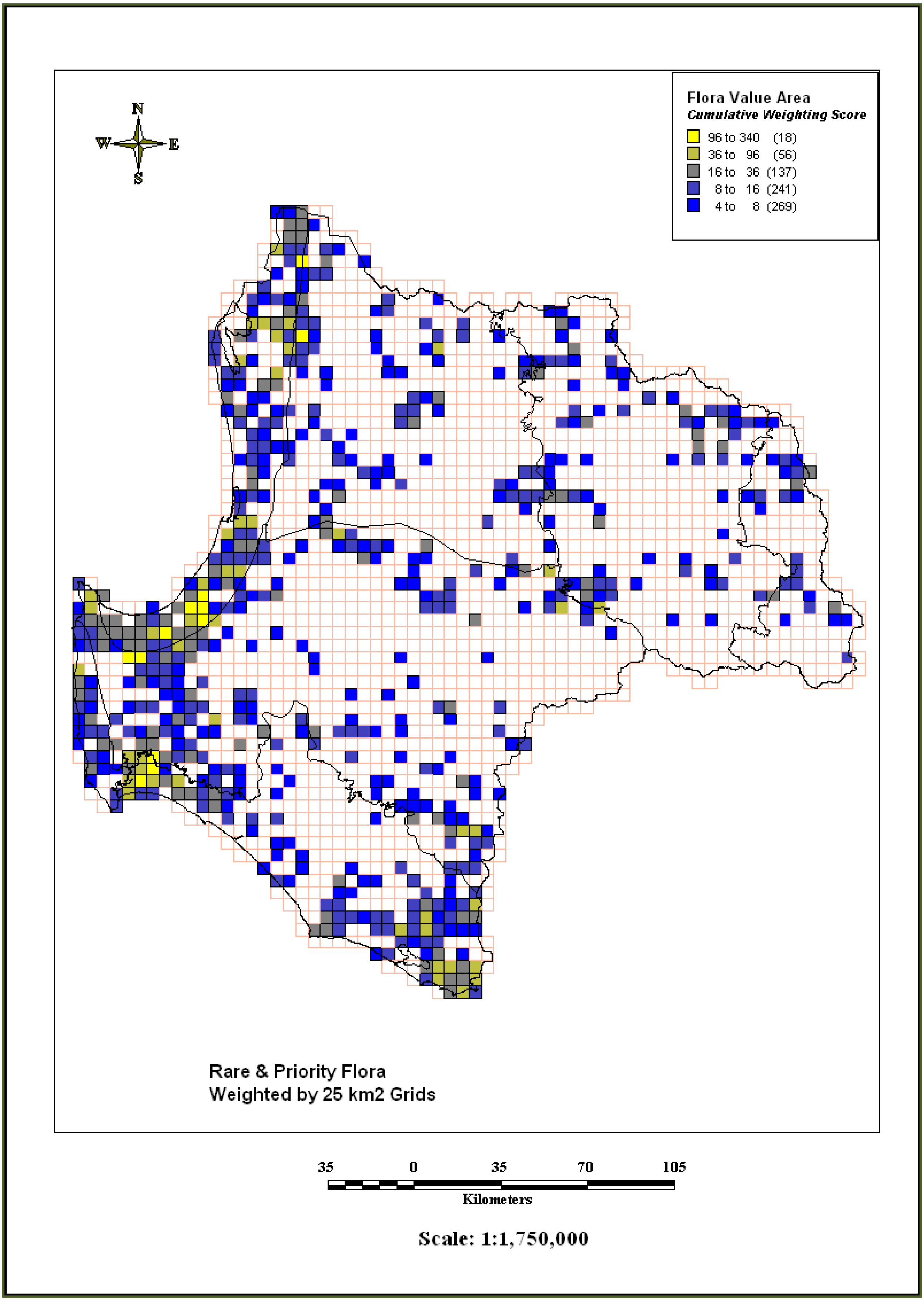

Figure 6: Rare and Priority Flora within SWCC landscapes

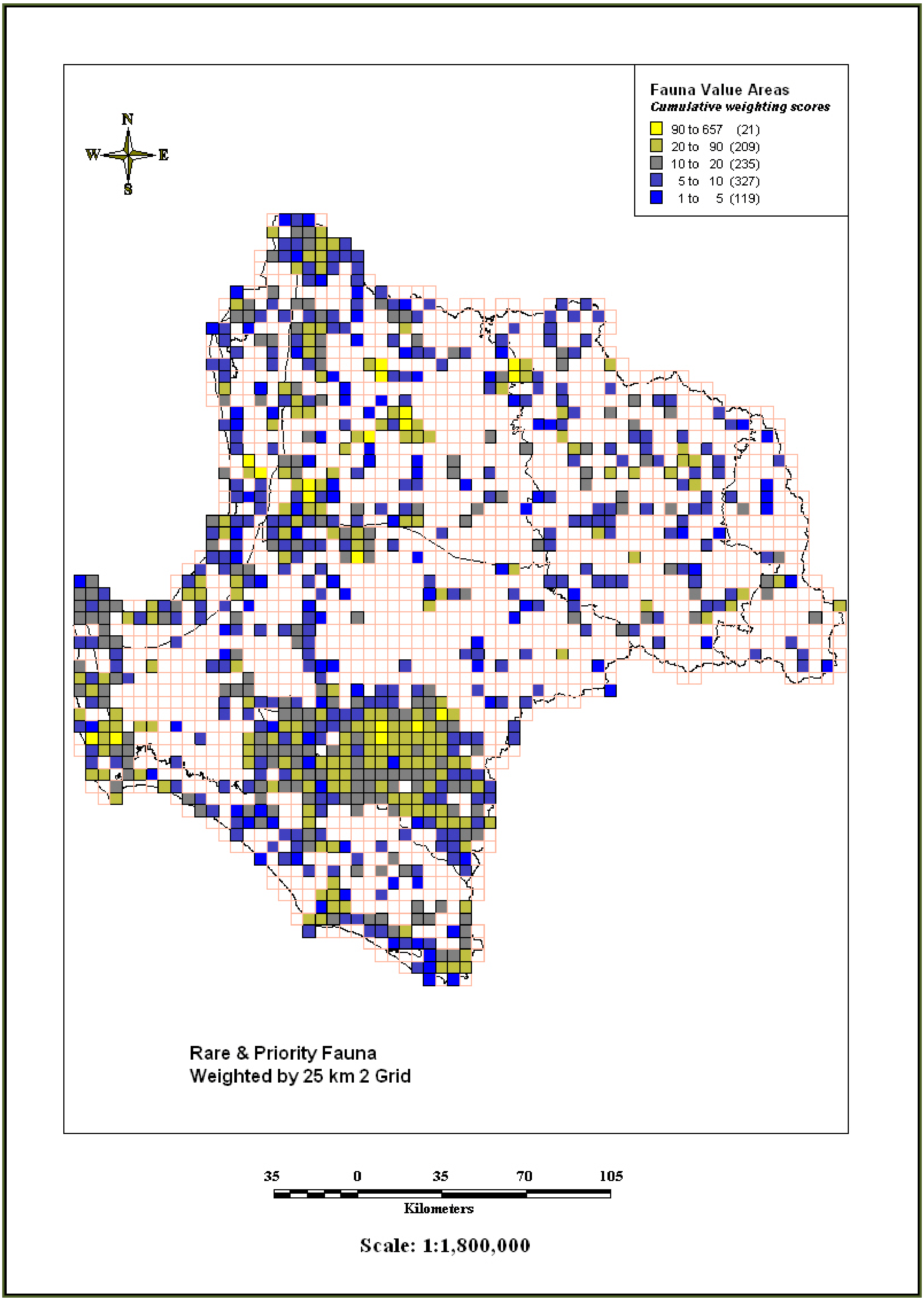

Figure 7: Rare and Priority Fauna by SWCC Landscape

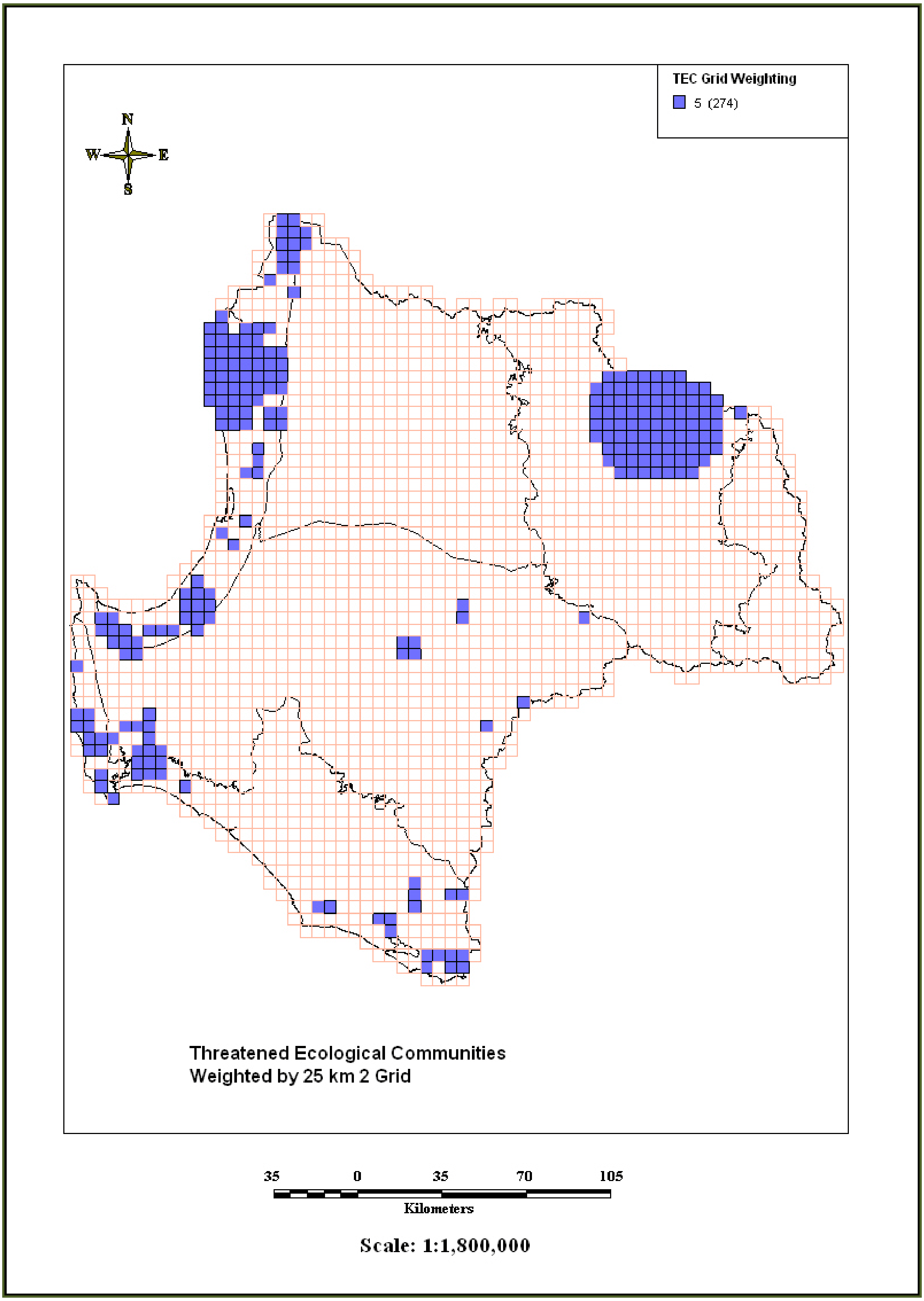

Figure 8: Threatened Ecological Communities within SWCC Landscapes

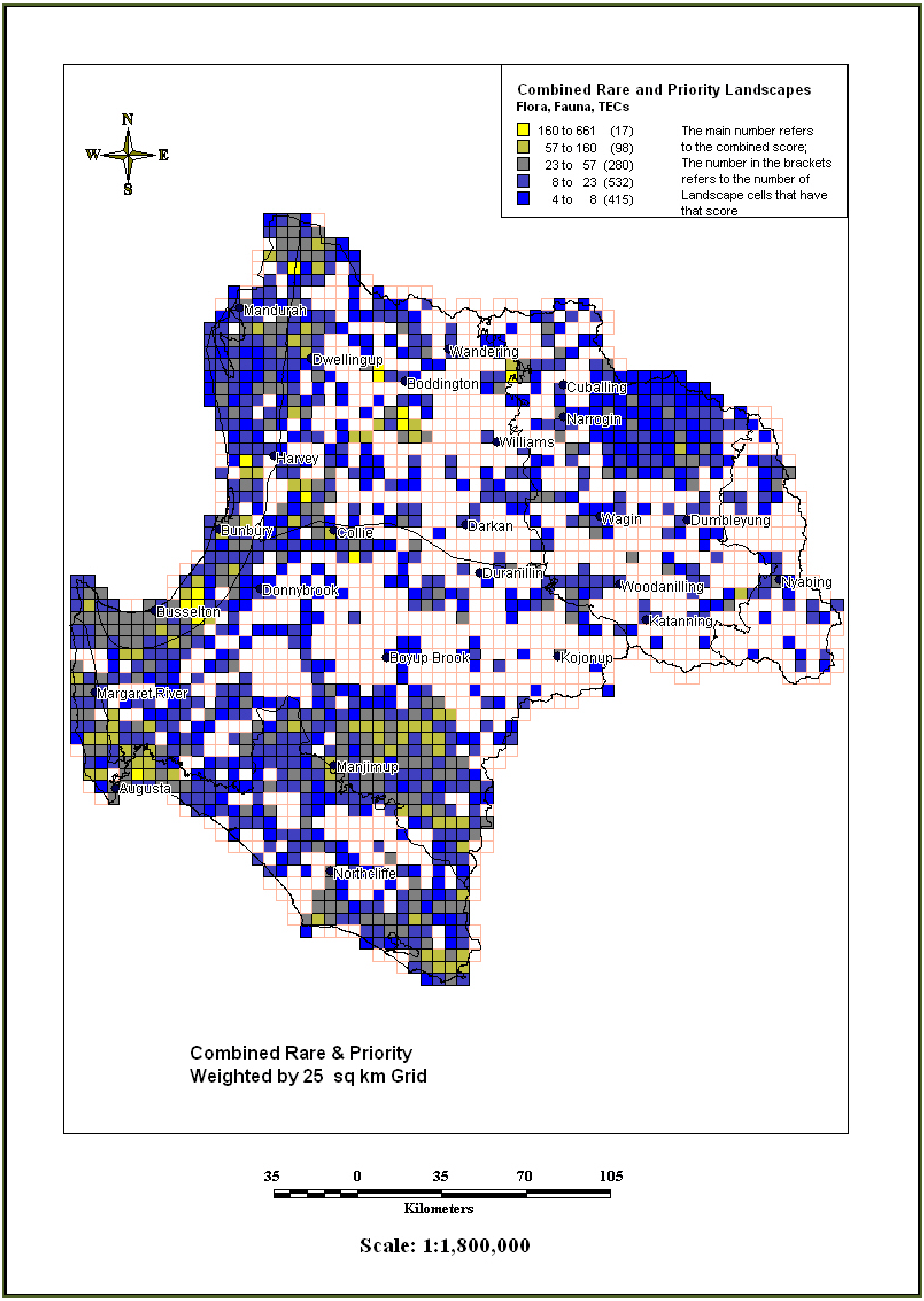

Figure 9: Combined Rare and Priority Areas within SWCC

3.3.3. Strategic Prioritisation of Remnant Vegetation

The prioritisation process does not work as well with native vegetation, however, due to the final weighting of the expert panel and the patterns of land clearing within the south west NRM region. Thus, the panel's responses and rankings varied significantly for different quality or condition of the remaining vegetation. This resulted in prioritising almost the entire vegetation areas within the Swan Coastal Plain, Avon Wheatbelt and Mallee areas of SWCC[9], which does not give enough differentiation for any strategic prioritisation to occur.

The best option to allow for vegetation prioritisation is therefore to highlight specific vegetation associations within each sub bioregion and prioritise them based on the level of vegetation remaining, when compared to each association's estimated pre-European extent. Unfortunately, no methodology currently exists for large-scale regional assessment of the condition of remnant native vegetation. Therefore for the sake of the present analysis, at a regional and sub bioregional scale, it must be assumed that all of the remaining vegetation is in Good or better condition (after Keighery 1994). This will logically not be correct for all remnant vegetation. Hence once investment processes or project areas are being developed, ground-truthing of the condition of remaining native vegetation needs to be undertaken and incorporated into the final project's overall evaluation.

The expert panel ranked vegetation association with less than 10% remaining and those with less than 30% both as significant. Prioritisation will still need to occur within these segments as it results in too many vegetation associations in the highest category.

Within this strategy, it will be assumed that the criteria of rarity will have a higher weighting. Hence those vegetation associations with a lower percentage remaining of their original extent, are prioritised over those with higher levels remaining (this also assumes that the condition, verified by ground truthing, is of a similar value – see above). Those vegetation associations that have only a small area remaining have thus been prioritised highest. The minimum or appropriate size of such areas has yet to be scientifically defined, but it is suggested that an area of 1,000 hectares or less be used initially until better information is available. It should be noted, however, that prudent judgement and evaluation of the remaining extent,

[9] All of the landscape cells in the three bioregions become highlighted! This shows that vegetation associations with less than 30% remaining are widely dispersed though these bioregions.

as well as the remaining percentage, remains an essential part of the evaluation process for all anticipated conservation projects.

An approach adopted in Victoria can be modified to suit SWCC's situation. There a conservation status is assigned to a vegetation association according to its level of rarity[10] which allows for discussion to occur using a common language throughout the region. The categories of conservation status for vegetation associations are:

- Presumed Extinct;
- Endangered;
- Vulnerable;
- Depleted; and
- Least Concern.

Table 20 defines the conservation status of vegetation associations.

Table 20: Conservation Status of Vegetation Associations

Status	Definition	Code
Presumed Extinct	High probability that the association no longer is present in the bioregion, or if present, is below the resolution of current available mapping	**X**
Endangered	Less that 10 per cent of its pre-European extend remains	**E**
Vulnerable	10 to 30 per cent of pre-European extent remains	**V**
Depleted	Greater than 30 percent but less than 50 percent of pre-European extent remains.	**D**
Least Concern	Greater than 50 percent of pre-European extent remains	**LC**

Appendix C summarises the specific vegetation association within each sub-IBRA area highlighting original area, area remaining and the percentage remaining. Tables 21 and 22 summarise the results of this analysis.

[10] Once more detailed spatial information on threatening process, and a finer scale of vegetation mapping are available, a series of criteria incorporating probability of threats can also be developed for SWCC.

Table 21: Vegetation Association Numbers by Bioregion.

IBRA sub-region	Number of IBRA Veg Associations (% remaining within the SWCC region)				
	<10% (E)	10-<30% (V)	30-<50% (D)	>50% (LC)	Percentage range
SWA1	13	17	4	8	0.9-86.6
JF1	1	21	5	12	7.1-100.0
JF2	6	23	16	32	2.4-100.0
WAR	1	3	7	75	6.5-100.0
AW2	22	20	13	7	0.1-95.6
MAL	14	7	4	2	0.1-65.3
Totals	**57**	**91**	**49**	**136**	

Table 22: Vegetation Associations by Area Remaining.

IBRA	Number of Veg Associations Remaining within the SWCC region (Area in Ha)				
	<10ha	10-<100ha	100-<1,000 ha	1000- <10,000ha	>10,000ha
SWA1	4	8	18	10	2
JF1	0	1	12	15	11
JF2	3	11	27	29	7
WAR	5	15	33	23	10
AW2	4	13	29	13	3
MAL	2	7	13	5	0 (in SWCC)

3.3.4. Targeted BioLandscapes.

A total of 1,324 landscapes have been identified using the prioritisation approach for rare and endangered flora, fauna and communities with a combined “biodiversity value” between 4 and 661. By focusing on those landscapes that have combined values of more than 100, 32 landscapes have been identified. This represents less than 1% of the total biodiversity landscapes (BioLandscapes) derived from the model and provides areas where conservation actions could return significant benefits to biodiversity, which is both logical and achievable.

By overlaying these rare and endangered landscapes with endangered and vulnerable vegetation associations (those with less than 30% remaining), another level of prioritisation can occur. This additional process highlights those

BioLandscapes that contain high densities of rare and endangered taxa and communities as well as rare and endangered vegetation associations. By adding a buffer of 3kms around these cells, a number of landscapes join together resulting in a total of 19 priority BioLandscapes. Of these, eight have a combination of high rarity for flora/fauna/communities and vegetation associations. These eight are classified as Highest Priority BioLandscapes. The remaining eleven landscapes become the Second Priority Landscapes and although these secondary landscapes have native vegetation within them, the vegetation is not rare. Figure 11 shows the location of the former within the SWCC region and Table 23 presents further information on the vegetation values of these eight Highest Priority BioLandscapes.

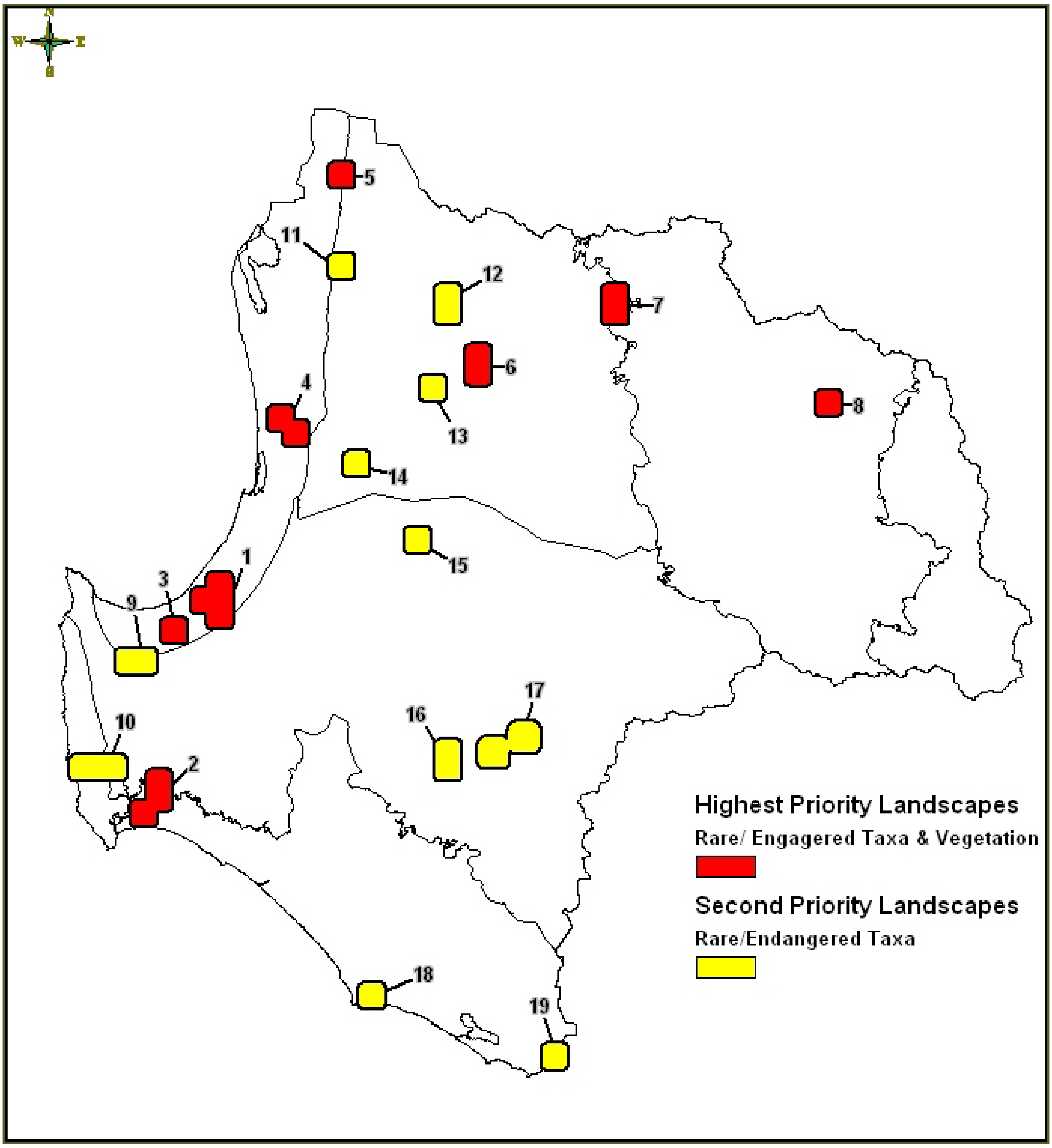

Figure 10: Priority BioLandcapes within SWCC

Table 23: Priority A Vegetation Biolandscapes.

Bio Landscape	Endangered Vegetation (<10%)		Vulnerable Vegetation (10-<30%)	
	Association	Area remaining (ha)	Association	Area remaining (ha)
1	Bassendean 1136	387	Bassendean 1000	15,440
	Bassendean 973	1.1	Bassendean 949	217
	Bassendean 990	182	Bassendean 4	12,182
	Pinjarra 1136	3,794	-	-
2	-	-	Scott River 1137	161
3	Pinjarra 1136	3,794	Pinjarra 949	217
4	Pinjarra 968	6,418	Bassendean 1000	15,440
	-	-	Spearwood 6	4,517
	-	-	Bassendean 1182	440
5	Pinjarra 968	6,418	Pinjarra 3	1,530
	-	-	Bassendean 1000	15,440
6	-	-	Bannister 4	12,182
	-	-	Bannister 49	135
7	-	-	Narrogin 1023	21,670
	-	-	Dryandra 1023	1,202
8	Dumbleyung 1023	15,709	Dumbleyung 952	4,443

Caution is, however, needed when interpreting Table 23 as there is no specific knowledge of the actual condition of the vegetation remaining. Ground truthing of these data are therefore needed before any investment consideration is finalised.

3.4. Regional Management Responses

3.4.1 Overview

Conservation of biodiversity requires that not only areas of high species richness, levels of endemism or number or rare or threatened species are protected, but that unique elements of biodiversity are also conserved (also referred to as *complementarity*) (Margules *et al*. 1988; Pressey *et al*. 1993).

Another concept to consider is *irreplaceability* (Pressey *et al*. 1994), which is a measure of an area's or asset's uniqueness and represents the biodiversity values that many be lost if that site or asset is not considered for conservation.

These two elements form the foundation for much of the selection of reserves and conservation targets around the world. The concept of uniqueness and

irreplaceability are also fundamental drivers within this strategy when selecting biodiversity assets and threatening processes that impact upon them.

Another aspect that must be considered is the scale or dimensions in which ecological processes occur and at which decisions on them are made. Thus, many environmental and ecological problems have their origins in the mismatch between these scales or dimensions. For example, outcomes at any given environmental scale are often critically influenced by interactions of ecological, socioeconomic, and political[11] factors from other scales. Therefore, by focusing solely on a single scale (for example species), the NRM manager is likely to miss such interactions (such as genetic flows between species and populations, energy dynamics and fluctuations), which are critically important in understanding the drivers of ecosystem change and their implications for the conservation of biodiversity (and human well-being).

Finally, there is also a need to consider the long term persistence of the species, communities and ecosystems that are conserved, apart from representing biological diversity within conservation areas or targets. To retain biota over time, planning must take into account the maintenance of ecosystem processes that are appropriate to meet the needs of the biota protected or managed. This is particularly important within the SWCC region as it has a particularly high proportion of unique elements such as rare and threatened taxa/communities and many of the vegetation associations are degraded or almost completely cleared. Once lost, these would be irreplaceable. This poses difficult questions that SWCC needs to consider when deciding where investment in biodiversity conservation is to take place[12].

Landscape ecology provides insights into the functions of native vegetation and an approach has been developed that applies a common language and allows for differing management responses based on different landscape categories (James and Saunders 2001).

Three broad principles can be adopted when conducting conservation planning, i.e. general, enhancement and strategic planning. General and enhancement approaches aim to improve on the current situation by increasing the probability of species persisting without specifying the magnitude of the desired change (Lambeck and Hobbs 2001). In particular, they employ ecological principles to

[11] For example, differing funding priorities at Federal, State and Regional level.
[12] It should also be noted that the term "conservation area" is defined in this strategy as being an area in which the primary management concern is the conservation of specific biota or environmental features.

develop conservation plans or project[13]. On the other hand, strategic planning aims to address a specified outcome, such as conserving the populations of a species or reintroducing species that have disappeared from an area, e.g. translocation of egg masses of a threatened frog species, such as *Geocrinia alba,* into suitable habitat where it no longer exists. As such these approaches have generally focused on a single species.

A combined approach has been adopted in this strategy, which is discussed further below.

3.4.2. Relationship to NRM Biodiversity Targets

SWCC has one aspirational target that focuses on biodiversity:

> *Natural Biological Diversity at all levels (genetic, species and ecosystems) are appreciated, conserved and managed to maintain the range of natural, cultural and socio-economic values for present and future generations.*

This target is aimed to provide a vision for biodiversity over a 50 + year timeframe and to set the context for more specific Resource Condition Targets (RCTs). The approach outlined within this strategy nests well within this target as it states that a range of biological levels needs to be considered (genetic, species, and ecosystems). In addition, the term "appreciated" implies the need for education and awareness-raising of biodiversity elements, whereas "conserved" links the target to the concept of conservation, i.e., elements of the biological diversity need to be protected and preserved for future generations, which is a major underlying principle of biodiversity conservation. The last term, "managed," highlights the concept that elements of biodiversity will need to be actively managed to maintain and/or improve their conservation values while considering an assorted suite of threatening processes.

SWCC currently has 5 endorsed RCTs, which are aimed to provide, over a 10-20 year timeframe, biodiversity targets that are:

- Specific time-bound and measurable;
- Pragmatic and achievable;

[13] For the readier with an interest on further information: These principles are drawn form ecological theories of island biogeography (MacArthur & Wilson, 1963), species-area relationships (Connor & McCoy, 1979; Boecklen & Gotelli, 1984), Niche theory (Cody, 1968; Connell, 1975) and metapopulation theory (Hanski, 1991; Harrison, 1994; Lambeck & Hobbs, 2001.)

- Related to the minimum set of matters for regional targets; and
- Related to the anticipated condition of a suite of resources.

A review of these targets was conducted in March 2007 (Ecosystem Solutions 2007), which recommended the re-drafting of the original targets to eliminate jargon and to clarify the resource asset and asset category they are focused upon. The five recommended RCTs for biodiversity are:

1. No species, where conservation action is undertaken, becomes extinct by 2027.
2. No ecological community, where conservation action is undertaken, becomes extinct by 2027.
3. Expand native vegetation coverage of the region by 20,000 ha by 2027.
4. X% of native vegetation within the region to be classified as being in Good or better condition (after Keighery, 1994) by 2027.
5. Each IBRA sub-region within SWCC contains at least one representative landscape project by 2027.

All of these “draft” RCTs fit within the strategic approach advocated within this strategy. They focus on the major hierarchical elements of biodiversity and biological organisations, are consistent with the ecological assumptions used within this strategy, and integrate with the scale of potential management options available for biodiversity conservation outlined in the regional guidelines. The concepts of Retention, Restoration and Revegetation can easily be incorporated into these RCTs.

3.4.3. Regional Guidelines

Given the global uniqueness and value of the biodiversity within the region, SWCC has an onerous task and obligation to ensure that the best outcomes for conservation for each dollar of investment are achieved. It is important to note that there will never be sufficient funds, skills, time and information for all conservation actions to be undertaken. There will also be no single answer to the plethora of potential problems and issues that are faced. The broad regional principles and management guidelines that follow are therefore intended only as a preliminary guide to conservation investment and should not be interpreted as being fully developed management plans for areas or species. Ideally, once the proposed framework for regional strategic planning has been accepted and adopted by SWCC, then future planning can focus on specific landscapes or taxa. This is the case in Victoria, where Regional Biodiversity Strategies provide the direction for IBRA-scale strategies, under which specific and targeted Landscape Action Plans are nested. It is this final level of planning where specific and costed projects are identified and then prioritised with explicit discrete and measurable conservation outcomes.

3.4.3.1. Regional Ecosystem Approach

An ecosystem-driven approach is adopted within this strategy that includes aspects of general, enhance and strategic planning. This is summarised as follows (Grumbine 1994):

- Maintain viable populations of species;
- Maintain representative ecosystems;
- Maintain key ecological processes (including natural disturbance regimes);
- Maintain the evolutionary potential of species; and
- Ensure that human uses and needs can be accommodated.

The strategic hierarchy for actions on biodiversity is based on the principles of the **3 Rs**. For assets of equal value, the highest priority is to **Retain** the existing biodiversity values. The focus should then move onto efforts to **Restore** those values and the final priority should be to **Revegetate** or **Rebuild** the required habitat.

- **Retention**

Remnant native vegetation and its associations with the native taxa and communities within it are more complex than we will ever be able to understand. To begin with the suite of species contained within it includes more than the easily seen plants and animals; there are many cryptic organisms such as mosses, lichens, invertebrates, and soil microfauna/flora. In addition, the associated processes that are required to maintain and support all the living organisms are also often poorly understood. Many of these species and processes are absent in degraded sites and revegetated areas and it is likely that they can only be restored over very long time scales, i.e. at least tens to hundreds, if not thousands of years). Thus, to a significant extent, these species and processes are irreplaceable. Retaining existing native vegetation and species is therefore the highest priority because it is the most effective, efficient and least expensive way of preserving native flora, fauna, their habitats, and the ecological processes that maintain them.

- **Restoration**

This refers to those areas where some remnants of native vegetation remain. Restoration implies that an initial framework and structure of native vegetation or necessary habitat is present, that it should not be further degraded, and that this provides a starting point for improvement. The priority here is to improve upon those assets that currently exist. General management responses to a restoration objective will range from encouraging natural regeneration though weed control to selective revegetation or provision of required habitat elements that are missing, e.g. establishing nesting boxes for Carnaby's Black Cockatoo.

- **Revegetation / Rebuilding**

The lowest priority would be to reconstruct biological habitat and ecological function into areas where the original assets have been completely removed or are so degraded that full reconstruction is required[14]. This is the most expensive and least effective option for restoring ecosystems. Repeating the complexity of habitat composition, structure and function is very difficult (if not impossible with our available knowledge and resources) and, in many cases, not a feasible option. It is important to note, however, that in specific instances it may be the only

[14] Indeed, some authors contend that it is virtually impossible in time-scales that are meaningful to the human condition.

option available, e.g. in threatened species crisis management situations. Rebuilding an ecosystem is a complex and challenging task, and for long-term viability should be considered only when the landscape context for the target taxa or system is good. Both the feasibility and cost-effectiveness of these types of programmes should also be evaluated before any investment is made. This type of action should be considered the lowest priority for SWCC investment in biodiversity conservation, except in extraordinary and well-documented circumstances, such as dealing with local extinctions.

3.4.3.2. Conservation Planning Principles

Conservation planning principles must form the basis of all actions within the SWCC region. From an analysis of the literature on biology, ecology and conservation management, a set of broad principles have been developed for specific landscapes based on the remaining native vegetation within it. These landscape are not spatially explicit and can range from the IBRA region down to one of the individual 25 km^2 landscape cells or finer. These broad principles are only intended to provide guidance, whilst acknowledging that individual circumstances and the specific landscape situation may prevent this type of generalisation from being universally useful. Discretion and judgement for each individual situation is therefore recommended.

The proposed principles are outlined in Table 24. They are based on the theory of landscape ecology and have been devised so that managers can apply them readily to specific situations. This is because managers and investors are rarely experts in the various disciplines that contribute to effective resource management. They are based on the research and experience of two landscape ecologists that have worked in the West Australian agricultural areas for many years and are drawn directly from their published works (Lambeck and Hobbs 2001).

It is also important to recognise that many of these principles provide guidance about the types of actions that are required, but may not provide details about the magnitude of those actions, e.g. weed control may range from a single action within a population of rare flora, to broad-scale control of an invasive weed over a landscape. Most of the principles are largely drawn from ecological theory because formal land-use planning for nature conservation has not been widely applied, and in the cases where it has, there has been insufficient time to assess the

consequences (Lambeck and Hobbs 2001), e.g. it may take hundreds of years for a seedling to become mature and develop nesting hollows. Figure 11 shows their relationship.

However, the general principles are likely to be appropriate for most conservation planning scenarios. In particular, the enhancement principles would apply to situations where there is limited biological information and little opportunity to gather such information. They can nest within the broader general principles. On the other hand, where sufficient biological information is available to provide spatially explicit recommendations about the type, amount and placement of habitat, the strategic principles would apply, e.g. recommendations on the type of habitat and potential sites to translocate *Geocrinia alba* within the Geocrinia Recovery Plan. These principles are demonstrated in the management direction tables to follow (Tables 26-29).

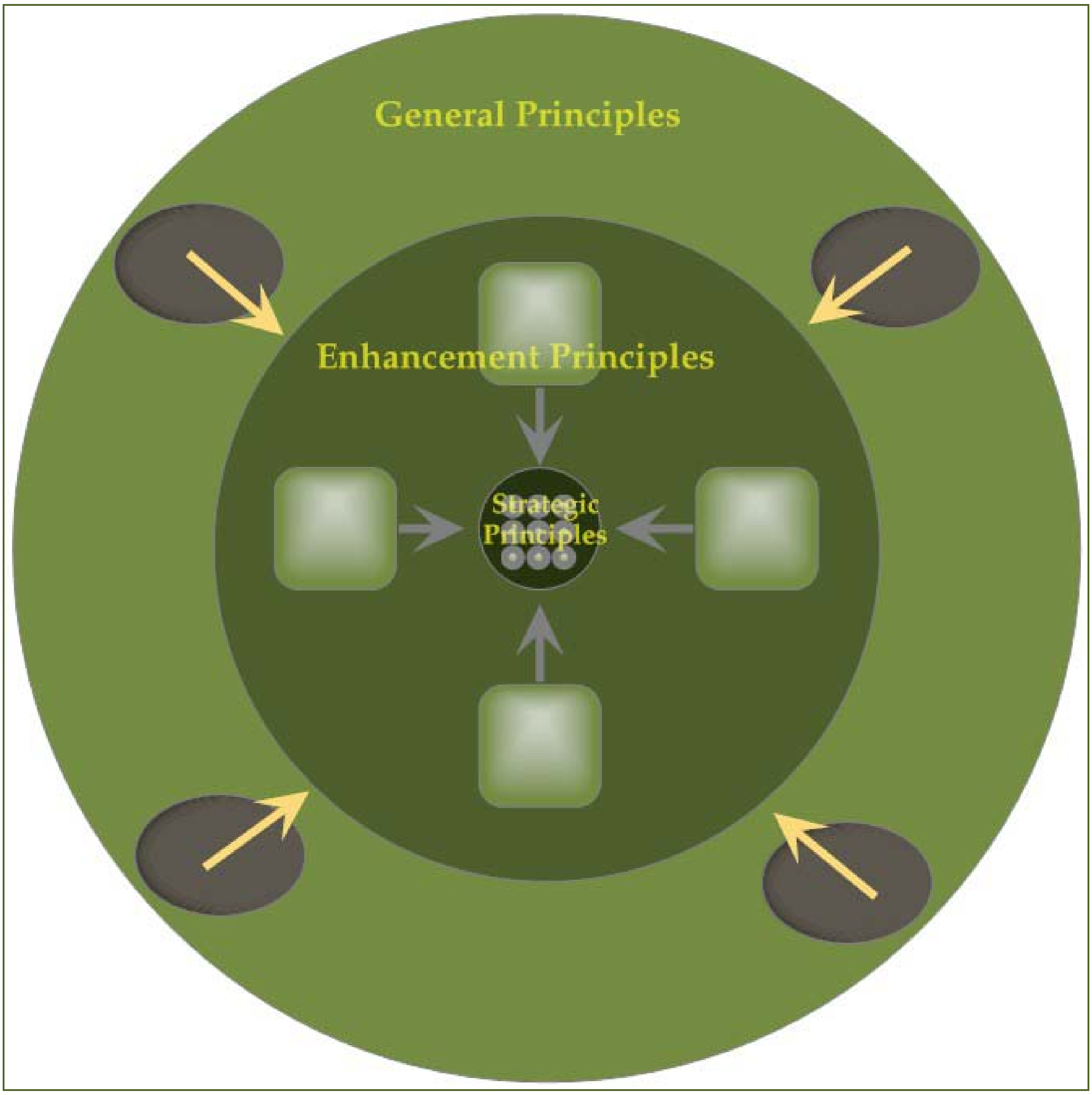

Figure 11: Conservation Planning Principles Relationship

Table 24: Conservation Planning Principles

General Principles
General Principle 1: Conservation goals must be clearly articulated and agreed to by all parties, otherwise it will not be possible to determine the appropriateness of alternative actions or the adequacy of the outcome. **General Principle 2:** Conservation goals must be appropriate to the spatial extent of the area being managed. If a conservation goal cannot be realistically met in a given area, either the extent of the planning must be changed, or the conservation goal must be modified to reflect what is achievable at the given scale of management. **General Principle 3:** The scale of management must match the spatial scale of processes that are being managed. For example, the management of species should cover an area that ensures, first, that the habitat requirements of individuals are met, and second, that population processes are maintained. **General Principle 4:** Regional conservation planning should aim to ensure that land-use practices in a region do not result in the loss of species from that region. While the distribution and abundance of species may change as a result of the land uses applied, they should not change to the extent that species are eliminated from that region.
General Enhancement Principles
General Enhancement Principle 1: Larger areas of habitats are generally better than smaller areas. Larger areas usually encompass more environmental variation and hence contain a greater array of habitats which, in turn, support a wider range of species. Larger areas are also more likely to encompass ecosystems processes that are essential for the maintenance of biota. **General Enhancement Principle 2:** More diverse habitat will generally support more species than uniform habitat. This diversity can be achieved by having a range of patch types and diversity of species within each patch type. However, if patches are too small, they may not provide the resources required by sedentary habitat specialists (refer to the section below on relict landscapes). **General Enhancement Principle 3:** More connected landscapes are more likely to maintain population processes than more fragmented landscapes. If individual reserves or remnants cannot support viable populations of the constituent biota, it will be necessary to have a connected landscape that can support numerous sub-populations of some species. A metapopulation structure will increase the probability of recolonisation following local extinctions. **General Enhancement Principle 4:** Wider corridors are likely to facilitate movement for a wider range of species than narrow corridors. For dispersal-limited species that do not have viable populations in individual habitat patches, these corridors will have to provide necessary habitat.

Strategic Planning Principles

Strategic Planning Principle 1: Planning at regional scales must aim to represent the range of biological diversity in the region and ensure that all components of the diversity are able to persist in the region in the long term.

Strategic Planning Principle 2: Criteria of comprehensiveness, representativeness and adequacy should underpin the selection of areas for nature conservation. Selection procedures should also:

- be able to identify the relative importance of different sites (irreplaceability);
- enable choices between alternative sites (flexibility); and
- ensure that species-poor sites with unique species are included in addition to species-rich sites.

Note that the definition of areas for nature conservation within this context, not only refers to formal reserves, but is equally applicable to biodiversity conservation project sites.

Strategic Planning Principle 3: Planning at a local scale should ensure that patches of habitat can support breeding units of the most habitat demanding species, and that these patches are within reach of neighbouring patches for the most dispersal limited species. Linking vegetation should provide habitat for species with low dispersal ability.

Strategic Planning Principle 4: Planning at the individual remnant scale should focus on the type, number and configuration of habitat patches within a remnant, and on threats that affect the condition of those patches. Local landowners managing small portions of a landscape cannot solve problems that arise from impacts over a much larger area. Therefore, they can only seek to ensure that their management actions contribute to goals set at larger spatial scales.

Strategic Planning Principle 5: Regional conservation planning should be applied to areas that are relative homogeneous in terms of their biophysical and anthropogenic characteristics. Guidelines developed with such areas can then be legitimately extrapolated to the remainder of the area[15].

Strategic Planning Principle 6: Local actions should be clearly linked to regional strategies. If conservation agencies are unable to achieve conservation goals within designated conservation estate, it will be necessary to achieve that goal in partnership with private landholders. For these landholders to feel that their contribution is of value, it will be necessary to identify the actions that they can take, and to demonstrate that these actions will contribute to the regional goal.

Strategic Planning Principle 7: Actions that attempt to ensure no further species loss from a region must ensure that the needs of constituent species are met. This requires some degree of species focus in regional conservation planning and investment.

Strategic Planning Principle 8: Species-based approaches must be able to demonstrate the benefits extend beyond just the target species. If keystone or umbrella species are employed, criteria for their selection must be clearly articulated.

Strategic Planning Principle 9: Ecosystem processes must function at rates and via pathways to ensure that the needs of the biota (and of the human populations) are met.

Strategic Planning Principle 10: Threatening processes must be managed at levels that protect the most sensitive species. If species most sensitive to a given threat are protected, other species less sensitive to that threat should also benefit.

(Principles adapted from Lambeck and Hobbs, 2001).

[15] This strategy attempts this by using IBRA boundaries rather than catchments.

3.4.3.3. Management Directions for Landscape Categories

While the principles are useful as a guiding philosophy on which to base biodiversity conservation projects within the SWCC region, it is also possible to list a suite of management responses that could be implemented depending upon the type of landscape they are focused on. Tables 25 to 28 are based on broad and general information obtained from James and Saunders (2001) and the conservation literatures that are relevant to the landscapes in SWCC's region.

The tables also refer to landscape design elements, which are attributes concerning the size, shape, type and arrangement of native vegetation patches within a landscape. Hence their focus is on habitat restoration and revegetation. Little scientific information is available on the significance of landscape design on conservation outcomes, but it is generally accepted that it is profound (James and Saunders 2001). It has been shown that design elements are most important for landscapes with less than 70% native vegetation cover remaining. Below 30% cover, design is an essential component of revegetation to maximise results for effort. In landscape with 30-70% native vegetation remaining, design principles can help to avoid thresholds of change that cause rapid loss of species and change in functions (James and Saunders 2001). In landscapes with less than 10% vegetation remaining, design elements can guide restoration and revegetation efforts that aim to restore the native vegetation cover up to 30 % (refer to the Appendix D for rationale of 30% vegetation cover targets). While some of these elements are repeating the general principles above, they are included in the table for easy reference.

An appropriate terminology has also been developed to allow for the categorisation of landscapes based on these values for remaining cover of native vegetation (Table 23) (McIntire and Hobbs 1999).

Table 25: Landscape categories by remaining native vegetation.

Remaining Vegetation	Landscape Category
>70%	Intact
30% – 70%	Variegated
10% - 30%	Fragmented
<10%	Relictual

The following general ecological principles are acknowledged as being universally applicable to landscape design (James and Saunders 2001).

- Landscapes with less than 30% native vegetation cover have generally gone beyond the threshold of sustainability for terrestrial biodiversity and ecosystem function. Restoration of native vegetation to at least 30% overall native vegetation cover is the primary order goal to stabilise the loss of ecosystem functions and loss of terrestrial biodiversity (refer Appendix D for the rationale behind this goal). Note that at this level of native vegetation cover, prioritisation on where to target conservation actions will be a balance between SWCC's, land manager's, society's and government's priorities.
- If patches of habitat which support populations of a species are too far apart, species may slowly decline to extinction. Each isolated population is vulnerable if it is small, and cannot be re-established by immigration if it is wiped out (by fire for example). Although detailed data for many species do not exist, the key response is to ensure that patches are in close enough proximity to allow interchange among populations.
- There are three important concepts that need to be considered regarding connectivity (after Newmark, 2007):
    - connectivity is scale and species dependant, e.g. a spider has different requirements compared to bird;
    - if the primary objective is to enhance species viability, detailed information on population persistence and dynamics[16] is needed rather than research on movement or connectivity; and
    - Historical evidence shows that the actual implementation of broad-scale connectively plans have been, and continue to be, the major difficulty to improve connectivity in fragmented landscapes.
- It is important, as far as is practicable, to plan for representative diversity (arrangement of habitat types relative to one another). The variety of life occurs across a gradient of different habitats (beta-diversity) and a greater diversity of habitats supports a greater variety of biodiversity. This is because the variety of biodiversity and ecological functions is partly a

[16] For example, patterns of distribution and abundance, habitat use, reproductive success, population viability and responses to disturbance.

response to the complex interactions among different species. This is not just through having different habitat types, but through the juxtaposition of different types of habitats that create boundaries (ecotones). Some species preferentially inhabit the ecotones between habitats. The maintenance of the variety of habitats and their juxtaposition therefore should be incorporated into revegetation plans (and land use planning!).

- Planning is also needed to ensure that restoration efforts are targeted towards those patches where their position in the landscape will enhance their chances of success, especially considering groundwater levels and salinity risk.

Table 26: Relictual Landscapes Management Directions

Landscapes with less than 10 % remaining native vegetation: Relictual Landscapes
General Features
• Small dysfunctional patches of native vegetation, often less than 10 hectares. • Patches that remain are often isolated and in poor condition. • Vegetation remains on soils with low agricultural productivity or other barriers to agriculture. • Moderate to large proportion of plant and animals (including invertebrates) are declining (or extinct). • Extinction debt likely to result in declining status of species and communities for many years. • Salinity is a significant threat to biodiversity
Focus Areas
• Maintain the current status of rare and endangered taxa. • Native vegetation that remains is important, need to focus on larger areas and/or those in "Good" or better condition. • Protect those remnants in the best condition first. • Target projects that aim to restore or recover ecosystem functions • Connectivity or linkages though the landscape may need to be considered for some taxa
Landscape Design Elements

Size of habitat patches
• Patch sizes in this landscape are usually very small and the approach should be to firstly protect existing remnants in good or better condition, then strategically increase the size of patches (including adding new patches to increase the overall area and reduce the separation distances). This will be necessary just to ensure that the species currently there are retained. Species extinction lags behind clearing by many generations of a species, so just halting clearing will not be enough to guarantee persistence.
• Patch sizes of at least 20 ha are the minimum required to support some woodland bird species, as long as they are no too far apart (size and separation is species dependant).
• Some patches of at least 200 ha are needed for declining woodland bird species.
• A few patches of 500 ha are recommended, if possible.
Shape of habitat patches
• Vegetation blocks where the length is more than ten times the width help some species to disperse, but may not be as useful for many of the species that are declining rapidly as was originally thought. Future effort should go into strategically:
    o Increasing the size of existing sub-size patches;
    o Creating new patches of minimum viable size with short separation distances between existing patches; or
    o Increasing the width of existing linear strips to greater than 50 m.
Connectivity of habitat patches
In these landscapes, the separation of patches and the very different vegetation that grows between the patches means that many species do not disperse between patches effectively. Therefore, viable sized patches need to be created as an even network in preference to planting narrow linear strips. In addition, the spacing of patches depends on their size; larger patches can afford to be further apart; smaller patches need to be closer together. The literature suggests that to maintain bushland birds that appear to be the most sensitive of the birds, patch sizes of 20 ha cannot be more than 100 m apart.
 	
Arrangement and Location within the landscape
General guidelines include:
• Do not plant the same small number of species in each revegetation patch – establish representative samples of each different type. Be guided by what examples of native vegetation remains and what will grow in different parts of the landscape.
• Try to re-establish or restore patches as examples of as many different vegetation types that existed as possible.
• Locate the vegetation types in parts of the landscape where they are more likely to survive, with consideration for soil, slope, aspect and water tables, initially focusing on areas at low risk.
• Make some vegetation patches (of a viable size) that consist of a mixture of two or three different vegetation types.
• Try to restore and re-establish the original vertical complexity (i.e. the historic structure and strata). Take particular notice of the understorey and try and restore its complexity.
• Ensure all forms of vegetation are restored from fungi, to grasses as well as trees.

Table 27: Fragmented Landscapes Management Directions

Landscapes with between 10 % and 30 % remaining native vegetation: Fragmented Landscapes
General Features
• Most of the vegetation has been cleared on productive soils • Many small patches remain (mostly dysfunctional); however some larger ones also remain. • Ecosystem services are partially functional in some areas, but dysfunctional in others[17] • Many taxa are vulnerable due to their isolation • Moderate proportion of plant, bird, mammal and reptile species are declining • Extinction debt likely to result in declining status of species and communities for many years to come, however gains can be made.
Focus Areas
• Maintain the current status of rare and endangered taxa. • The focus should be on retaining all remaining native vegetation patches to gain representation of the variety of habitat types. • All remaining native vegetation contributes to the landscape's viability; however, with scarce resources, the priority should be to focus on those larger areas in excellent condition, then to those larger areas where restoration is needed and the smaller remnants in excellent condition. • Improve the condition (habitat values) of patches (by priority) by the removal of threats, if possible (e.g. removing grazing pressures) and strategic revegetation (refer to landscape design considerations).
Landscape Design Considerations
• Landscapes with less than 30% native vegetation cover have generally gone beyond the threshold of sustainability for terrestrial biodiversity and ecosystem function. Restoration of native vegetation to at least 30% overall native vegetation cover is the primary order goal to stabilise the loss of ecosystem functions and loss of terrestrial biodiversity. • The landscape design considerations for relictual landscapes (<10% vegetation remaining) also apply to fragmented landscapes; however, site selection and prioritisation will need to be carefully considered on a site-by-site basis as there will be generally more flexibility in choice.

[17] This is because there is no systematic pattern of land clearing, which results in some areas with larger or larger number of remnants within the landscape, while other may have little or no vegetation remaining. Hence habitat loss is not consistent throughout the landscape.

Table 28: Variegated Landscapes Management Directions

Landscapes with between 30 and 70 % remaining native vegetation: Variegated Landscapes
General Features
• Much native vegetation is still present, but many communities and vegetation associations have been disproportionately over-cleared or degraded (e.g. productive ones or riparian areas). • Many plant species are rare and moderate numbers of bird species are in decline. • Ecosystem functions are changing due to removal, fragmentation and degradation of native vegetation.
Focus Areas
• Maintain the current status of rare and endangered taxa, but the extent of management input could be less than landscapes with less vegetation. • Overall aim should be to retain representative patches of each of the vegetation communities where possible and to restore and revegetate where needed. • Native vegetation conservation and management should be targeted towards mainlining existing good quality larger remnants, then the smaller ones, then restoring vegetation communities by focusing on those with high levels of clearing (i.e. small proportion remaining) or provide specialised known habitat values, or have threatening processes that can be addressed with a high feasibility and probability.
Landscape Design Considerations
These landscapes require careful planning, adherence to the precautionary principle, and adaptive management learning to help prevent unsustainable catastrophic collapse of ecosystem function. **Size of habitat patches** Patches no smaller than 500 ha have been recommended in the Murray Darling Basin for variegated landscapes, preferably with connections to other patches, of no more than 1 km gaps across cleared lands. Until proven otherwise, this assumption should apply to the SWCC region. **Shape of habitat patches** Short linear strips may be useful for connecting patches if the long axis is less than five times the length of the short axis **Connectivity of habitat patches** • In variegated landscapes, native vegetation patches are usually less isolated, often connected by strips of native vegetation (including riparian zones), and surrounded by a landscape matrix that is more favourable for dispersion of individuals. • Ensure that patches for biodiversity conservation and ecosystem function do not exceed 2 km spacing when completely surrounded by cleared land. **Arrangement and Location within the landscape** The arrangement and location principles outlined for relictual landscapes are applicable to variegated landscapes as well. More choices will be available and careful consideration for individual landscape considerations will need to be analysed on a case by case basis.

Table 29: Intact Landscapes Management Directions

Landscapes with greater than 70 % remaining native vegetation: Intact Landscapes
General Features
• Most native vegetation is intact so the range of communities and habitats are reasonably secure. • Variation in condition is evident due to the effects of grazing, altered fire regimes, weeds and feral animals. • Particular individual species or communities have been identified as declining. • The clearing that has occurred is usually associated with a particular soil type, thereby reducing the associated vegetation and fauna. • Ecosystem functions are usually OK, except where mismanagement (e.g. over-grazing, inappropriate fire regimes etc.) has lead to degradation.
Focus Areas
• Maintain the current status of rare and endangered taxa. However, only special cases will require significant input of management, unless reintroduction style actions are prescribed. • Vegetation associations should be targeted to maintain an adequate representation of the various habitats within that landscape. • Good quality vegetation should be the primary focus as there is a greater return on conservation for a smaller level of investment. • Vegetation associations that are highly cleared can be targeted, with any good quality patches managed, then degraded ones restored. • If there are sufficient funds, resources, skills and commitment area of completely degraded habitat that are no longer present can be rebuilt using revegetation techniques.
Landscape Design Considerations
In these areas there is likely to be flexibility in which examples are selected for conservation actions. **Size of habitat patches** Patches of at least 1000 ha are recommended in intact landscapes. **Shape of habitat patches** The shape of patches in intact landscapes is not generally an issue because in these landscapes there is a matrix of natural and semi-natural vegetation, rather than a matrix of introduced or alien vegetation. **Connectivity of habitat patches** In these areas, climatic variation forces species to wax and wane in abundance over the landscape. Spatial planning must be done to anticipate this need, even though we don't know the detailed requirements of each species. Because there are pathways for movement through native vegetation, the spacing of "refuge" patches can be greater that it can in landscapes with a higher degree of clearing. Therefore, patches set aside for species that are sensitive to grazing and other disturbances, should form an even network with 5-10km spacings where possible. **Arrangement and Location within the landscape** In these landscapes it is not possible, nor necessary, to try and change the natural arrangement of patches of vegetation and habitat.

3.4.4. Monitoring and Evaluation

Monitoring and evaluation (M & E) are essential components of environmental and natural resource management programmes and must always be included in the planning process. M & E processes track the progress and help judge the success of a project or programme. Monitoring involves the regular measurement or collection of information over time to determine change. Evaluation is the analysis of information gathered by monitoring to determine whether investment or management activities have been effective in achieving the objectives of the programme. Monitoring provides the raw information to answer questions about progress. Evaluation is about analysing that information and drawing conclusions (Coote, *et al*, undated).

Monitoring for biodiversity will help to:

- Initiate management action (for the protection or maintenance of biodiversity);
- Asses whether management actions work;
- Improve ecosystem management;
- Determine whether biodiversity targets have been achieved; and
- Provide opportunities for community learning and informing the public about biodiversity and its management.

The development of a monitoring programme for biodiversity is complex however and difficult to achieve at an appropriate scale and level of precision. Consequently monitoring of biodiversity at a regional scale has historically been poorly done. Direct specific measurements of elements of biodiversity are difficult and expensive to obtain, particularly at the regional scale. Therefore effective regional monitoring requires the use of appropriate indicators that can be used as either direct or surrogate measures of biodiversity. Effective indicators need to be (Fisher *et al,* 2006):

- Informative – in terms of the biodiversity values of concern;
- Sensitive – to the changes in abundance of the species or condition of the variable on interest, within a reasonable time frame;
- Easy – to assess;

- Meaningful – in terms of peoples understanding of biodiversity, i.e. where specific or surrogate; and
- Linked – clearly to management actions.

The actual practice of using and monitoring selected indicators can also be difficult. Effective monitoring of most biodiversity indicators requires:

- Sufficient time and funds;
- Knowledge of the monitoring methods available for particular indicators, and knowing the most appropriate method to use,
- Decisions on the location and number of monitoring sites;
- Decisions on the frequency of monitoring; and
- Knowledge on how to record and interpret the information.

Given the breadth of scale of biodiversity and the ecological processes that maintain them, it is no wonder that biodiversity monitoring is a difficult process.

SWCC needs to concentrate at regional level biodiversity targets and devise appropriate indicators for these that are consistent with their level of skill and resources.

A previous report to SWCC has highlighted a number of potential indicators against draft Resource Condition Targets (RCTs) and Management Action Targets (MATs) (Ecosystem Solutions, 2007). These are included in Appendix E and could be used as the first stages in formulating a regional biodiversity monitoring and evaluation programme for SWCC.

4. Integrated Decision Support System

Even with the most rigorous prioritisation process available, the process of allocating resources to conservation actions is not easy. Scientific principles of biology and ecology merely provide a transparent[18] and systematic way to determine areas and assets of high biodiversity and provide broad summaries of the threatening processes in that associated landscape.

Personal biases in perceptions, expertise and philosophy can interplay within any investment decision process, even if only the scientific criteria are evaluated.

For example, threatened species or communities' ecologists would naturally gravitate towards projects that focus on threatened taxa, whereas landscape ecologists prefer to support projects that focus on landscape pressures and interactions. Similarly, botanists would prefer plant-based projects, whereas zoologists prefer animals (and within these broad categories are the mycologist, orchid specialists, invertebrate biologists, ornithologist etc).

So just within the biological conservation focus there will always be debate on where to invest to get the best return. This situation is dynamic with no concrete answer. There is a continuum between the short term "crisis" management of threatened species protection and conservation and the longer term, broader measures advocated under landscape conservation (Figure 13). No region (or land manager) wants the responsibility of having a species within their patch become extinct through measures where additional funding or resources could have prevented it (as opposed to catastrophic stochastic events such as wildfire, flood etc.). Similarly, many would like to see a longer term investment in landscape and patch scale projects that ultimately will prevent species and populations from declining to the point where they become listed as endangered.

[18] Transparency in this case refers to the fact that the methodology presented here is a process whose individual steps can be easily understood by others, be replicated and criticised and changed or improved as new knowledge becomes available.

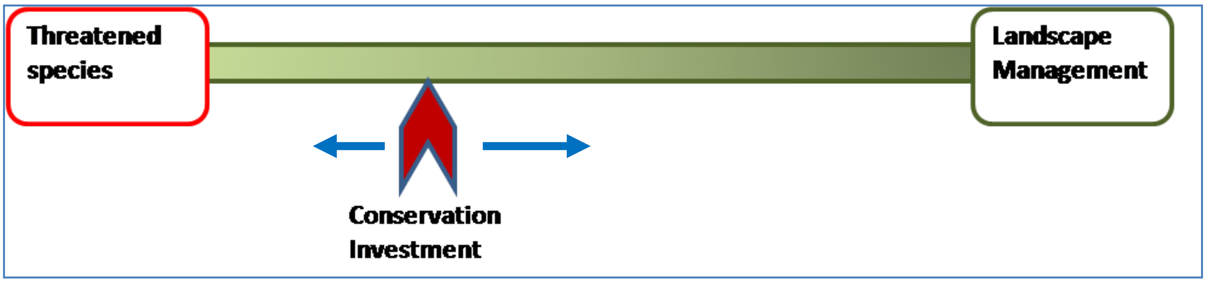

Figure 12: Continuum of conservation investment

Given the high abundance of threatened species within SWCC, it is likely that the threatened species end of the equation might receive more attention at the beginning of the strategic phases to ensure no preventable extinction occurs. As time progresses it would be expected that the investment mix would move more towards landscape management, especially as species and populations become more secure.

This challenge is difficult enough when dealing just with the scientific data. SWCC's focus, however, will be influenced by many factors other than biodiversity conservation, including:

- Political foci and will;
- Social acceptance;
- Available skills and knowledge;
- Philosophical position;
- Funding availability; and
- Delivery methods and protocols.

Once such considerations have been made, other factors need to be considered such as the feasibility of achieving the conservation objective and the ability and history of the groups or managers undertaking the action.

No form of tool will (or should) take the decision making away from the people responsible for the decision. All that can be hoped for is a tool that can provide a certain amount of information to decision-makers so that a thorough analysis of the alternatives can be made. This includes understanding what will be forgone by deciding to invest in one direction or project over another.

The complexity of making decisions in environmental management and NRM has led to the development of a vast array of decision-support tools. These range from simple matrices or decision flow charts to complex computer-based, scenario-testing algorithms. The main strength in these tools is that they provide a formal

and objective way of structuring the problems and presenting the information required to increase the likelihood of good decisions.

A separate project initiated by SWCC, which focuses on Waterways, Wetlands and Estuaries, has developed a computer-based multi-criteria analysis IDSS that will be used to support the implementation of the SWCC Waterway Health Sub-Strategy (Spatial Vision Innovations 2007). The logic and approach adopted in this IDSS is compatible with the approach taken for terrestrial biodiversity in this strategy. It is therefore beneficial to nest the terrestrial biodiversity strategic principles and data within this current IDSS, making one system that will suit both approaches. The terrestrial biodiversity strategic approach advocated within this strategy will be integrated into the GIS-based IDSS vehicle developed by Spatial Vision. A companion document provides further details of the integration process (Ecosystem Solutions 2008).

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6. Glossary

(Adapted from the draft 100 Year Biodiversity Conservation Strategy for WA)

Ameliorate: To make or become better; improve.

Animal: Any member of the Kingdom Animalia (other than a human being).

Anthropogenic: Of, relating to, or resulting from the influence of human beings.

Aquatic: Living or growing in, on, or near water (usually taken to mean freshwater, as opposed to marine).

Biodiversity: The variability among living organisms and the ecosystems and ecological complexes of which those organisms are a part and includes:

(i) diversity within native species and between native species;

(ii) diversity of ecosystems; and

(iii) diversity of other biodiversity components.

Biodiversity asset: Threatened taxa and ecological communities, significant ecosystems, vegetation association or taxa.

Biodiversity component: Includes habitats, ecological communities, genes and ecological processes.

Biogeographic regions (IBRA): Interim Biogeographic Regionalisation for Australia (IBRA) is a framework for conservation planning and sustainable resource management within a bioregional context. IBRA regions represent a landscape based approach to classifying the land surface from a range of continental data on environmental attributes, including climate and geomorphology

Biota: All life, including plants, animals, and fungi.

Catchment: Area of land drained by a river and its tributaries.

Conservation: Includes maintenance and restoration.

Critical habitat: Means habitat critical to:

(i) the survival of a native species or ecological community where the loss of habitat of the species or ecological community would result in the native species or ecological community being eligible for listing as a threatened native species or a threatened ecological community; or

(ii) the survival of a threatened native species or a threatened ecological community.

[Adopted from EPBC Act without amendment.]

Dieback: A symptom of disease or exposure in trees and other vegetation in which the foliage progressively dies from the extremities; commonly referred to with respect to native forests, heathlands or woodlands. (See *Phytophthora* dieback and *Phytophthora cinnamomi*.)

Ecological community: A natural assemblage of organisms that occurs in a particular type of habitat.

Ecological process: Means any event taking place between:

(i) organisms that are native species; or

(ii) organisms that are native species and the natural abiotic components of an ecosystem, that contributes to the functioning of an ecosystem.

Ecosystem: Means a dynamic complex of ecological communities and their abiotic environment interacting as a functional unit.

Endemic: Species naturally restricted to a specified region or locality.

Fauna: Animals found in a specific area.

Feral species: A domesticated species that has become wild, for example donkey, camel, horse, pig and goat.

Flora: Plants found in a specific area.

Habitat: Means the biophysical medium:

(i) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or

(ii) once occupied (continuously, periodically or occasionally) by an organism or group of organisms, and into which organisms of that kind have the potential to be re-introduced.

Indigenous: Originating or occurring naturally in a particular place.

In situ: Conserving species within their natural habitat.

Interim recovery plans: Documents for the management and protection of threatened taxa or threatened ecological communities where no full recovery plan has been prepared. Interim recovery plans prescribe immediate actions that are necessary to halt the decline and commence recovery of a species or ecological community. (See recovery plans.)

Introduced species: A species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities (including exotic organisms, and genetically modified organisms).

Invasive species: Species introduced deliberately or unintentionally outside their natural habitats where they have the ability to establish themselves, invade, outcompete natives and take over the new environments.

Invertebrate: Any animal without a backbone (vertebral column) such as insects, squid, snails and worms.

International Union for the Conservation of Nature and Natural Resources (IUCN) categories I-IV: Areas of land formally protected for nature conservation values, including strict nature reserve/wilderness (managed for science or wilderness), national park (managed for ecosystem conservation and recreation), natural monuments (managed for conservation of specific features) and habitat/species management areas (managed

mainly for conservation through management intervention.) This is contrasted with IUCN categories V and VI, which are areas of land formally protected for nature conservation values, including protected landscapes/seascapes (managed mainly for landscape and seascape conservation and recreation) and managed resource protected areas (managed mainly for sustainable use of natural ecosystems).

Land for Wildlife: Land for Wildlife is a voluntary program managed by the Department of Environment and Conservation (DEC) that recognises the conservation efforts of private landholders and managers and helps them to conserve biodiversity on their lands by protecting, managing or recreating suitable habitat.

Landscape: A mosaic where the mix of local ecological communities and ecosystems or land uses is repeated in a similar form over a kilometre-wide area. In agricultural areas, a landscape unit that is repeated with a similar pattern of land use, including natural habitats. From a biodiversity perspective, the distances over which significant species occur should govern the upper size limit of a landscape for biodiversity planning.

Marine: Inhabiting, salt water in or connected to the sea.

Natural diversity recovery catchment: Area established as part of the Natural Diversity Recovery Catchment Program under the State Salinity Strategy to help recover and protect significant natural areas, particularly wetlands, from salinity and waterlogging. Selection is based on a number of criteria, including representative of nature conservation values and the likelihood of recovering and protecting areas from salinity.

Natural resource management: Management of land, water, air and biodiversity resources of the State for the benefit of existing and future generations, and for the maintenance of life support capability of the biosphere. Includes use of natural resources by extractive and mining industries.

Non-vascular plants: Non-vascular plants lack specialised tissues to carry water and dissolved food substances throughout the plant body. Examples include: mosses, lichens, and liverworts.

Organism: Individual living plant or animal.

Pest: Any animal that has a negative effect on human or economic activities. They can include both introduced and native species.

Phytophthora cinnamomi: A soil-borne organism (often referred to as a fungus) belonging to the Class Oomycetes or 'water moulds', known to cause root-rot disease in Australian flora species. (See dieback.)

***Phytophthora* dieback:** Death or modification of native vegetation caused by *Phytophthora cinnamomi.*

Plant: Member of the Kingdom Plantae

Recovery plans: Documents that set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community. Recovery plans are appropriate for species or ecological communities where sufficient information is available to prescribe recovery actions with confidence (see interim recovery plans).

Representative landscapes: Significant samples of sub-regional or regional biota. These samples will provide comprehensive, adequate (i.e. viable) and representative samples of the subregional or regional biota. The dimensions of representative landscapes will vary considerably, depending on the geomorphology and distribution of natural environments, and how they are repeated across a region or sub-region.

Salinity: The concentration of salts in soil or water. Secondary salinity or salinisation (which takes the form of either dryland or irrigation salinity) is brought about by land use and management change, such as removal of deep-rooted vegetation. It leads to rising groundwater and the mobilisation of salts, which affects plant growth, and often to habitat loss.

Species: A group of organisms that ¾

(i) interbreed to produce fertile offspring; or

(ii) possess common characteristics derived from a common gene pool;

and includes

(iii) a sub-species.

Species richness: The number of species within a specified area.

Taxon (taxa pl.): A group or category, at any level, in a system for classifying organisms.

Terrestrial: Living or growing on land.

Threat abatement: Eliminating or reducing a threat.

Threatened ecological community: An ecological community that is threatened by destruction and is formally listed as either vulnerable, endangered, critically endangered or presumed destroyed.

Threatened species/taxa: Species/taxa classified as being threatened by extinction and listed as either vulnerable, endangered, critically endangered or presumed extinct.

Threatening process: A process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

Wildlife: Native plant or animal.

Appendices

A) IBRA sub regional descriptions.

a) Swan Coastal Plain

The Swan Coastal Plain is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by C. obesa-marri woodlands and Melaleuca shrublands, are extensive only in the south.

The Perth subregion (SWA2) is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvial soils are the predominant vegetation types. The area also includes a complex series of seasonal wetlands. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean.

b) Jarrah Forest 1

The Jarrah Forest is a duricrusted plateau of Yilgarn Craton characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by woodlands of Wandoo - Marri on clayey soils. Eluvial and alluvial deposits support Agonis shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands.

Northern Jarrah Forest (JF1) incorporates the area east of the Darling Scarp, overlying Archaean granite and metamorphic rocks of an average elevation of 300 m, capped by an extensive lateritic duricrust, dissected by later drainage and broken by occasional granite hills. In the east the laterite becomes deeply dissected until it compresses isolated remnants. Rainfall is from 1300 mm on the scarp to approximately 700 mm in the east and north. Vegetation comprises Jarrah - Marri forest in the west with Bullich and Blackbutt in the valleys grading to Wandoo and Marri woodlands in the east with Powder bark on breakaways. There are extensive but localised sand sheets with Banksia low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands in the north and east. The majority of the diversity in the communities occurs on the lower slopes or near granite soils where there are rapid changes in site conditions.

c) Jarrah Forest 2

Southern Jarrah Forest (JF2): South of Collie the plateau broadens and slopes gently to the south coast. Drainage is still dissected in the west but broadening and levelling of the surface in the east causes poor drainage and large and small wetlands. The ironstone becomes less evident being buried beneath sands. Rainfall is from 1200 mm in the south-west to 500 mm in the east. Vegetation comprises Jarrah - Marri forest in the west grading to Marri and Wandoo woodlands in the east. There are extensive areas of swamp vegetation in the south–east, dominated by Paperbarks and Swamp Yate. The understorey component of the forest and woodland reflects the more mesic nature of this area. The majority of the diversity in the communities occurs on the lower slopes or near granite soils where there are rapid changes in site conditions.

d) Avon Wheatbelt 2

The Avon Wheatbelt is an area of active drainage dissecting a Tertiary plateau in Yilgarn Craton which is gently undulating landscape and of low relief. Proteaceous scrub-heaths, rich in endemics, on residual lateritic uplands and derived sandplains; mixed eucalypt, *Allocasuarina huegeliana* and Jam-York Gum woodlands on Quaternary alluvials and eluvials.

Within this, Avon Wheatbelt P2 (AW2) is the erosional surface of gently undulating rises to low hills with abrupt breakaways. Continuous stream channels that flow in most years. Colluvial processes are still active. Most soil is formed in colluvium or in-situ weathered rock. Vegetation is varied and species rich. It includes woodlands of Wandoo, York Gum and Salmon Gum with Jam and Casuarina. However the vegetation has been predominantly cleared for agriculture and primarily consists of fragmented and isolated remnants. The climate is Semi-arid (Dry) Warm Mediterranean

e) Warren

The Warren bioregion consists of dissected undulating country of the Leeuwin Complex, Southern Perth Basin (Blackwood Plateau), South-West intrusions of the Yilgarn Craton and western parts of the Albany Orogen with loamy soils supporting Karri forest, laterites supporting Jarrah-Marri forest, leached sandy soils in depressions and plains supporting low Jarrah woodlands and paperbark/sedge swamps, and Holocene marine dunes with *Agonis flexuosa* and Banksia woodlands and heaths. The climate is moderate Mediterranean. The bioregion is not further divided into subregions.

f) Mallee

The Mallee bioregion is the south-eastern part of Yilgarn Craton. Its landscape is gently undulating, with partially occluded drainage. Mallee over myrtaceous-proteaceous heaths on duplex (sand over clay) soils are common. Melaleuca shrublands characterise alluvia, and Halosarcia low shrublands occur on saline alluvium. Vegetation consists of a mosaic of mixed eucalypt woodlands and mallee occurring on calcareous earth plains and sandplains overlying Eocene limestone strata in the east. The landscape is fragmented with particular surface-types almost completely cleared for agriculture.

Western Mallee (MAL2) subregion has more relief than its eastern counterpart. Its main surface-types comprise clays and silts underlain by Kankar, exposed granite, sandplains and laterite pavements. Salt lake systems occur on a granite basement. Its drainage system is occluded. Mallee communities occur on a variety of surfaces; Eucalyptus woodlands occur mainly on fine-textured soils, with scrub-heath on sands and laterite. The climate is warm Mediterranean and annual rainfall is 250-500mm.

B) Questionnaire used in the determination of priority.

i) Letter sent to "Experts"

Outcome of Process

The aim of this process is to assist SWCC in determining where to target their investment in biodiversity conservation and management, based on the relative values of their assets and the severity and significance of threatening processes that affect them.

Background/Assumptions

The ranking of biodiversity values is a subjective activity, based primarily on one's perspective, experience and world-view. There is a difficulty in determining relative values due to differing assessment methodologies in different contexts.

In order to allocate a discrete "value" to the suite of biodiversity assets and the severity and impact of threats upon them, a number of people with skills, knowledge and/or experience on biodiversity conservation are asked to rank the "value" of a list of biodiversity assets from a biological /ecological perspective. They are also asked to assign a relative value against a number of attributes that contribute to a number of threatening processes that impact biodiversity.

This "expert panel" approach aims to develop a transparent, repeatable and defensible methodology for prioritisation. While acknowledging the qualitative nature of the information, these data will be compiled and utilised to guide the strategic investment in biodiversity conservation for the South West Catchments Council.

This process is not intended to produce empirical and statistically valid data, but provide a transparent and repeatable process upon which biodiversity assets and threats can be prioritised.

Experts, for this process, are defined as those with knowledge of some components of biodiversity within the region (or sub IBRA region) and familiarity of the important factors that influence the spatial and temporal distribution of these biodiversity components.

Process

Hard copies of the worksheets are attached with this document. A CD with an Excel Spreadsheet with the tables listed in separate tabs, is also included should you want to complete the tables digitally.

1. Review the List of Assets in the following table or on the "Assets List" tab in the excel worksheet (in the attached disc).
2. Review the Asset Rankings guide attached or Asset Rankings tab in the spreadsheet.
3. For each of the listed assets, assign a relative value based on your opinion, knowledge or "best-guess".
4. Review the list of threats in the Threats list or "Threats Ranking" tab in the attached disc.
5. Review the Threats Criteria table in the guide or tab.
6. Allocate a ranking of high, medium or low for each of the separate categories for each threat that you feel you have sufficient knowledge to complete. Base this on your experience, knowledge or "best-guess".
7. Place a tick or mark in those sub-IBRA regions that you feel are most affected by the threat (tick all those that apply). A map of the areas is attached as well as in the spreadsheet.

Please attach any comments back as well.

Mail, fax, or email the tables back to Ecosystem Solutions.

Mail: PO Box 685, Dunsborough WA 6281

Fax: 08 9759 1920

Email: info@ecosystemsolutions.com.au

Your responses will be incorporated into a combined ranking. We intend to repeat the process in five years or so the data can be improved or amended based on new knowledge or information. Any future surveys will preferentially target those that have responded to this survey, therefore your contact details will be maintained by SWCC.

ii) Explanatory Notes on Biodiversity Asset Values

Biodiversity Asset Comparative Values

Value as a Biodiversity Asset	Interpretation	Example
Significant	Has recognised International or National values (i.e. is globally unique and vital as a representative of global or national biodiversity).	Its conservation is considered essential as an example of global or national biodiversity.
High	Has a State conservation value.	Its conservation is considered essential as an important example of Western Australian biodiversity.
Moderate	Has regional significance or is not as high as the previous category.	Its conservation is considered an example of south west biodiversity; however it is not considered a State or National important asset.
Minor	Has local significance; important for conservation at a catchment or sub IBRA region.	Its conservation is considered as a good or significant example of local biodiversity or landscape level biodiversity.
Low	Has no real relative conservation value or its value is low when compared to other biodiversity assets within the region.	The asset is found in many locations, its occurrence does not appear to be declining, it is well represented in the conservation estate and it is not identified as being under threat.

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iii) Asset Ranking Sheet.

Criteria	Category	Value	Ranking

Rarity	**Flora**	**Declared Rare**	
		Priority	
	Fauna	**Threatened**	
		Priority	
	Communities	**Threatened**	
		Priority	
	Vegetation Type	**<10% of Pre-European extent remaining**	
		Good Condition	
		Poor Condition	
		<30% of Pre-European extent remaining	
		Good Condition	
		Poor Condition	
		<50% of Pre-European extent remaining	
		Good Condition	
		Poor Condition	
		>50% of Pre-European extent remaining	
		Good Condition	
		Poor Condition	
	Native Vegetation Extent	<10% over landscape	
		Good Condition	
		Poor Condition	
		<30% over landscape	
		Good Condition	
		Poor Condition	
		<50% over landscape	
		Good Condition	
		Poor Condition	
		>50% over landscape	
		Good Condition	
		Poor Condition	
Representative	**Vegetation Type**	**<10% within conservation reserves**	
		<30% within conservation reserves	
		<50% within conservation reserves	
		>50% within conservation reserves	
	Tenure	**National Parks**	
		Nature Reserves	
	Government	**Natural Diversity Recovery Catchments**	
		Land for Wildlife sites	
		Conservation Covenant sites	
Richness	**Species**	**High number of species within a landscape**	
		Areas of overlap of botanic and zoologic districts	
Distinctiveness	**Species**	**Areas of endemism**	
		Relictual/outlying species/populations	
		Locally significant species	
Naturalness	**Vegetation**	**Areas greater than 40 ha**	
		Known research/reference sites	

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Definitions

DRF	Those taxa/communities ranked as CR, EN or VU
Priority	Those taxa/communities listed below DRF (e.g. priority levels)

Condition	Note that the vegetation condition will impact on conservation value, therefore we need to determine the relative ranking of vegetation based on Good or better and Poor or worse
	Note that there is no standard condition ranking, as a rough guide Keighery (1994) is used.
Landscape	There is no fixed scale of landscape at this stage, however the term is meant to relate to areas where the mix of local ecological communities and ecosystems or land uses is repeated in a similar form over a wide area.
Conservation Reserves	Refers to IUCN Conservation Reserves I-IV, i.e. reserves with the primary purpose of conservation (does not include State Forest Areas ect).

iv) Threat Ranking Notes

Attribute	Knowledge Of Threat	Significance	Occurrence	Rate Of Spread	Capacity To Degrade	Feasibility
Notes	What is our current level of knowledge of the threat?	A measure of the **significance of the asset affected** by the threatening process, not **how much** the asset is affected by the threat. Based on the **primary** impacts of the threat. Eg: if the threat is likely to affect rare species/ecosystems or high quality areas of known habitat or other significance, then a High ranking should be given. If is likely to affect areas of degraded vegetation or species and communities already well conserved or managed, then a Low ranking should be given.	An indication of the **relative distribution** of the threat within the **region.** Based on a "snap-shot" of the distribution as of **the date of assessment** (i.e. not to include aspects included in rate of spread).	An indication of the **relative speed of spread** of the threat within the **region.** Timeline used for reference is 5 years. Need to assume no **additional** management input.	An indication of the **relative severity** of the threat, or its capacity to degrade the resources it is impacting.	An indication of how **feasible** current techniques or management actions are in preventing, halting or mitigating the impacts of the threat. Need to base assessment on our current knowledge and skill.
Ranking						
High	Current information provides a sound basis for decision making.	Threat affects ecosystems in near-natural conditions or species and/or communities with high conservation significance.	Widespread throughout the region. Affects all catchments and/or bioregions.	Rapid relative spread. Will affect all of region within 5 years.	Major impact will result. High probability that the threat will result in extermination of species, ecosystems and/or irreversible degradation to key regional conservation values.	Current methods of control are **proven** or have been **highly successful** in halting or minimising the impact of the threat on biodiversity values. The level of resources required is available and readily implemented.
Medium	Management actions/decisions need to be accompanied by further research or data gathering.	A small proportion of near natural ecosystems or those of particular conservation significance are threatened, but most is judged to be in a lesser category.	Not widespread and affecting the whole region, but spatially affecting more than localised areas. Affects 3 or more catchments or bioregions.	Moderate rate of spread. Likely to affect a significant more proportion of assets in 5 years, however unlikely to affect the whole of the region.	Moderate impact likely. The threat may impact severely on the biota of the specific site, but are unlikely to result in extinctions or **major** degradation of regional conservation values.	Current approaches and techniques appear to have some impact on the threatening process, but the results are patchy or dependant on an extraordinary level of resources.
Low	More information needed for sound management decisions/actions.	The threat mostly affects degraded ecosystems or species /communities of relatively low conservation significance.	Localised within the region. Easily able to list areas affected due to their small areas affected. Affects only 1 catchment, one bioregion.	Slow relative spread. Unlikely to affect any more areas within 5 years	Minor impact likely to result. Improbable those extinctions will occur and the impact of the threat can be reversed.	No current techniques are available (at a suitable scale) to address the threat. New approaches or techniques need to be developed or trialled.

v) Threat Ranking Sheet

Broad Category	Specific Management Issue	Knowledge of Threatening Process	Significance of Assets Threatened	Distribution of the Occurrence	Speed of the Rate of Spread	Capacity to Degrade Environmental Assets	Level of Feasibility to Manage	Regions most affected					
								Swan	JF 1	JF 2	WAR	AW 2	Mal
Altered biogeochemical processes													
	Salinity												
	Climate change												
Impacts of introduced plants and animals													
	Environmental weeds- Category A												
	Environmental weeds- Category B												
	Feral predators												
	European Fox												
	Cats												
	Other: *specify*												
	Feral Competitors												
	Rabbits												
	Grazing by stock												
	Pigs												
	Other: *specify*												
Impacts of problem native species													
	Competition for food and shelter												
	Parrots												
	Kangaroos												
	Insects												
	Other: *specify*												
Impacts of disease													
	Dieback (Phytophthora spp)												
	Armillaria												
Detrimental regimes of physical disturbance events													
	Fire (including inappropriate regimes)												
	Flood												
	Drought												
	Erosion												
Impacts of pollution													
	Chemical/Pesticide contamination												
Impacts of competing land used													
	Recreational management/Access												
	Agricultural impacts												
	Forestry												
	Illegal activities (e.g. rubbish dumping)												
	Mines and quarries												
	Urban expansion												
Destruction of habitat (food, water, shelter, oxygen, access to mates)													
	Land Clearing												
	Removing buffer/riparian vegetation												
	Habitat fragmentation/Isolation												
	Physical removal of plants or animals												

Category A Weeds	A weed ranked as High or Moderate in the Environmental Weed Strategy for WA
Category B Weeds	A weed ranked as Mild or Low in the Environmental Weed Strategy for WA

Category A Examples	Bridal Creeper, Veld Grass, Freesia, Pelargonium, Arum Lily, Watsonia, Cape Weed
Category B Examples	Morning Glory, Ink Weed, Annual Winter Grass, Wild Radish, Onion Weed, Cootamundra Wattle, Marram Grass

C) Vegetation Associations within sub-IBRA region.

Table 30: Vegetation Associations of the SWA sub IBRA within SWCC.

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
ROCKINGHAM_3048	9,889.5	84.5	0.9
BASSENDEAN_37	782.3	25.2	3.2
BASSENDEAN_990	622.8	21.5	3.5
SPEARWOOD_1008	44.7	1.7	3.9
PINJARRA_968	132,157.0	6,418.4	4.9
PINJARRA_973	18.8	1.1	5.7
BASSENDEAN_973	1,088.8	70.5	6.5
SPEARWOOD_1001	3,572.7	251.6	7.0
CHAPMAN_1136	323.2	22.8	7.1
SPEARWOOD_990	2,502.1	182.1	7.3
SPEARWOOD_125	5,691.8	483.9	8.5
BASSENDEAN_1136	4,396.4	386.9	8.8
PINJARRA_27	1,534.4	147.2	9.6
BASSENDEAN_949	1,398.4	166.0	11.9
BASSENDEAN_1182	3,693.2	439.5	11.9
BASSENDEAN_998	1,051.7	125.7	12.0
PINJARRA_3	12,616.4	1,530.2	12.1
BASSENDEAN_6	449.2	56.8	12.6
BASSENDEAN_1001	20,978.9	2,693.8	12.8
SPEARWOOD_676	1,255.5	191.3	15.2
SPEARWOOD_1000	5,221.7	906.6	17.4
SPEARWOOD_27	594.2	103.4	17.4
BASSENDEAN_1000	88,122.2	15,439.9	17.5
SPEARWOOD_973	1,418.0	262.0	18.5
PINJARRA_37	383.7	73.9	19.3
PINJARRA_949	1,053.9	217.2	20.6
SPEARWOOD_6	19,755.3	4,516.7	22.9
BASSENDEAN_4	27.1	6.7	24.5
SPEARWOOD_37	3,561.8	892.3	25.1
BASSENDEAN_126	188.6	50.6	26.9
SPEARWOOD_949	19.8	6.2	31.1
BASSENDEAN_27	3,406.1	1,363.9	40.0
PINJARRA_998	1,398.6	625.1	44.7
SPEARWOOD_3	2,022.8	963.4	47.6
PINJARRA_126	328.0	169.9	51.8
SPEARWOOD_2	3,142.8	2,061.9	65.6
ROCKINGHAM_997	3,487.9	2,354.7	67.5
ROCKINGHAM_129	835.6	572.4	68.5
SPEARWOOD_998	28,624.7	19,963.1	69.7
ROCKINGHAM_48	1,831.8	1,516.2	82.8
SPEARWOOD_48	1,348.5	1,160.2	86.0
ROCKINGHAM_1007	3,032.6	2,627.1	86.6

Table 31: Vegetation Associations of the JF1 sub IBRA within SWCC.

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
WILLIAMS_352	371.2	26.4	7.1
DRYANDRA_4	22,945.3	2,305.4	10.1
WILLIAMS_4	170,888.9	18,652.7	10.9
WILLIAMS_1023	2,243.3	247.2	11.0
NARROGIN_1023	189,186.2	21,670.9	11.5
DRYANDRA_1023	10,394.1	1,202.0	11.6
DRYANDRA_352	9,369.7	1,243.5	13.3
DRYANDRA_1003	2,006.0	287.0	14.3
WILLIAMS_7	11,307.0	1,620.6	14.3
WAGIN_1036	456.5	75.0	16.4
DRYANDRA_3	7,025.5	1,175.0	16.7
WILLIAMS_1003	2,245.8	378.4	16.9
BANNISTER_4	60,632.1	12,182.0	20.1
WILLIAMS_992	12,612.3	2,626.6	20.8
BANNISTER_352	4,240.4	945.7	22.3
WILLIAMS_5	1,992.0	458.3	23.0
WILLIAMS_3	6,359.2	1,578.5	24.8
DRYANDRA_1006	8,272.6	2,153.6	26.0
BANNISTER_49	507.4	134.9	26.6
WILLIAMS_37	154.9	42.0	27.1
BANNISTER_1003	8,047.9	2,329.6	29.0
WILLIAMS_949	427.0	126.2	29.6
BANNISTER_946	901.1	285.4	31.7
WILLIAMS_1073	460.2	156.0	33.9
WILLIAMS_1006	737.9	284.2	38.5
EAST DARLING_946	463.4	192.8	41.6
WEST DARLING_1184	14,009.3	6,181.8	44.1
BRIDGETOWN_1114	11,136.8	5,892.1	52.9
BANNISTER_3	91,363.3	48,731.9	53.3
BANNISTER_1005	256.4	140.3	54.7
EAST DARLING_3	224,542.5	176,717.6	78.7
BANNISTER_128	289.0	231.5	80.1
WEST DARLING_4	39,225.7	33,281.5	84.9
EAST DARLING_128	925.5	795.2	85.9
EAST DARLING_1114	5,710.6	4,981.9	87.2
WEST DARLING_3	419,685.0	369,049.6	87.9
WEST DARLING_1185	2,777.6	2,535.0	91.3
WEST DARLING_128	285.1	282.1	99.0
WEST DARLING_1114	2,997.3	2,997.3	100.0

Table 32: Vegetation Associations of the JF2 sub IBRA within SWCC.

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
BEAUFORT_51	50.5	1.2	2.4
KWORNICUP_3	107,947.2	6,648.0	6.2
PINJARRA_1136	43,422.1	2,793.7	6.4
PINJARRA_1182	8,691.0	705.8	8.1
WAGIN_946	1,225.3	107.0	8.7
JINGALUP_4	167,018.7	16,073.6	9.6
BEAUFORT_4	233,798.4	26,129.3	11.2
BEAUFORT_967	8,761.7	1,097.9	12.5
PINJARRA_1000	329.2	43.9	13.4
BEAUFORT_931	70.8	9.5	13.4
BEAUFORT_1073	3,464.4	491.3	14.2
JINGALUP_968	6,785.9	992.4	14.6
CHAPMAN_4	3,300.6	565.6	17.1
CHAPMAN_128	70.4	12.2	17.3
BEAUFORT_987	2,555.6	491.6	19.2
BRIDGETOWN_992	80,537.9	16,138.9	20.0
PINJARRA_1017	525.1	106.3	20.3
BEAUFORT_946	422.9	87.6	20.7
KWORNICUP_126	6,101.5	1,271.8	20.8
BRIDGETOWN_999	381.5	80.1	21.0
BEAUFORT_125	325.3	68.8	21.2
BEAUFORT_992	26,525.3	5,791.3	21.8
BEAUFORT_3	16,554.6	3,756.2	22.7
BEAUFORT_126	14.0	3.5	24.7
JINGALUP_3	34,366.2	8,507.5	24.8
JINGALUP_992	1,732.9	459.0	26.5
CHAPMAN_999	11,153.4	2,996.8	26.9
BEAUFORT_968	700.7	204.6	29.2
BRIDGETOWN_963	522.7	155.0	29.7
BEAUFORT_48	11,555.7	3,616.3	31.3
BEAUFORT_938	1,067.7	335.0	31.4
CHAPMAN_1	248.0	96.8	39.0
SCOTT RIVER_27	21,478.3	8,444.1	39.3
KWORNICUP_51	1,293.3	510.8	39.5
CHAPMAN_23	273.9	109.3	39.9
WEST DARLING_1017	55.8	23.7	42.5
BRIDGETOWN_126	486.5	216.5	44.5
BRIDGETOWN_1184	49,577.8	22,101.1	44.6
CHAPMAN_1181	15,826.5	7,099.0	44.9
JINGALUP_14	288.5	130.1	45.1
JINGALUP_1003	2,056.2	975.3	47.4
JINGALUP_1111	160.6	78.2	48.7
JINGALUP_126	721.8	354.4	49.1
CHAPMAN_37	590.9	290.2	49.1
CHAPMAN_949	244.1	120.9	49.6

JINGALUP_27	6,887.4	3,761.5	54.6
CHAPMAN_1000	6,015.1	3,400.1	56.5
PINJARRA_1181	3,397.4	1,974.3	58.1
CHAPMAN_129	48.1	28.8	59.9
BRIDGETOWN_4	3,480.0	2,174.7	62.5
BRIDGETOWN_27	7,015.0	4,416.5	63.0
CHAPMAN_1034	59.7	37.9	63.5
BRIDGETOWN_3	698,891.6	454,377.9	65.0
CHAPMAN_22	116.5	76.6	65.8
CHAPMAN_1182	11,062.5	7,912.3	71.5
SCOTT RIVER_1134	3,744.9	2,786.8	74.4
CHAPMAN_27	5,262.6	3,965.2	75.4
CHAPMAN_990	393.6	303.8	77.2
KWORNICUP_1134	6,492.4	5,196.1	80.0
CHAPMAN_3	320,782.9	262,335.4	81.8
KWORNICUP_27	8,336.3	6,908.8	82.9
CHAPMAN_1183	9,064.6	7,738.3	85.4
CHAPMAN_1134	7,106.7	6,091.3	85.7
WAGIN_4	119.2	106.3	89.2
CHAPMAN_1017	11,069.9	9,873.1	89.2
CHAPMAN_1180	1,873.2	1,732.7	92.5
CHAPMAN_1185	9,900.2	9,250.2	93.4
BRIDGETOWN_1134	8,417.6	8,012.5	95.2
CHAPMAN_1132	151.9	145.2	95.6
CHAPMAN_51	538.2	530.1	98.5
CHAPMAN_1109	536.3	528.6	98.6
BRIDGETOWN_37	876.9	868.7	99.1
CHAPMAN_1002	12,515.2	12,505.4	99.9
CHAPMAN_975	1,574.4	1,573.4	99.9
BRIDGETOWN_1157	217.8	217.8	100.0
BRIDGETOWN_1185	2,496.7	2,496.7	100.0
CHAPMAN_965	451.2	451.2	100.0

Table 33: Vegetation Associations of the WAR sub IBRA within SWCC.

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
BORANUP_973	9.5	0.6	6.52
SCOTT RIVER_1137	916.9	160.8	17.54
SCOTT RIVER_1008	31.3	5.5	17.68
BORANUP_2	7.3	2.1	28.94
SCOTT RIVER_973	25.1	8.3	33.1
BORANUP_128	42.0	15.2	36.1
SCOTT RIVER_126	819.9	341.9	41.7
SCOTT RIVER_51	26,241.4	10,958.9	41.8
BORANUP_27	1,002.7	447.8	44.7
SCOTT RIVER_129	54.2	26.1	48.3
SCOTT RIVER_1000	161.1	78.6	48.8

BORANUP_1	12,135.8	6,844.2	56.4
NORNALUP_129	514.4	295.7	57.5
SCOTT RIVER_949	1,101.1	660.8	60.0
BORANUP_129	11,936.8	7,509.0	62.9
SCOTT RIVER_975	1,181.1	765.6	64.8
NORNALUP_23	12,834.6	8,395.5	65.4
BORANUP_949	631.3	418.3	66.3
NORNALUP_1151	275.4	182.9	66.4
SCOTT RIVER_37	85.2	58.3	68.5
SCOTT RIVER_14	194.9	136.0	69.8
NORNALUP_126	287.3	209.9	73.1
SCOTT RIVER_1108	521.3	387.6	74.4
BORANUP_1180	856.0	649.8	75.9
SCOTT RIVER_23	20,027.5	15,621.5	78.0
BORANUP_1138	646.6	504.5	78.0
SCOTT RIVER_22	1,911.6	1,519.0	79.5
BORANUP_51	2,392.9	1,921.5	80.3
NORNALUP_990	655.1	534.8	81.6
BORANUP_1112	63.2	51.6	81.6
SCOTT RIVER_3	10,894.3	9,112.3	83.6
SCOTT RIVER_1132	113.0	94.6	83.7
SCOTT RIVER_990	1,336.1	1,124.0	84.1
SCOTT RIVER_125	55.4	47.4	85.7
NORNALUP_1002	2,715.4	2,349.4	86.5
NORNALUP_1152	5,737.0	4,976.8	86.8
NORNALUP_949	2.3	2.0	87.1
SCOTT RIVER_1109	2,762.0	2,441.6	88.4
BORANUP_1030	139.7	124.0	88.8
NORNALUP_1116	4,633.6	4,127.0	89.1
BORANUP_990	12,456.3	11,105.6	89.2
BORANUP_975	1,158.3	1,049.2	90.6
BORANUP_1108	8,541.4	7,748.7	90.7
NORNALUP_1130	1,014.6	927.6	91.4
BORANUP_23	4,633.0	4,235.9	91.4
BORANUP_22	587.9	538.0	91.5
NORNALUP_3	165,429.8	152,360.7	92.1
NORNALUP_975	481.0	443.0	92.1
SCOTT RIVER_1144	1,858.2	1,712.0	92.1
NORNALUP_1139	15,085.6	13,955.0	92.5
NORNALUP_1112	10,696.1	9,991.4	93.4
NORNALUP_1	40,677.2	38,041.6	93.5
BORANUP_1113	1,638.6	1,532.7	93.5
NORNALUP_1144	157,877.5	148,244.5	93.9
SCOTT RIVER_1	3,030.7	2,851.5	94.1
BORANUP_1109	30,393.1	28,599.7	94.1
NORNALUP_1150	5,394.5	5,119.0	94.9
BORANUP_1009	22.9	21.7	95.1
SCOTT RIVER_1002	271.1	258.1	95.2

NORNALUP_27	37,961.6	36,242.6	95.5
NORNALUP_1157	1,039.8	993.0	95.5
SCOTT RIVER_1115	992.7	948.6	95.6
BORANUP_14	730.0	700.1	95.9
BORANUP_1000	36.2	34.9	96.3
NORNALUP_1113	3,535.5	3,405.7	96.3
BORANUP_3	38,761.6	37,381.1	96.4
NORNALUP_1134	8,315.2	8,021.5	96.5
NORNALUP_1109	575.9	556.0	96.5
BORANUP_1137	163.2	158.7	97.3
BORANUP_1134	1,766.9	1,722.2	97.5
NORNALUP_51	3,368.7	3,286.5	97.6
BORANUP_37	395.7	386.3	97.6
NORNALUP_999	140.6	137.6	97.9
BRIDGETOWN_1112	143.1	141.3	98.7
NORNALUP_37	319.7	318.1	99.5
BORANUP_126	18.8	18.7	99.8
BORANUP_1002	88.5	88.5	100.0
BORANUP_1115	276.8	276.8	100.0
BORANUP_1131	282.0	282.0	100.0
BORANUP_1144	576.3	576.3	100.0
BRIDGETOWN_1	93.4	93.4	100.0
NORNALUP_1111	640.9	640.9	100.0
NORNALUP_1132	42.7	42.7	100.0
NORNALUP_38	30.4	30.4	100.0
NORNALUP_965	59.4	59.4	100.0
SCOTT RIVER_1112	289.2	289.2	100.0

Table 34: Vegetation Associations of the AW2 sub IBRA within SWCC

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
PINGELLY_352	10,814.8	8.4	0.1
PINGELLY_128	361.8	1.2	0.3
CORRIGIN_1023	199,200.5	1,400.9	0.7
TAMBELLUP_967	67,282.1	740.6	1.1
PINGELLY_1023	142,552.0	2,871.4	2.0
CORRIGIN_1147	2,493.0	54.4	2.2
TAMBELLUP_1023	12,035.0	348.4	2.9
NARROGIN_352	12,038.4	465.4	3.9
PALLINUP_1023	287.3	12.3	4.3
PALLINUP_1094	5,120.1	266.7	5.2
DUMBLEYUNG_142	9,175.1	515.8	5.6
PALLINUP_1075	19,958.3	1,126.0	5.6
TAMBELLUP_1075	83.6	5.3	6.3
DUMBLEYUNG_1092	77,981.4	5,192.7	6.7
DUMBLEYUNG_1023	227,933.5	15,709.3	6.9

DUMBLEYUNG_125	7,021.0	494.4	7.0
WAGIN_125	4,307.4	312.4	7.3
BROOMEHILL_1085	51,803.9	3,946.2	7.6
WAGIN_1023	243,701.9	20,884.8	8.6
DUMBLEYUNG_1075	7,343.9	670.2	9.1
NARROGIN_952	229.0	20.9	9.2
DUMBLEYUNG_955	2,876.4	287.5	10.0
WAGIN_126	7.5	0.9	11.7
PINGELLY_3041	2,849.2	367.1	12.9
WAGIN_967	2,104.1	290.7	13.8
DUMBLEYUNG_2048	2,333.3	325.6	14.0
WAGIN_952	92.2	13.3	14.4
WAGIN_48	2,757.2	398.6	14.5
WAGIN_128	99.5	14.9	15.0
CORRIGIN_955	6,108.9	939.3	15.4
WAGIN_25	161.4	25.2	15.6
NARROGIN_1074	2,405.7	384.1	16.0
NARROGIN_3041	467.3	76.4	16.4
PINGELLY_947	5,610.2	1,140.0	20.3
WAGIN_1083	10,384.6	2,198.0	21.2
DUMBLEYUNG_1031	411.2	87.6	21.3
NARROGIN_125	1,597.9	354.2	22.2
DUMBLEYUNG_952	17,807.4	4,442.7	25.0
NARROGIN_949	1,482.5	407.6	27.5
DUMBLEYUNG_48	830.5	231.0	27.8
WAGIN_1087	619.9	178.4	28.8
NARROGIN_5	8,538.6	2,461.9	28.8
DUMBLEYUNG_1091	716.0	223.7	31.3
DUMBLEYUNG_25	441.9	149.6	33.8
BROOMEHILL_1073	89.0	32.2	36.1
DUMBLEYUNG_128	251.9	92.0	36.5
WAGIN_1073	13,413.0	4,973.4	37.1
DUMBLEYUNG_953	471.7	181.6	38.5
NARROGIN_947	19,273.4	7,598.1	39.4
WAGIN_1074	2,206.5	928.8	42.1
NARROGIN_1073	873.6	382.0	43.7
NARROGIN_1053	1,117.7	490.5	43.9
DUMBLEYUNG_2093	9,419.9	4,212.7	44.7
WAGIN_37	325.7	146.2	44.9
DUMBLEYUNG_963	3,971.2	1,784.5	44.9
DRYANDRA_5	25,934.1	13,739.3	53.0
DRYANDRA_946	1,681.6	895.7	53.3
BROOMEHILL_1087	133.4	71.6	53.7
BROOMEHILL_1088	203.8	119.4	58.6
PINGELLY_952	1,138.6	723.8	63.6
DUMBLEYUNG_1074	15.3	13.6	88.9
NARROGIN_946	40.3	38.5	95.6

Table 35: Vegetation Associations of the MAL sub IBRA within SWCC

Vegetation Association	Original Area (ha)	Area Remaining (ha)	Percentage Remaining
HYDEN_961	8,780.4	5.2	0.1
CHIDNUP_938	1,853.4	4.8	0.3
PALLINUP_1200	41,461.4	400.5	1.0
HYDEN_1200	70,255.5	1,980.3	2.8
HYDEN_131	30,012.4	883.2	2.9
HYDEN_955	6,616.7	205.1	3.1
CHIDNUP_1075	147,867.4	5,465.4	3.7
HYDEN_142	3,340.2	137.5	4.1
DUMBLEYUNG_1094	1,830.4	105.4	5.8
HYDEN_1094	63,247.8	3,687.1	5.8
PALLINUP_142	320.3	21.0	6.6
HYDEN_1075	108,390.8	8,398.8	7.8
HYDEN_1023	4,292.2	370.3	8.6
DUMBLEYUNG_1093	8,202.3	782.2	9.5
HYDEN_1005	530.9	55.1	10.4
PALLINUP_967	2,102.6	220.1	10.5
CHIDNUP_1200	1,406.1	182.0	13.0
HYDEN_352	1,796.2	255.5	14.2
HYDEN_128	47.6	12.9	27.1
CHIDNUP_929	313.4	91.0	29.0
HYDEN_2048	10,881.8	3,196.2	29.4
HYDEN_967	1,258.1	463.0	36.8
CHIDNUP_1096	355.7	134.2	37.7
CHIDNUP_48	653.4	262.8	40.2
HYDEN_25	90.6	39.8	43.9
CHIDNUP_931	31.5	19.6	62.2
HYDEN_938	45.7	29.9	65.3

D) Discussion on 30 % native vegetation targets.

Biodiversity and ecosystem function is lost as habitat is lost or degraded. As the percentage of suitable habitat declines, the rate of loss of biodiversity and ecosystem services is suggested to increase at a faster rate than the rate of loss of habitat and there are thresholds where the loss of biota is dramatically accelerated (Andren, 1994).

The effect of the loss of patch connectivity on biodiversity depends on the characteristics of species and its movement potential in relation to landscape structure (With, *et al*, 1997). Thresholds differ for different types of organisms; however empirical data on different effects of habitat loss on specific species is sparse.

Theoretic studies have shown that when suitable habitat covers more than 80% of the landscape, most of the habitat is continuous. Thus, for organisms that require large areas of continuous habitat, or require particular types of habitat to disperse through, more than 70% cover of suitable vegetation may be necessary (James & Saunders, 2001). As clearing or degradation proceeds to reduce the cover of suitable vegetation, a threshold of connectivity is passed. The threshold comes from theoretical studies using landscape models (neutral landscape and percolation theory) in which simulated clearing is done at random (Green, 1994; Pearson, *et al*, 1996; With *et al*, 1997; With 1997). From 100% to approximately 70% cover, the habitat is continuous and the inter-patch distance is zero (i.e. a single large patch exits). From 70 and 60% cover and below, suitable habitat begins to form discrete patches (as opposed to continuous) and the interpatch distance increases. Patch size declines and average interpatch distance increases logarithmically as clearing continues. Down to 30% habitat cover, the number of discrete patches in the landscape increases, but below 30% the number begins to decline, corresponding with the increase in interpatch distance. There results suggest fundamental changes in the landscape patterns associated at clearing around 60-70% and 30%. These models, however, are based on random removal of habitat and this is not a characteristic of clearing in the real world. Clearing or intensification of land occurs on those parts of the landscape that are most suitable for land uses, usually associated with the most productive soil types.

If the landscape matrix comprises an intensive land use such as cropping, the effect on species diversity from habitat loss can be greater, and the critical

threshold of remaining suitable habitat will be substantially higher (Monkkonen & Reunanen, 1999).

While theoretical studies indicate that clearing native vegetation produces thresholds of connectivity and leads to fragmentation of habitats, studies in changes of abundance of plants and animals has shown that species are lost at particular thresholds of land clearing. Bennet and Ford (1997) modelled woodland bird species richness and suggested that significant declines occurred when the vegetation cover fell below 10% of the landscape and the decline was present, but declined between 10-30%.

The rate of species decline lags behind the rate of habitat loss and so species may continue to be lost for many decades after clearing of habitat has occurs. This is also known as extinction debt or species relaxation.

Extinction debt means that it is likely that in landscapes with less than 30% cover of native vegetation, species and ecosystem services will continue to be lost from the landscape for decades to come, even if vegetation clearing were stopped immediately.

Revegetation of landscapes will be necessary to prevent this future decline. The rate at which vegetation is re-established will be important because species ill be lost over the time interval it takes to reach the recommended levels.

Reid (200) examined the loss of bird species in the wheat-sheep belt of NSW. He estimates that in the landscapes he studied (approx 6.5% vegetation cover) 20 species of land birds may have already become locally extinct. Revegetation to 30% cover may still lead to an additional nine species being lost.

James and Saunders (2001) reviewed the conservation literature for the Murray Darling Basin and came up with two main observations:

- Loss of habitat is the main reason for the loss of species and ecosystem function; and
- Beyond a 30% landscape cover of native vegetation, loss of indigenous biodiversity is accelerated.

The figure of 30% derives from studies that show theoretical (Andren, 1994) and empirical (McIntyre *et al,* 2000) reasons for a threshold, below which the rate of loss of species and ecosystems are more rapid. The figure of 30% is a minimum value for vegetation communities and landscapes as surrogates for biodiversity retention, and for the retention of ecosystem function. They suggest the raising of all landscapes with less than this amount to 30% cove and in landscapes with greater than 30%, no clearing should be conducted. They strongly advocate that this does not justify the clearing of all landscapes down to 30% vegetation cover because:

- Species are lost at all levels of clearing down to 30%, not just below 30%;
- Ecosystem services are likely to have been impaired by the time 30% cover is reached;
- 30% cover rarely means equitable clearing of all vegetation communities so some will have been cleared far more that the 30% threshold and therefore most species from those communities will be either gone or under threat.

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E) Potential indicators for monitoring SWCC's RCTs and MATs

Resource	Condition	RCT (draft)	Measure or indicator
Significant Species	No extinctions	No species, where conservation action is undertaken, becomes extinct by 2027	Number of significant species within each conservation category; change in trend
			Number of significant species within region that have conservation actions undertaken.
Significant Ecological Communities	No extinctions	No ecological community, where conservation action is undertaken, becomes extinct by 2027	Number of significant ecological communities within each conservation category; change in trend
			Number of significant ecological communities within region that have conservation actions undertaken.
Native Vegetation	increase native vegetation cover within region	Expand native vegetation coverage of the region by 20,000 ha by 2027.	Extent of native vegetation by IBRA subregion (ha)
			Proportion remaining of each native vegetation type by IBRA sub region, measured as a percentage of pre 1750 extent.
	X% of native vegetation be classified as Good or better	X% of native vegetation with the region to be classified as Good or better condition by 2027	Proportion of each native vegetation type in each IBRA subregion that is estimated to be in a specified condition class.
Representative Landscapes	a representative landscape within each IBRA subregion being actively managed for conservation.	Each IBRA sub-region within SWCC contains at least one representative landscape project by 2027.	Number of IBRA sub-regions with a functional representative landscape project. Trend.
			Proportion of each native vegetation type in each IBRA subregion, that is managed for conservation (via reserves, covenants, LfW or any other conservation schemes)

No	Draft MAT	Potential Indicator or Measure
1	The conservation status of regionally significant species and communities is updated every 5 years.	• Trend in conservation status of regionally significant species and communities.
2	Development of a process by which Native vegetation status/condition can be assessed throughout the region by 2008.	• Ultimate development of a process that is relatively easy to implement and compliments adjoining regions process and is acceptable to the Australian government.
3	A situation statement comprising an inventory of regionally significant species, communities and ecosystems and trends in conservation status, degree of reservation and condition is developed by 2007 and updated every five years.	• Inventory of regionally significant taxa and systems in completed, conservation status trend analysis, vegetation area of extent and condition; percentage within formal reserve system; percentage under conservation management.
4	Develop a landscape scale conservation programme that aims to have each IBRA region within SWCC represented by 2017. • Avon Wheatbelt – by 2008 • Swan Coastal Plain- by 2010 • Warren – by 2012 • Jarrah Forest – by 2014.	• Landscape project developed as per target; • Area under conservation within representative landscape.
5	Prepare and implement regional scale management plans and approaches to protect biodiversity from regionally significant Environmental Weeds by 2008.	• Trends in threatened species and other key biodiversity values conservation status as a result of control of threatening processes. • Regional extent of target weeds. • Area of management for weed control.
6	Prepare and implement regional scale management plans and approaches to protect biodiversity from regionally significant Invasive Animals by 2008.	• Trends in threatened species and other key biodiversity values conservation status as a result of control of threatening processes. Regional extent of specific invasive animals. • Area of management for invasive animal control.
7	Prepare and implement regional scale management plans and approaches to protect biodiversity from Phytophthora Dieback by 2008.	• Trends in threatened species and other key biodiversity values conservation status as a result of control of threatening processes. • Trends in regional extend of dieback areas. • Area of management for PC.
8	Prepare and implement regional scale management plans and approaches to protect and enhance biodiversity using appropriate Fire Management for Biodiversity by 2008.	• Trends in threatened species and other key biodiversity values conservation status as a result of control of threatening processes. Area under management for biodiversity specific fire practices.
9	Prepare and implement regional scale management plans and approaches to protect biodiversity from secondary salinisation by 2008.	• Trends in threatened species and other key biodiversity values conservation status as a result of control of threatening processes.
10	A SWCC Regional Vegetation Management Strategy and Action plan is created by 2008, with actions commencing by 2009.	• Plan developed. • Area of vegetation being managed under plan. • Trends in vegetation condition and extent in managed areas. • Trends in conservation status of threatened species and communities (if appropriate)
11	Identify current and potential deficiencies in planning mechanisms that hinder biodiversity conservation, including perverse incentives against biodiversity conservation by 2008.	• Proportion of planning processes reviewed. • Gap analysis completed.
12	Conduct a survey to determine levels of awareness of biodiversity, its values and related issues by 2008, to act as an awareness benchmark. Repeat survey every 3 years.	• Survey conducted; • Trends in level of awareness and understanding.
13	Develop and implement a biodiversity communication and education programme by 2008, aimed at the regional community, to promote biodiversity conservation and gain support for conservation initiatives.	• Programme developed. • Number and type of information released by the region. • Number of people actively involved in biodiversity conservation actions; • Trends in awareness and understanding of biodiversity issues and its conservation.
14	Develop a protocol for the collection, storage and retrieval of information on regional biodiversity elements, processes and threats by 2008. (NOTE: may be part of a larger regional data protocol development project.)	• Protocol developed. • Trends in feedback on the effectiveness of protocol and its individual elements.
15	Develop a process for accessing and distributing information on regional biodiversity components, processes and threats by 2009.	• Number of users accessing information (e.g. website visits, data requests etc.). • User satisfaction survey trends. • Proportion of people that utilise information accessed.
16	Assist in the development and implementation of recovery plans for threatened taxa and ecological communities, in priority order as determined by IUCN conservation status – CR>En>Vu>Priority (Timeline needs to be synchronised with State Biodiversity Strategy).	• Trend in recovery plans prepared as a result of SWCC's contribution. • Number of recovery plans prepared as a result of SWCC's contribution. • Trend in recovery of target threatened taxa/communities as a result of SWCC's contribution.
17	Assist in the development and implementation of Natural Diversity Recovery Catchments Management Plans, as outlined under the State Salinity Strategy. (Timeline needs to be synchronised with State Biodiversity Strategy).	• Number of natural diversity recovery catchments in the region for which SWCC has assisted. • Area covered by natural diversity recovery catchments within the region that SWCC has assisted with. • Trends in biodiversity elements within natural diversity recovery catchment in which SWCC has assisted.

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