

Appendix 3

A strategy for the EPA to identify regionally significant natural areas in its consideration of the Greater Bunbury Region Scheme portion of the Swan Coastal Plain

**A STRATEGY FOR THE EPA TO IDENTIFY
REGIONALLY SIGNIFICANT NATURAL AREAS
IN ITS CONSIDERATION OF THE
GREATER BUNBURY REGION SCHEME PORTION
OF THE SWAN COASTAL PLAIN**



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1 INTRODUCTION

The Environmental Protection Authority has been particularly concerned with the identification and protection of regionally significant natural areas since its inception. An initial, pivotal role, of the Authority was established through the Conservation Through Reserve System reports produced in the 1970's and early 1980's. In recent times the identification and protection of natural areas has become a co-operative program across a series of government agencies, particularly the Departments of Conservation and Land Management, Environmental Protection, Planning and Infrastructure, and the Water and Rivers Commission. However the Authority has maintained an active interest in the System 6 area, particularly the Swan Coastal Plain portion of this System (Map 1). This interest has been maintained as the Swan Coastal Plain has high natural values, is the most populous and densely settled area of the state and, together with the Wheatbelt, is the most heavily cleared area of the state.

As a consequence the Swan Coastal Plain is the focus for the largest number of development proposals brought to the Authority for the assessment of their environmental impacts. To deal with these development proposals in a proactive manner the Authority began an update of System 6 in 1994. The update focused on the Swan Coastal Plain from the Moore River to Dunsborough, including the Swan Coastal Plain portion of System 1 (Map 1) with the objective of reviewing the conservation recommendations for this region to take account of the more recent and much improved information on the flora and fauna of the Swan Coastal Plain. In 1996 this program was split with priority given to the Perth Metropolitan Region (PMR) of the Swan Coastal Plain. This process, the Bushplan Project, was completed with the release of *Bush Forever* (Government of WA 2000a & b).

The Authority recognises there is a continued need for the update of the remainder of System 6 and part System 1 area to be completed as proposed in *Bush Forever*, through a similar co-ordinated program, subject to government funding. In the meantime there is a need for the Authority to consider the Draft Greater Bunbury Region Scheme (GBRS). As a consequence this Strategy has been developed to respond to the Scheme in a manner consistent with the System 6 report, the update and *Bush Forever*.

The System 6 portion of the Greater Bunbury Region (GBR) on the Darling and Blackwood Plateaux is not addressed here. The *Regional Forest Agreement* (Government of WA 1999) and the Forest Management Plan currently being prepared are the primary policy documents for the identification of a comprehensive, adequate and representative system of protected areas in that portion of System 6¹.

2 THE SWAN COASTAL PLAIN

2.1 The Natural Values of the Swan Coastal Plain

To identify the value of a natural area at a regional level it is necessary to place the area in the appropriate **natural** regional context. The Greater Bunbury Region is conspicuously divided into two distinct landscape units: the ancient Archaean Block to the east expressed as the Darling Plateau, and to the west the Phanerozoic sedimentary deposits of the Perth Basin expressed as the Swan Coastal Plain. In 1995 these were identified as distinctive natural regions on a national scale being the Jarrah Forest and Swan Coastal Plain Interim Biogeographic Regions (Map 1, after Thackway and Cresswell 1995). This Strategy is concerned with the area of the Greater Bunbury Region (a planning region) which intersects with the Swan Coastal Plain Interim Biogeographic Region which is, hereafter, referred to as the Swan Coastal Plain. The System 6 and part System 1 Update covers the area south of the Moore River which is, hereafter, referred to as the southern Swan Coastal Plain (Map 1).

Compared with the Plateau the Swan Coastal Plain is of very recent origin, the soils of the Plain having been laid down in the Pleistocene and Holocene periods. The entire Plain is characterised by

¹ The EPA expects to provide separate advice on this area of the GBRS.

low relief and extensive areas which are subject to seasonal or intermittent inundation or waterlogging (wetlands).

Over 1700 native vascular plants are recorded on the southern Swan Coastal Plain (Keighery 1999). More than 70% of these are endemic to the south-west of WA and many are endemic to the Swan Coastal Plain. This outstanding level of species diversity is reflected in a high level of plant community diversity. The patterning of plant species distribution and of the communities in which they grow is determined by

- the soils which are patterned from east to west: the alluvial soils of the Ridge Hill Shelf; the Pinjarra Plain; the river valleys; and the aeolian soils of the Bassendean, Spearwood and Quindalup Dunes
- the degree of seasonal or intermittent waterlogging of these soils, and
- climatic gradients along the 500km long Plain.

The Swan Coastal Plain's diverse vertebrate fauna is driven by these same factors.

A series of regional, or part region (southern Swan Coastal Plain) vegetation, flora, fauna and wetland studies have described aspects of the natural diversity of the Swan Coastal Plain. These studies can be used to provide comparable information on each natural area for an assessment of regional value. These national and regional attributes are listed in Table 1. The national and regional studies were published or were in an advanced stage, in 1994 when the System 6 and part of System 1 Update began.

Table 1: National and Regional Information Sets for the Swan Coastal Plain (after table prepared by DEP - Conservation Branch in 1997).

<p>LANDFORM AND SOIL (various sources)</p> <p>VEGETATION AND FLORA Vegetation Types (Beard 1979a, b&c, Beard 1981; Smith 1973 & 1974 and Hopkins <i>et al.</i> 1996)* Vegetation Complex (Heddle <i>et al.</i> 1980 and CALM) Floristic Community Types (Gibson <i>et al.</i> 1994, DEP 1996)</p> <p>WETLANDS Wetland Types (Hill <i>et al.</i> 1996a&b and as updated periodically by WRC) Consanguineous suite (Hill <i>et al.</i> 1996a&b) Wetland Management Objective (after Hill <i>et al.</i> 1996a&b, Semeniuk 1998 and as updated periodically by WRC) Lake's EPP (Government of WA 1992)</p> <p>THREATENED ECOLOGICAL COMMUNITIES After English and Blyth 1997 and as updated periodically by CALM</p> <p>THREATENED SPECIES CALM current Declared Rare and Priority Flora and Fauna Lists, reports, specific area survey</p> <p>INTERNATIONAL AND NATIONAL SIGNIFICANCE Reference to international treaties, Commonwealth <i>Environment Protection and Biodiversity Act 1999</i>, listing on the register of the National Estate etc.</p>

*Not applied in Government of WA (2000a&b), see Appendix 2 for description of the dataset.

This regional information is generally derived from mapped information in GIS formats. As a consequence it is necessary to verify the regional information, which is often extrapolated from limited ground survey, and identify the actual natural values of each area through specific area survey. Table 2 lists the individual area natural attributes that need to be collected through such survey. Collation of this information is an ongoing task.

The outlines, on which the Tables are based, were prepared in 1997 to form the basic template for descriptions of areas being considered for the System 6 Update, and for use by DEP officers in advising consultants preparing environmental assessment documents on natural areas on the Swan Coastal Plain. *Bush Forever* (Government of WA 2000b) outlines each of the studies (and the values

they describe) listed in Tables 1&2. One regional vegetation study was not used in *Bush Forever* and this is described in Appendix 2.

Table 2: Specific Area Information (after table prepared by DEP - Conservation Branch in 1997). Note: the limitations of any survey work should be clearly stated.

<p>LANDSCAPE FEATURES</p> <p>VEGETATION AND FLORA any existing information and specific area survey</p> <p>STRUCTURAL UNITS should be mapped and related to on the ground descriptions</p> <p>VEGETATION CONDITION should be mapped or recorded using standard terminology (Government of WA 2000b)</p> <p>TOTAL FLORA including total flora (level of survey should be indicated), significant flora (DRF, priority taxa, range extensions, species at geographic limits etc.)</p> <p>FAUNA including total fauna (level of survey should be indicated), significant fauna (DRF, priority taxa, range extensions, species at geographic limits etc.)</p> <p>LINKAGE adjacent bushland areas</p>

2.2 The Distribution of the Remaining Natural Areas on the Swan Coastal Plain

The Swan Coastal Plain has been significantly altered since European settlers introduced grazing animals and cleared the natural vegetation for housing, agriculture and mining. At times, housing, agriculture and mining, have also involved alteration of the landform. The remaining natural areas can be identified through mapping of the

- total extent and location of naturally vegetated areas remaining² (remnant native vegetation) and
- non-vegetated natural areas such as: water bodies (generally rivers, lakes and estuaries), bare ground (generally sand or mud) and rock outcrops.

Information on these remaining natural areas can be gained through use of the mapped information sets listed in Table 1, maps of remnant native vegetation and aerial photographs.

Recent mapping of remnant native vegetation on the southern Swan Coastal Plain (after Beeston *et al.* 2001) identifies that 78.7%³ of the original native vegetation has been cleared (Table 3a and 3b). Some general trends are evident in these patterns of clearing, these include:

- the preferential clearing of the alluvial soils of the Ridge Hill Shelf and the Pinjarra Plain (eastern side of the Swan Coastal Plain) for agriculture, with 92.3% of the original native vegetation having been cleared (Table 3a) and as much as 95% of some sections having been cleared (Table 3b, Guildford Complex);
- past retention of the native vegetation on poor soils such as the sands of the Quindalup, Spearwood and Bassendean Dunes and rocky soils of the areas of outcropping Tamala Limestones into the Spearwood Dunes (in recent years with the expansion of urban and industrial areas these soils are now being preferentially cleared); and
- small size of most of the remnants with most (86%) of the remaining remnants, particularly those on the eastern side of the Plain, being less than 5ha in area (see Figure 1).

Table 3⁴: Native vegetation on the southern Swan Coastal Plain (SCP) grouped in the major landform elements (after Government of WA 2000b) for vegetation complexes occurring in the Greater Bunbury Region (GBR).

² This includes vegetated uplands and wetlands, non-vegetated wetlands are referred to as 'water bodies'.

³ These figures are for the vegetation complexes in the GBR, not all vegetation complexes on the southern Swan Coastal Plain (see Table 3).

Information compiled at DEP from mapping of vegetation complexes after Heddle *et al.* (1980) and CALM (1998)⁵, remnant native vegetation after Beeston *et al.* (2001) and secure tenure⁶ (CALM 2002).

Table 3a: Native vegetation in the major landform elements on the SCP for those vegetation complexes occurring in the GBR.

Major Landform Elements	% of each remaining	% of each remaining in secure tenure
Foothills (Forrestfield Complex only)	17.4	0.3
Pinjarra Plain	6.9	0.4
Bassendean Dunes	27.0	0.7
Combinations of Bassendean Dunes/Pinjarra Plain	17.6	2.4
Spearwood Dunes	33.5	5.7
Quindalup Dunes	33.0	4.2
Marine (Estuarine and Lagoonal) Deposits	38.8	12.9

⁴ It is important to keep in mind a series of issues related to estimates of the original and remaining areas of native vegetation. These include the following:

- Sources of the intersecting GIS datasets and modifications of these datasets
Some issues related to the figures quoted in this Strategy are described below.
 - The remnant native vegetation mapping used in the Strategy uses Beeston *et al.* (2001) as the base data but this has been modified to remove plantations and an area of scattered trees over pasture.
 - Boundaries related to open water such as coastline, estuarine and lake boundaries – The coastline/estuarine boundary used in this document is that from Heddle *et al.* (1980), this differs from the coastline boundary used in EPA (2003).
- Limitations on the data
The remaining native vegetation mapping used is derived from dated aerial photography (in this case 1998) with limited ground truthing. As a consequence the percentages of ecological communities remaining is generally an overestimate of that remaining at present and at the date of the Strategy. The principal factors contributing to this overestimation are:
 - the preferential mapping of treed landscapes, leading to some mapping of areas that are parkland cleared or completely degraded;
 - the inclusion of areas that are approved for clearing through development approvals and/or clearing permits; and
 - some areas that have been cleared since the time of the aerial photography.

It is therefore very important to bear these issues in mind when the percentage of the native vegetation remaining in a particular vegetation complex approaches 30% and, when comparing different sets of figures.

⁵ Vegetation complex mapping for the Busselton area is now available on a limited basis from the Department of Conservation and Land Management. This mapping was done for the Regional Forest Agreement This mapping divides the Cartis Complex mapped in Heddle *et al.* (1980) and has been used to determine an area for this complex and the complexes on the small area of the GBR outside Heddle *et al.* in this document.

⁶ Secure tenure = National Parks, Nature Reserves, Conservation Parks and 5(g) Reserves. This gives an indication of the percentage protected but does not include native vegetation in state forests, local government reserves, *Bush Forever* Sites (outside these categories) which has a level of protection.

Table 3b: Native vegetation on the southern Swan Coastal Plain (SCP) for those vegetation complexes found in the Greater Bunbury Region (GBR).

Major Landform Units/ Vegetation Complex	Original Area (ha) on SCP	Remaining on SCP		Remaining on SCP in secure tenure	
		Area (ha)	% original area	Area (ha)	% of original area
Foothills					
Forrestfield Complex	20169	3518	17.4	61	0.3
Cartis Complex#	NA	NA	NA	NA	NA
Pinjarra Plain					
Abba	53367	3199	6.0	77	0.1
Guildford Complex	92497	4662	5.0	143	0.2
Swan Complex	15783	2454	15.6	0.0	0.0
Dardanup Complex	9504	754	7.9	0.0	0.0
Serpentine River Complex	19856	2103	10.6	558	2.8
Bassendean Dunes					
Bassendean Complex-Central And South	87626	23635	27.0	572	0.7
Combinations of Bassendean Dunes / Pinjarra Plain					
Cannington Complex	16661	1659	10.0	883	5.3
Southern River Complex	57979	11501	19.8	882	1.5
Spearwood Dunes					
Karrakatta Complex-Central And South	51620	14811	28.7	1256	2.4
Cottesloe Complex-Central And South	45300	18474	40.8	3955	8.7
Ludlow	8673	2112	24.3	772	8.9
Quindalup Dunes					
Quindalup	54476	18000	33.0	2309	4.2
Marine (Estuarine and Lagoonal) Deposits					
Vasse Complex	11196	3287	29.4	1228	11.0
Yoongarillup Complex	26580	11367	42.8	3632	13.7

#The Cartis Complex is mapped in Heddle *et al.* (1980) and CALM (1998).

The areas mapped in CALM (1998) are apparently a subset of Heddle *et al.* and are only given for the GBR (see Table 4).

The remaining natural areas, both vegetated and non-vegetated, have been altered by a series of disturbance events associated with threatening land uses, both within and adjacent to the natural area. As a consequence, with respect to the remnant native vegetation mapping, areas are mapped that have been altered to such an extent that they can no longer be classed as bushland. Bushland areas are a smaller subset of the mapped remnant native vegetation, being areas that are intact or if altered still representative of the structure and floristics of the natural vegetation (see Appendix 1). Most regionally significant areas of native vegetation meet the definition of bushland. However, similarly with *Bush Forever* which focussed on the identification of areas of regionally significant bushland and wetlands, some regionally significant natural areas are native vegetation that no longer meets the definition of bushland.

3 THE GREATER BUNBURY REGION OF THE SWAN COASTAL PLAIN

3.1 The Natural Values of the Greater Bunbury Region of the Swan Coastal Plain

The Swan Coastal Plain in the Greater Bunbury Region shows the same high species and community diversity, in a landscape with little relief, as the remainder of the Plain. In addition, the Plain in the Bunbury area has a series of particular natural values associated with a series of distinctive features. These features are broadly outlined below, together with a listing of the regionally significant natural areas that have been identified by the EPA from a series of previous reports and studies. These reports and studies are:

- System reports – System 1 and System 6 (DCE 1976, 1983);
- Areas of threatened ecological communities: as defined by English and Blyth (1997), locations established in Gibson *et al.* (1994) and DEP (1996); and
- Areas of Threatened and Poorly Reserved Plant Communities: EPA (1994, derived from Gibson *et al.* 1994) these are shown in **bold**.

The majority of these areas are recognised in the Draft Greater Bunbury Region Scheme and the earlier, related planning document, *Bunbury-Wellington Region Plan* (Ministry for Planning 1995). A series of additional regionally significant areas are proposed in the Draft Greater Bunbury Region Scheme and other reports, these are not listed here.

- *Diversity of Foothills ecological communities*

In the GBR the Darling and Whicher Scarps meet, the ecological communities changing from being the foothills of the Darling Plateau (Ridge Hill Shelf) to the foothills of the Blackwood Plateau. Harvey townsite is located near the junction of these two scarps.

Previously identified areas (see Map 2)

System 6: C86 - Dardanup Management Priority Area.

Contains areas of threatened ecological communities/Threatened and Poorly Reserved Plant Communities: **Yarloop Townsite**

- *Extensive, highly cleared Pinjarra Plain*

In the area of the GBR the Pinjarra Plain broadens and encompasses as much as two thirds of the Plain. However there are few remaining areas of native vegetation, the little remaining occurring in small remnants many of which are trees over pasture. It is expected that all remnants will contain threatened ecological communities.

Previously identified areas (see Map 2)

System 6: C62 - Wellard Road Nature Reserve, C64 - Byrd Road Nature Reserve, C65 - Benger Swamp

Contains areas of threatened ecological communities/Threatened and Poorly Reserved Plant

Communities: **Waterloo**, C62, C64, **Manea Park**, Kemerton Buffer Link

- *Most southern area of extensive Bassendean Dunes*

The most southern areas of extensive Bassendean Dunes are found in the area of the GBR. South of Gelorup the Bassendean Dunes are reduced to isolated shallow sand ridges in a broader Pinjarra Plain. As a consequence the last extensive area of vegetated Bassendean Dunes on the Plain are found along Riverdale Road, in and north of the Kemerton area, and at Gelorup. The Bassendean Dunes in the GBR are broad low relief dunes often forming shallow sand sheets around extensive areas of wetland. These wetlands are varied and complex as a result of different underlying soils and inundation/waterlogging regimes. Some of the communities on these wetlands are threatened ecological communities.

Previously identified areas (see Map 2)

System6: C60 - Nature Reserves

Contains areas of threatened ecological communities/Threatened and Poorly Reserved Plant

Communities: Franklandia Nature Reserve (Reserve 1167), **Capel Nature Reserve and adjacent Bushland**

- *Undulating Spearwood Dunes*

The most southern of the massive limestone ridges associated with the Spearwood Dunes occurs in Yalgorup National Park, north of the GBR. The Spearwood Dunes of the GBR are characterised by low relief generally forming extensive flats to the west and bounded to the east by dunes of slightly higher relief that merge into the Bassendean Sands. The higher eastern dunes are found from Myalup to Gelorup, south of Gelorup only the low dunes remain. The Spearwood Dunes are vegetated with *Banksia* woodlands and some of the most intact Tuart woodlands on the Plain.

Previously identified areas (see Map 2)

System 6: Part C56 – McLarty Management Priority Area, C54 -Yalgorup National Park, C57 - Myalup Management Priority Area and C61 – Lake Preston (Crampton Nature Reserve); C63 – Myalup Swamp and Mialla Lagoon, C71 - Dalyellup Reserves

System 1: part 1.1.2 - Tuart Forest Reserve (extend beyond GBR)

- *Narrow Coastal Quindalup Dunes*
A narrow band of mostly naturally vegetated Quindalup Dunes extends along the coast. Some of these dunes, such as the Maidens, are conspicuous high points in GBR. The Quindalup Dunes are characterised by coastal heathlands and near coastal woodlands. Large areas of these woodlands are dominated by Tuart and are the most extensive areas of Tuart woodland on Quindalup Dunes remaining on the Plain.
Previously identified areas (see Map 2)
System 6: C66 - Leschenault Inlet, C70 - The Maidens.
 - *A diverse near coastal wetland belt*
This includes a series of permanent water bodies, Lake Preston, the Leschenault Inlet Estuary and Wonnerup Estuary. Interspersed between these are a series of sumpland and dampland areas. These wetlands provide significant habitat for water birds including migratory species. The Wonnerup Wetlands are internationally significant (listed Ramsar Wetlands). Significant areas of these wetlands retain their cover of native vegetation. Some of these wetlands are formed on calcareous silts and a plant community associated with these silts is a threatened ecological community.
Previously identified areas (see Map 2)
System 6: Part C54 - Yalgorup National Park, C66 - Leschenault Inlet, C68 - Anglesea Island/Koombana Bay Inlet, C69 - Big Swamp
System 1: part 1.1.3 – Wonnerup Estuaries (extend beyond GBR)
Contains areas of threatened ecological communities: Hay Park, C54
 - *Regionally significant sequences of ecological communities within and between the major landform elements*
Two types of linked (or potentially linked) sequences of communities can be distinguished.
Vegetated sequences
Four predominantly vegetated sequences are evident, being: Riverdale Road Transect; Kemerton Buffer Link; Ocean to Preston River Park and the Dalyellup/Gelorup/Preston River/Plateau Link. It should be appreciated that these sequences have significant north/south components.
Previously identified areas (see Map 2)
Riverdale Road Transect: C57 - Myalup MP Area;
Kemerton Buffer Link: C63 – Mialla Lagoon
Ocean to Preston River Park: C70 - The Maidens, **Manea Park**
Dalyellup/Gelorup/Preston River/Plateau: C71, C 86 - Dardanup Management Priority Area.
- River Corridors
The Brunswick, Collie, Wellesley, Preston and Capel Rivers (and their tributaries) of the GBR form natural corridors between the coast and the Darling/Blackwood Plateaus, these are heavily cleared but significant natural areas are associated with each of these
Previously identified areas (see Map 2)
System 6: C67 - Brunswick, Collie and Wellesley Rivers

3.2 The Distribution of the Remaining Natural Areas of the Greater Bunbury Region on the Swan Coastal Plain

The natural areas of the Swan Coastal Plain in the GBR have also been significantly reduced and/or altered. Recent mapping of remnant native vegetation on the GBR Swan Coastal Plain (Beeston *et al.* 2001) identifies that clearing in the GBR is comparable with that described for the entire southern Swan Coastal Plain in that:

- 77.1% of the original vegetation has been cleared (after Table 4); and
- clearing has occurred in the same general pattern (see Table 4 and Figure 1 and section 2.2), particularly in relation to the major landform elements (Table 3a&b).

Table 4⁷: Native vegetation on the southern Swan Coastal Plain (SCP) and the Greater Bunbury Region (GBR) within those vegetation complexes found in the GBR. The vegetation complexes are grouped in the major landform elements. Information compiled at DEP from mapping of vegetation complexes after Heddle *et al.* (1980) and CALM (1998), native vegetation after Beeston *et al.* (2001), and existing and proposed ROS after WAPC (2000)⁸.

Major Landform Units/ Vegetation Complex	Remaining area for SCP as % of original area on SCP	Original Area (ha) in GBR	Remaining on SCP in GBR		Remaining on SCP in existing and proposed ROS in GBR	
			Area (ha)	% of original	Area (ha)	% of original
Foothills						
Forrestfield Complex	17.4	2066	475	23.1	144	7.0
Cartis Complex#	NA	1379	246	17.8	0	0.0
Pinjarra Plain						
Abba	6.0	9264	463	5.0	0	0.0
Guildford Complex	5.0	33294	1470	4.4	121	0.4
Swan Complex	15.6	5646	917	16.0	164	2.9
Dardanup Complex	7.9	5201	335	6.4	64	1.2
Serpentine River Complex	10.0	6990	1129	16.1	607	8.7
Bassendean Dunes						
Bassendean Complex-Central And South	27.0	23970	9430	39.3	720	3.0
Combinations of Bassendean Dunes / Pinjarra Plain						
Cannington Complex	10.0	1487	68	4.6	6	0.4
Southern River Complex	19.8	16070	3320	20.7	631	3.9
Spearwood Dunes						
Karrakatta Complex-Central And South	28.7	11686	6091	52.1	1587	13.6
Cottesloe Complex-Central And South	40.8	1334	602	45.1	455	34.1
Ludlow	24.3	1190	465	39.1	160	13.5
Quindalup Dunes						
Quindalup	33.0	6236	2531	40.6	1102	17.7
Marine (Estuarine and Lagoonal) Deposits						
Vasse Complex	29.4	3730	857	23.0	454	12.2
Yoongarillup Complex	42.8	13448	4437	33.0	1084	8.1

#The Cartis Complex is mapped in Heddle *et al.* (1980) and CALM (1998). These figures are after CALM (1998) which appears to be a subset of Heddle *et al.* and are only given for the GBR.

In recognition of this high level of clearing on the Plain in the GBR there is a need to preferentially locate developments in cleared areas on the Swan Coastal Plain.

While the general pattern of clearing across the southern Swan Coastal Plain is similar, the clearing patterns influence the area of native vegetation remaining in particular local government areas. Prior to urbanisation, coastal municipalities, will have larger areas of native vegetation remaining as they are predominantly located on the aeolian sands and Tamala Limestones. Municipalities primarily located on the eastern side of the Plain will have little remnant vegetation remaining.

The remaining natural areas, both water bodies and native vegetation, have also been variously altered by a series of disturbance events associated with adjacent land uses. That is the remnant native vegetation mapping includes significant areas that have been altered to such an extent that they can no longer be termed bushland, often being trees over non-native species.

⁷ See footnote on Table 3.

⁸ Existing and proposed ROS is used within the GBR as this is considered to better indicates the area of native vegetation with some level of protection.

4 IDENTIFICATION OF REGIONALLY SIGNIFICANT NATURAL AREAS IN THE GREATER BUNBURY REGION OF THE SWAN COASTAL PLAIN

4.1 Introduction

A series of regionally significant natural areas have been previously identified in the GBR (see Section 3.1). However, as the EPA needs to consider the regional significance of natural areas affected by proposed new zones and reserves as well as the adequacy of the proposed Regional Open Space reserves in the GBRS, a Strategy has been developed. This Strategy aims to establish a process to be used to identify particular areas that are suitable to contribute to a comprehensive, adequate and representative (CAR) system of reserved and protected areas in the Greater Bunbury Region portion of the southern Swan Coastal Plain. This Strategy measures an individual area's natural values (according to Table 1 and 2) against the selection criteria for the identification of regionally significant natural areas developed for System 6 and Part System 1 Update and the Bushplan Project (Table 5) to determine regional significance.

Table 5: Selection criteria for the identification of regionally significant natural areas on the southern Swan Coastal Plain (Government of WA 2000a and b).

<p>REPRESENTATION OF ECOLOGICAL COMMUNITIES A number of areas selected to represent the range of ecological communities and the places in which these communities merge</p> <p>DIVERSITY Areas with a high diversity of flora and/or fauna species or communities in close association</p> <p>RARITY Areas containing rare or threatened communities or species, or species of restricted distribution</p> <p>MAINTAINING ECOLOGICAL PROCESSES OR NATURAL SYSTEMS Maintenance of ecological processes or natural systems at a regional or national scale</p> <p>SCIENTIFIC OR EVOLUTIONARY IMPORTANCE Areas containing evidence of evolutionary processes either as fossilised material or as relict species and areas containing unusual or important geomorphological or geological sites; Areas of recognised scientific and educational interest as reference sites or as examples of the important environmental processes at work</p> <p>GENERAL CRITERIA FOR PROTECTION OF WETLAND, STREAMLINE, AND ESTUARINE FRINGING VEGETATION AND COASTAL VEGETATION Conservation category wetland areas including fringing vegetation and associated upland vegetation; Coastal vegetation within the accepted coastal management zone</p>

These six criteria, updated to current policy standards and adapted to a largely rural environment, are proposed for use in the GBR. The criteria, and their application are described in more detail in Appendix 3.

The criteria relate to ecological communities⁹ as the basis for addressing regional representation, as this is the level:

- at which the most comprehensive regional plot and map based information on the biological diversity of the Swan Coastal Plain is available (see Table 1); and
- on which both the National policies and *Urban Bushland Strategy* focus.

For the Greater Bunbury Region ecological communities are determined at the regional level using the most comprehensive Swan Coastal Plain regional datasets (Table 1) and, as necessary reference to specific area information (Table 2). Within the terms of this Strategy vegetation complexes, floristic community types and, those ecological communities listed as threatened, are considered to meet the definition of ecological communities.

⁹ Ecological communities are 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blyth 1997).

4.2 Application of the Criteria

To determine if a particular natural area is regionally significant the area's natural values (according to Table 1 and 2) are measured against the selection criteria. It is necessary to stage the application of the criteria as one aspect of 'Representation of Ecological Communities' requires consideration of all remaining areas of the ecological communities, here principally expressed as native vegetation. Other aspects of 'Representation of Ecological Communities' criterion and the remaining five criteria are then addressed.

4.2.1 Application of Representation of Ecological Communities Criterion in relation to the remaining areas of native vegetation

To encompass current recognised levels of remnant native vegetation retention this Strategy uses a standard level of native vegetation retention of at least 30% of the pre-clearing extent of the ecological communities on the Swan Coastal Plain. These levels have been most recently recognised in the *National Objectives and Targets for Biodiversity Conservation 2001-2005* (Commonwealth of Australia 2001) which recognised that the retention of 30%, or more, of the pre-clearing extent of each ecological community was necessary if Australia's biological diversity was to be protected. This level of recognition is in keeping with the targets set in the EPA's Position Statement on the 'Environmental protection of native vegetation in Western Australia: clearing of native vegetation, with particular reference to the agricultural area' (EPA 2000).¹⁰

For the Greater Bunbury Region (except for lands identified in the 'GBR Constrained Area' in Map 2 and described below) this means the objective is to seek to:

- retain at least 30% of the pre-clearing extent of the ecological communities in the GBR, where >30% of an ecological community remains on the Swan Coastal Plain
- preferentially locate developments in cleared areas, where 30% or <30% of the pre-clearing extent of the ecological community remains on the Swan Coastal Plain.

Within the terms of this criterion vegetation complexes, which are mapped for the entire extent of the southern Swan Coastal Plain, are used as the base mapping of ecological communities. It is evident from Table 4 that much of the Swan Coastal Plain is altered to such an extent that 12 of the 15 vegetation complexes have 30% or less of their area remaining on the Plain. As a consequence all remaining vegetation in these complexes is in need of retention and some level of protection for the targets to be met. In recognition of this situation the following specific policy statement is applied.

The general protection of remnant native vegetation on the Swan Coastal Plain in the Greater Bunbury Region be achieved through the preferential location of developments in cleared areas.

These levels are modified on the 'GBR Constrained Area' of the Swan Coastal Plain (Table 6). The 'GBR Constrained Area' includes the consolidated area urban, urban deferred and industrial zoned identified on Map 2¹¹. This area has been defined in conjunction with the Department of Planning and Infrastructure in Bunbury. The modified objective on the 'Constrained Area' being to seek to:

- retain at least 10% of the pre-clearing extent of the ecological community in the 'Constrained Area' of the GBR where >10% of the ecological community remains on the Swan Coastal Plain (the natural region) OR

¹⁰ It is important to note that the 'at least 10%' target adopted in the *Urban Bushland Strategy* (based on the IUCN 1991 guidelines) was only ever intended to apply to constrained urban environments. It is now well recognised that the 'at least 10%' target is inadequate to provide effective conservation of biodiversity. In 1997, in the preliminary stages of preparing the Draft GBRS the DEP advised MfP, that it was becoming increasingly recognised that '20% of the land surface should be retained under natural vegetation cover for biodiversity and soil conservation.'

¹¹ The Perth Metropolitan Region section of the Swan Coastal Plain has similarly been recognised as a 'Constrained Area' in Bush Forever.

- retain all remaining areas of each ecological community in the 'Constrained Area' of the GBR where 10% or <10% of this ecological community remains on the Swan Coastal Plain.

However this does not limit application of all the criteria, especially the 'Rarity' and 'Maintaining Ecological Processes or Natural Systems' criteria. That is an area in the 'Constrained Area' can be considered regionally significant if selection of the natural area is:

- from an ecological community below 10% pre-clearing extent;
- a threatened ecological community; and/or
- part of a regionally significant sequence of ecological communities.

Table 6¹²: Native vegetation remaining on the southern Swan Coastal Plain (SCP) and the Greater Bunbury Region (GBR) Constrained Area within those vegetation complexes occurring in the GBR. The vegetation complexes are grouped in the major landform elements. All vegetation in those vegetation complexes in bold italics should be conserved under this Strategy.

Major Landform Units/ Vegetation Complex	Remaining area for SCP as % of original area on SCP	Original Area (ha) on SCP in GBR Constrained Area	Remaining on SCP in GBR Constrained Area		Remaining on SCP in existing and proposed ROS in GBR Constrained Area	
			Area (ha)	% of original	Area (ha)	% of original
Pinjarra Plain						
Guildford Complex	5.0	572	75	13.2	2	0.4
Swan Complex	15.6	917	196	21.4	116	12.6
Bassendean Dunes						
Bassendean Complex-Central And South	27.0	928	187	20.2	22	2.3
Combinations of Bassendean Dunes / Pinjarra Plain						
Southern River Complex	19.8	3862	1247	32.3	292	7.6
Spearwood Dunes						
Karakatta Complex-Central And South	28.7	3040	1617	53.2	336	11.0
Quindalup Dunes						
Quindalup	33.0	993	354	35.7	187	18.9
Marine (Estuarine and Lagoonal) Deposits						
Vasse Complex	29.4	814	56	6.9	32	3.9
Yongarillup Complex	42.8	2545	725	28.5	151	5.9

4.2.2 Application of all of the Criteria

The remaining criteria are then addressed in order to :

- **identify the particular area/s** of those ecological communities in the GBR
 - where >30% of an ecological community remains on the Swan Coastal Plain (that is, the actual areas, that will be identified, to collectively constitute at least 30% of the extent each of these ecological communities in the GBR) or
 - in the 'Constrained Area' where >10% of an ecological community remains on the Swan Coastal Plain (that is, the actual areas, that will be identified, to collectively constitute at least 10% of the extent each of these ecological communities in the 'Constrained Area' of the GBR); and
- **recommend** appropriate levels of protection for regionally significant areas identified by application of the criteria.

In applying the other aspects of 'Representation of Ecological Communities' criterion and the remaining five criteria a series of individual area attributes that apply to several criteria need to be highlighted. These are briefly outlined below. The criterion to which they apply are given in brackets after each attribute.

¹² See footnotes on Table 3.

Size and Shape (Representation of Ecological Communities, Maintaining Ecological Processes or Natural Systems)

Size is of key importance in determining the viability of natural areas for long term retention. In general, the capacity of an area to support the full species range of a given community will diminish with decreasing size. Shape determines the ratio of perimeter to area, the ratio being greater in more elongate patches. Elongate remnants may have value as connecting links, but the more extended they are the greater will be their susceptibility to weed invasion and disturbance.

Area selection is guided by the following general principles:

- a large remnant is preferable to a small one;
- a compact shape is preferable to an irregular or an elongate shape;
- replicates across the range of a community are preferable to a single area; and
- areas close to others or linked by natural areas are preferable to isolated ones.

The lower size limit of 20ha given in the *Urban Bushland Strategy* is accepted as a preferred lowest area limit, but smaller areas are significant where a community is seriously threatened or poorly reserved (less than 10% protected). Account is also taken of evidence from recent observations through comprehensive regional survey programs, which indicates that very small areas (to as small as 1ha) on certain soil types are resistant to weed invasion. Small areas may also be significant for fauna that have large home ranges extending beyond single areas. These areas also facilitate movement between patches, especially dispersal of offspring to new territories.

Vegetation Condition (Representation of Ecological Communities, Maintaining Ecological Processes or Natural Systems)

Remnants in largely undisturbed condition which retain the highest values are preferred; remnants with basic vegetation structure and floristics are intact (bushland) are the next best alternative. However, in cases where no other choices are available (generally where <30% remains), remnants in lesser condition are included. Areas containing scattered native species, especially a tree canopy, can retain vital roles as fauna habitat and ecological linkage for some species.

Uplands and Wetlands (Representation of Ecological Communities, Diversity, Maintaining Ecological Processes or Natural Systems)

The patterning of ecological communities on the Swan Coastal Plain is driven by the presence of wetlands, where the soils that are seasonally or intermittently waterlogged and/or inundated, and uplands, where the soils are not subject to this process. Natural areas containing both ecological community groups (uplands and wetlands) support the highest biodiversity and are a focus for protection.

Ecological Communities below 10 percent pre-clearing extent and threatened ecological communities (Representation of Ecological Communities, Rarity)

For those ecological communities where less than 10% remained, all areas are regionally significant, irrespective of the level of constraint on the land. Most communities in this category are communities typical of the eastern side of the Coastal Plain (principally the Pinjarra Plain), where the communities are highly fragmented and the remnants too numerous to be individually assessed at the strategic level. All of these remnants are regionally significant under the Rarity criterion, most containing threatened ecological communities. In keeping with *Bush Forever* these areas are not the subject of individual recommendations and are covered by the following specific policy statement:

There is a presumption that all areas of remnant native vegetation containing threatened ecological communities or vegetation of the major landform elements of which less than 10% currently remains on the Swan Coastal Plain will be retained and conserved in the Greater Bunbury Region.

In these areas there is also a need to consider restoration of ecological function. This can be approached through the identification of a series of regionally significant linkage opportunities.

Within these 'linkage areas' the restoration of ecological communities and landscape rehabilitation between and around the small remaining remnants on the eastern side of the Plain will be a priority. This issue can be covered by the following specific policy statement.

That there be proactive planning for the restoration of ecological communities and landscape rehabilitation between and around selected sequences of the small remaining remnants on the eastern side of the Swan Coastal Plain in the Greater Bunbury Region.

Relationship to other areas (Maintaining Ecological Processes or Natural Systems)

The importance of looking at the region's natural areas as an integrated ecological system is recognised, and the maintenance or establishment of linkage corridors is given a high priority. Areas adjacent to, or contiguous with, different communities may provide a necessary combination of habitats for particular fauna species.

Several other attributes are also taken into account. These are not related to the criteria for the identification of regionally significant natural areas.

Opportunities Outside the Greater Bunbury Region

This Strategy focuses on the Greater Bunbury Region portion of the Swan Coastal Plain; however, this is a planning boundary, representing only a portion of the Swan Coastal Plain. The possibilities for protecting additional areas, or to identify substitute areas outside the GBR to secure the desired minimum representation of ecological communities, is taken into consideration in the selection of areas. However, since the characteristics of a particular community will vary along its extent and with specific soil and moisture characteristics, replacement is not simply a matter of area-for-area exchange.

Ownership or reservation status

The objective of this Strategy is to identify areas of regional significance and to provide for their protection. Although it is important to recognise and take into account the values of natural areas in the planning process, the selection process should also recognise existing land use proposals. Hence, for example, publicly owned areas are preferred to those in private ownership; and, if privately owned, land zoned Rural is preferred to that zoned Urban, where opportunities to protect are more restricted. Where more than 30% of an ecological community is publicly owned or reserved and provides effective representation of the variation in the ecological community, the ecological community identified is provisionally considered to be adequately protected. The selection process then concentrates on landform units for which less than 30% of the ecological community has some degree of protection.

5 RESERVATION AND PROTECTION

This Strategy aims, within the limits of the natural areas available, to establish the process to be used to identify a comprehensive, adequate and representative (CAR) system of reserved and protected areas in the Greater Bunbury Region portion of the Swan Coastal Plain.

In terms of reserved areas this Strategy adopts the primary objective of the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996) which is to 'establish and manage a comprehensive, adequate and representative system of protected areas covering Australia's biological diversity'.

Comprehensiveness, adequacy and representativeness are terms defined in the *National Strategy* as follows:

- comprehensiveness — the degree to which the full range of ecological communities and their biological diversity are incorporated within reserves
- adequacy — the ability of the reserve to maintain the ecological viability and integrity of populations, species, and communities. (The interactions between reserves and surrounding areas should be taken into account in determining the reserve's ability to meet ecological viability and integrity criteria. Complementary management of the adjacent areas can play a significant role. In some instances, however, the ecological viability of the protected area itself will be paramount.)
- representativeness — the extent to which areas selected for inclusion in the national reserves system are capable of reflecting the known biological diversity and ecological patterns and processes of the ecological community or ecosystem concerned.'

However it is accepted that conservation reservation alone will not adequately protect regionally significant areas. To achieve this, there is a need to combine a series of protection measures including conservation on private lands. Conservation reservation is considered to provide the highest level of protection and it is appropriate that this is applied to areas with the highest natural value. In general, areas from the following categories, will be priorities for reservation:

- 15%¹³ of the pre-clearing extent of the ecological community on the Swan Coastal Plain;
- larger examples of threatened ecological communities or vegetation of the major land form element/s of which less than 10% currently remains;
- larger intact examples of contiguous areas of two or more ecological communities; and/or
- larger representative intact areas of an ecological community.

Inadequate funding is a major impediment in developing a CAR Reserves system. There is no equivalent of the Metropolitan Region Improvement Fund in the Bunbury Region (or elsewhere beyond the PMR). This is a broader issue for government consideration. An adequate funding mechanism, to both acquire and manage these lands, is a priority.

Mechanisms for off-reserve conservation could include conservation covenants, guided planning schemes, revolving funds and bushland/wetland banking and bushland/wetland mitigation. These protection measures need support through the development of new and improved tools integrated into an effective regional planning scheme. However, it must be understood that these measures also require adequate funding to support them so the outcomes are equitable.

¹³ In keeping with percentages established in the Regional Forest Agreement.

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WRC - Water and Rivers Commission

APPENDIX 1: Glossary – Definitions, Acronyms and frequently used Abbreviations

adequacy the ability of the reserve to maintain the ecological viability and integrity of populations, species, and communities. (The interactions between reserves and surrounding areas should be taken into account in determining the reserve’s ability to meet ecological viability and integrity criteria. Complementary management of the adjacent areas can play a significant role. In some instances, however, the ecological viability of the protected area itself will be paramount.)

biological diversity/biodiversity means genetic diversity, species diversity and ecosystem diversity.

Bioregion means Interim Biogeographic Region as defined by Thackway and Creswell (1995).

bushland is land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation, and provides the necessary habitat for native fauna.

comprehensiveness the degree to which the full range of ecological communities and their biological diversity are incorporated within reserves

Constrained Area an area where there is an expectation that development will be able to proceed, this may include urban, urban deferred or industrial zoned land or land with existing development approvals.

Declared Rare Flora

Extant Taxa: taxa which have been adequately searched for and are determined to be either rare, in danger of extinction, or otherwise in need of special protection in the wild, and have been declared under Section 23F of the *Wildlife Conservation Act* 1950 to be ‘rare flora’.

Presumed Extinct Taxa: taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, of which all known wild populations have been destroyed more recently, and which have been declared under Section 23F of the *Wildlife Conservation Act* 1950 to be ‘rare flora’.

eastern side of the Swan Coastal Plain: the Foothills and Pinjarra Plain major landform elements. For a more comprehensive description see Government of WA (2000b).

ecological communities: ‘naturally occurring biological assemblages that occur in a particular type of habitat’ (English and Blyth 1997). The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified. (Within the terms of this Strategy, vegetation complexes (Hedde *et al.* 1980), floristic community types (Gibson *et al.* 1994, DEP 1996) and, those ecological communities listed as threatened as defined in English and Blyth (1997), are considered to meet this definition for the Greater Bunbury Region.)

floristic community types are distinctive floristic assemblages identified on the southern Swan Coastal Plain in Gibson *et al.* (1994) and DEP (1996). The presence or absence of individual taxa in standard areas (plots, sites, quadrats) is used to define floristic groupings based on shared species.

Greater Bunbury Region (GBR) the area covered by the Bunbury, Capel, Harvey and Dardanup Local Government Authorities (LGAs).

major landform element: principally the Foothills, Pinjarra Plain, Bassendean Dunes, Spearwood Dunes, Quindalup Dunes and Marine (Estuarine and Lagoonal) Deposits (and combinations of these).

These are used to link the various regional datasets. For a more comprehensive description see Government of WA (2000b).

Metropolitan Region Scheme (MRS) means the town planning scheme for the Perth Metropolitan Region.

native vegetation is a category of vegetation adopted by *Bushplan* and Beeston *et al.* (2001) for mapping purposes, based on AGWEST Spatial Resource Information Unit classes:

remnant vegetation most closely resembles the natural state of vegetation for a given area; most similar to identifiably remnant areas of similar vegetation types; understorey intact; of the greatest structural diversity/complexity in comparison to disturbed vegetation in the region; minimal disturbance by agents of human activity.

modified vegetation degraded understorey; obvious human disturbance; saline incursions; high perimeter to area ratio; narrow corridors of vegetation along roads, railway lines.

natural area naturally vegetated area or non-vegetated areas such as water bodies (generally rivers, lakes and estuaries), bare ground (generally sand or mud) and rock outcrops.

natural region Interim Biogeographic Region as defined by Thackway and Creswell (1995).

Perth Metropolitan Region is the area covered by the *Perth Metropolitan Region Town Planning Scheme Act 1959*, as amended.

preservation means maintaining bushland in its existing state and preventing deterioration.

Priority Flora are plant taxa, lists of which are maintained by CALM, that are either under consideration as Threatened Flora but are in need of further survey to adequately determine their status, or are adequately known but require monitoring to ensure that their security does not decline.

protected refers to bushland which is under a management regime that provides for its continuing protection.

protection is all of the processes of ensuring the continued existence and viability of bushland, and may include preservation, maintenance, reinstatement, and restoration.

regeneration means the natural or assisted recovery of the natural integrity or condition of bushland.

regionally significant natural area A component of remnant native vegetation or water body that collectively aims to form a comprehensive, adequate and representative system of conservation areas. In order to establish whether an areas fall into this category they need to be either part of the existing or proposed conservation system or to meet, in part or whole, a range of criteria which are outlined in this Strategy.

representativeness the extent to which areas selected for inclusion in the national reserves system are capable of reflecting the known biological diversity and ecological patterns and processes of the ecological community or ecosystem concerned.'

reservation (reserve and reserved) refers to reservation under the *Land Act 1933* (LA).

restoration means returning bushland to a known past state, or to approximate the original natural condition, by repairing degradation, removing exotic species, reinstatement, or allowing recovery.

southern Swan Coastal Plain the System 6/System 1 section of the Swan Coastal Plain between the Moore River and Dunsborough. This is not the entire Swan Coastal Plain Interim Biogeographic Region as identified in Thackway and Cresswell (1995).

Swan Coastal Plain Swan Coastal Plain Interim Biogeographic Region as defined by Thackway and Cresswell (1995).

System 1 areas those specific localities (on the Swan Coastal Plain) as listed in The South West - System 1 in Conservation Reserves for Western Australia. Systems 1, 2, 3, 5 as recommended by the Environmental Protection Authority (Department of Conservation and Environment, 1976).

System 6 areas those specific localities as listed in The Darling System - System 6 Part II Recommendations for Specific Localities Report 13 Conservation Reserves for Western Australia as recommended by the Environmental Protection Authority (Department of Conservation and Environment, 1983).

Threatened Ecological Communities are naturally occurring assemblages of plants and animals listed by CALM as being threatened with extinction by human activity, or in danger of being destroyed or significantly modified by development and other pressures from people (English and Blyth 1997, 1999). They are ecological communities that have been assessed through a procedure (coordinated by CALM) and assigned to one of the following categories related to the status of the threat to the community: "Presumed Totally Destroyed", "Critically Endangered", "Endangered" or "Vulnerable" (English and Blyth, 1997). One of the criteria used to determine the categories is an estimate of the geographic range and/or the total area occupied and/or the number of discrete occurrences reduced since European settlement, where $\leq 10\%$ is Critically Endangered and $\leq 30\%$ is Endangered. On the Swan Coastal Plain a number of floristic studies and fresh water organism studies have delineated ecological communities in a form adequate for assessment (Government of Western Australia 2000b). So far 18 of the floristic community types identified by Gibson *et al.* (1994) have been assessed and determined to be threatened ecological communities.

Threatened Fauna are animal species likely to become extinct or which are rare, and declared so, under Section 14(2)(ba) of the *Wildlife Conservation Act 1950*.

Threatened Flora are plant species which are declared rare under Section 23F of the *Wildlife Conservation Act 1950* as flora likely to become extinct or which are rare or otherwise in need of special protection. To be declared rare, plant species must meet well defined criteria, which include the thoroughness of searches for the species, its rarity and the danger of extinction (see Declared Rare Flora).

Threatened or Poorly Reserved Plant Communities: plant communities that have been recognised and mapped by the Environmental Protection Authority (1994). This series of bushland areas on the Swan Coastal Plain was considered to be in need of interim protection under the System 6 and Part System 1 Update Program. The majority of these areas are on the eastern side of the Swan Coastal Plain, with several from the west of the Plain. Studies by Keighery and Trudgen (1992) and Gibson *et al.*, (1994) were used to identify these areas. Bush Forever Sites update and supersede the Threatened and Poorly Reserve Plant Community Sites within the study area.

vegetation complexes As defined by Heddle *et al.*, (1980) and CALM (1998, unpublished) in relation to the landform-soil units determined by Churchward and McArthur (1980). The delineation of vegetation complexes is based on the concept of a series of vegetation associations forming regularly repeating complexes associated with a particular soil and landform unit.

vegetation condition is a rating given to vegetation to categorise disturbance related to human activities. This rating refers to the degree of change in the structure, density and species present in the

bushland in relation to undisturbed bushland of the same type. A series of scales of disturbance has been used by different people.

wetlands: ‘areas of seasonally, intermittently or permanently waterlogged soils or inundated land whether natural or otherwise, fresh or saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries’ (Wetland Advisory Committee 1977). This definition is directly comparable with the definition of wetlands used in the State Wetland Conservation Policy (Government of Western Australia 1997) i.e. ‘areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed more than six metres’. The former definition is preferred in this Strategy and in *Bush Forever* as it allows for the boundaries of the wetland to be readily determined on the basis of the vegetation.

zones refers to the classification of land in planning schemes for use and development, excluding land in reserves.

AGWEST	Agriculture Western Australia
DCE	Department of Conservation and Environment
DEP	Department of Environmental Protection
DPI	Department for Planning and Infrastructure
EPA	Environmental Protection Authority
GBR	Greater Bunbury Region
GBRS	Greater Bunbury Region Scheme
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation for Australia
LGA	Local Government Authority
MfP	Ministry for Planning
MRIF	Metropolitan Region Improvement Fund
MRS	Metropolitan Region Scheme
PMR	Perth Metropolitan Region
SCP	Swan Coastal Plain
WAPC	Western Australian Planning Commission
WRC	Water and Rivers Commission

APPENDIX 2: Vegetation Types

The first comprehensive descriptions of the Swan Coastal Plain vegetation within the context of the vegetation south west of Western Australia were made by Diels (1906). Maps of vegetation on the Swan Coastal Plain began with the work of Speck in his Masters of Science (1952) and Doctor of Philosophy (1958) theses. Speck's 1952 map is the basis of the map of vegetation of the Perth area in Seddon (1972).

In the 1960's and 70's two other studies, Beard (1979a, b & c) and Smith (1973, 1974), built on the work of Speck to map the vegetation types of the Swan Coastal Plain. Together the maps of Beard and Smith map the extent of the vegetation types on the Swan Coastal Plain at a 1 : 250 000 scale, Beard mapping the Pinjarra, Perth and Hill River and Moora Sheets and Smith the Collie and Augusta and Margaret River Sheets. While the units mapped are comparable it should be noted that Beard mapped the original extent of the vegetation types while Smith mapped the current extent.

Later Beard (1981) produced a map at a 1 : 1 000 000 scale for the entire Plain.

Beard's 1 : 250 000 maps were digitised in the late 1990's and early 2000's (Hopkins *et al.* 1996, 2001). Where mapping by Beard was not available at this scale (area of Smith's studies) the mapping by Smith, the Forest Department and aerial photographs were used to develop new linework (Hopkins pers. comm.).

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APPENDIX 3: Details of the Selection Criteria

The selection criteria for the Bushplan Project were developed with input from a workshop (established for the System 6 and Part System 1 Update Program) attended by conservation scientists, consultants, representatives of a range of key government agencies and the community. These draft recommendations were reviewed through a broadly based Technical Working Group and the Steering Committee established for the System 6 and Part System 1 Update Program (organised by DEP), and the Urban Bushland Advisory Group (advisory group to the Western Australian Planning Commission). These criteria, updated to reflect current policy standards and adapted to the largely rural environment of the GBR are to be used by the EPA to identify regionally significant natural areas in their consideration of the GBRS portion of the Southern Swan Coastal Plain. Each of the criteria is presented and discussed below.

Representation of Ecological Communities

Representation of ecological communities is achieved using a combination of regional information on landform and soils, vegetation type, vegetation complexes, floristic community types, wetlands and significant species and, to a lesser extent, other information on the specific area's natural values. This criterion is aimed at maximising the comprehensiveness and representativeness of the areas identified for conservation.

Comprehensive representation of ecological communities is achieved primarily by attempting to select replicate areas that represent each of the floristic communities, in each of the vegetation complexes in which they occur in the GBRS; and to cover the geographic extent (relation to both landform and range) of each community within the GBRS.

REPRESENTATION OF ECOLOGICAL COMMUNITIES

A number of areas selected to represent the range of ecological communities and the places in which these communities merge.

Scope

Regional representation will be primarily based upon the target of achieving:

- comprehensive and adequate representation of each floristic community type within each vegetation complex (in uplands and vegetated wetlands).
- comprehensive and adequate representation of each natural wetland group and wetland types within each group.

Inclusion guidelines

- Areas which are good examples of each floristic community type, selected to be representative of the vegetation of a geomorphic unit.
- Areas contributing to at least 30 percent of each vegetation complex in at least ten separate areas. In the defined constrained area this may be modified to at least 10%.
- Best available examples of each natural wetland group and wetland types within each group.
- Best available examples of places where ecological communities merge.¹⁴
- Areas of native vegetation which are good examples its type with particular reference to fauna habitat¹⁴.
- Areas identified as being of national or international significance through treaty/convention/policy.

Exclusion guidelines

- Vegetation, which does not satisfy the definition of bushland, unless it is the good example of its type with particular reference to fauna habitat or it, constitutes one of the few examples of a particular ecological community¹⁴.
- Areas which are not the best available examples of particular ecological communities (floristic community type/vegetation complexes¹⁴) because there are more appropriate (bigger, better condition, richer/more diverse) areas elsewhere.

¹⁴ These Inclusion/Exclusion guidelines differ from those in EPA (2003) to improve their clarity.

Within an intensively settled and developed region such as the Swan Coastal Plain, clearing is extensive and the remaining bushland areas are generally fragmented. The overall extent of clearing and general pattern of clearing in the GBR is typical of the entire Plain. Several vegetation complexes are cleared to well beyond 90 per cent, such that the target of retaining greater than 30% of the natural vegetation in each complex cannot be uniformly met. However, within the area of the GBR some complexes retain significant areas of native vegetation, being more extensively cleared elsewhere. For example the Karrakatta Central South complex, retains more than 52% bushland in the GBR at present, but only 30% remains overall on the southern Swan Coastal Plain. In addition substantial areas of this vegetation complex in the PMR are subject to existing development proposals and Urban/Industrial Planning Zone, such that the target of protecting at least 10% will not be met in the PMR. As a consequence only 22% of this vegetation complex is potentially able to be protected. This is not typical of the highly cleared complexes, which are usually even more extensively cleared in the rural areas of the Plain than in the PMR.

Many areas will be selected primarily because they provide a good representation of one or more of the ecological communities on the Coastal Plain. Achieving a comprehensive, adequate and representative system of protected areas is a primary objective of conservation policy. As such, there is an emphasis on selecting areas that together provide a complete (comprehensive) representation of the ecological diversity found on the coastal plain.

Diversity

Diversity is an important supporting criterion, usually used in conjunction with representativeness. Within the primary objective of maximising representation, selections are made to choose natural areas supporting a diversity of landform units and/or plant communities. Both structural and floristic diversity contribute to plant community diversity.

The diversity of species is assessed for both general diversity and diverse types of a particular plant community or combination of plant communities. Diversity within species is also taken into account to encompass known aspects of genetic diversity.

DIVERSITY

Areas with a high diversity of landforms, flora and/or fauna species or communities in close association

Scope

The conservation of important areas by virtue of their richness, diversity or complexity for their physical or biological attributes at the community, species or genetic level. This will be primarily based on areas supporting:

- a wide variety of landform units.
- a wide variety of flora and/or fauna species.
- unusual concentrations of subspecies or varieties occurring together.
- a wide representation of floristic community types in close proximity.
- species-rich examples of communities of their type.
- a wide variety of plant associations, assemblages or communities.

This criterion will commonly support other criteria for selection of representative areas.

Inclusion guidelines

- Areas with high flora diversity at the community, species or genetic level.
- Areas with a high diversity of plant associations, assemblages or communities relative to the area.
- Areas with a high diversity of faunal assemblages.

Exclusion guidelines

- significantly altered or man-made landform units
- Floristic community types which are replicated in many areas.
- Areas with low to moderate diversity at the community, species or generic level.

Rarity

Rarity is considered from a community and individual species perspective. Selection of Threatened Ecological Communities (after English and Blyth 1997) is a priority, related to this criterion and the representativeness criterion. The *National Objectives and Targets for Biodiversity Conservation 2001-2005* (Commonwealth of Australia 2001) recognise that ecological communities reduced to 10% or less of their original extent should be considered rare.

Protecting rare or restricted taxa of flora and fauna (may be species, subspecies or varieties) is achieved through the preferential selection of representative examples of communities that are known to support populations of these species.

RARITY

Areas containing rare or threatened communities or species, or species of restricted distribution

Scope

This criterion applies to aspects of the environment, which are rare or relatively rare, and can encompass any environmental, biological or ecological feature or phenomenon which can be regarded as outstanding because it is one of the few of its type.

Inclusion guidelines

- Threatened ecological communities.
- Habitats of rare, uncommon or restricted flora and/or fauna species and/or species outside of or at the limit of their range.
- Areas supporting rare, uncommon or restricted communities and/or communities outside of or at the limit of their normal range.

Exclusion guidelines

- Habitats of species or communities whose significance (as described above) is not established.
- Areas which, if supporting outlying species or communities, are replicated by better examples elsewhere.

Maintaining Ecological Processes or Natural Systems

The selection of areas for their role in 'maintaining ecological processes or natural systems' relates to the 'adequacy' objective of the National Strategy (Commonwealth of Australia 1996). This is the most difficult of the national criteria to achieve fully on the Swan Coastal Plain, given the extent of clearing and the fragmented nature of much of the remaining native vegetation.

The protection of remaining large areas of native vegetation, particularly those providing representation of two or more vegetation complexes, a range of floristic community types or contiguous upland and wetland areas, is an important component of this selection criterion. These larger areas represent core regional areas with the best opportunity for maintenance of a more complete range of ecological function. For the same reasons, the identification, protection and enhancement of remaining and/or potential linkages or corridors of bushland across the Plain is considered an important component of providing for the on-going viability (adequacy) of the protected areas.

A series of wetlands on the Swan Coastal Plain are of international importance for the protection of migratory waterbirds, serving to maintain ecological systems that extend beyond Australia.

It is notable that small bushland areas on the eastern side of the Plain have demonstrated an ability to maintain good condition after many years of isolation in an agricultural environment, provided they have not been subject to gross disturbance. For example, areas as small as one hectare (Bush Forever Site 78) and less than 200 metres wide (Bush Forever Site 360) have been recognised as regionally

significant in Bush Forever (Government of WA 2000a&b). Similarly reduced areas have been recognised in the GBRS at Waterloo and adjacent to the GBRS along Wonnerup Road. However here and elsewhere on the Plain there is a preference for larger areas (greater than 20 hectares) as these generally able to maintain good or better condition over time.

MAINTAINING ECOLOGICAL PROCESSES OR NATURAL SYSTEMS

Maintenance of ecological processes or natural systems at a regional or national scale

Scope

This criterion applies to areas which are important in the maintenance of existing processes or natural systems.

This criterion would normally be used in conjunction with other criteria for the selection of representative areas.

Inclusion guidelines

- Large areas in natural condition with natural processes intact or largely so.
- Fauna habitats providing specific requirements for feeding/breeding/nursery functions.
- Substantive wildlife corridors connecting bushland areas.
- Habitats for significant populations of migratory birds.

Exclusion guidelines

- Areas which are replicated by other areas supporting significant populations or in better condition.
- Areas not recognised as being of national or international significance for migratory birds.

Scientific or Evolutionary Importance

This criterion is intended to address areas supporting restricted specialist communities, for example, the Lake Clifton stromatalites, areas of scientific significance, such as study areas for regional studies and areas of evolutionary significance.

SCIENTIFIC OR EVOLUTIONARY IMPORTANCE

Areas containing evidence of evolutionary processes either as fossilised material or as relict species and areas containing unusual or important geomorphological or geological sites; Areas of recognised scientific and educational interest as reference sites or as examples of the important environmental processes at work

Scope

This criterion applies generally to areas which contain evidence of past ecological or biological processes, and unusual or important geomorphological or geological sites and to areas which have recognised value as research sites, type localities or to sites having reference or benchmark value.

This criterion will usually support other criteria for selection of representative areas.

Inclusion guidelines

- Areas with unusual or important geomorphological or geological sites
- Areas with remains of flora and fauna now extinct (fossil sites).
- Areas with primitive or relict flora or fauna surviving from earlier times.
- Areas with fossil or other records of identifiable past climates or environments.
- Long-term scientific/educational monitoring sites or study areas.

Exclusion guidelines

- Areas in which the evidence of past processes is not clearly established.
- Areas which are replicated by places with clearer evidence of the above or in better condition.
- Areas not identified as important geomorphological sites.
- Areas not identified as important geological sites.

General Criteria for Protection of Wetland, Streamline and Estuarine Fringing Vegetation and Coastal Vegetation

Wetlands are recognised as an important feature of the Swan Coastal Plain where they are a focus of biological diversity and a key component for the maintenance of ecological functions associated with the hydrological cycle.

Conservation category wetlands (Hill *et al.* 1996a & b and Semeniuk 1998) have been identified as making a significant contribution to the protection of the diversity, representation and function of important examples of the remaining wetlands on the Swan Coastal Plain.

Streamline/riverine/estuarine fringing vegetation and coastal vegetation are also widely recognised as important, not only for conservation of biological diversity and the opportunities for linkage that they present, but also for maintenance of the stability of these environments and their protection as key areas of public open space and landscape diversity.

GENERAL CRITERIA FOR PROTECTION OF WETLAND, STREAMLINE, AND ESTUARINE FRINGING VEGETATION AND COASTAL VEGETATION

Conservation category wetland areas including fringing vegetation and associated upland vegetation; Coastal vegetation within the accepted coastal management zone

Scope

This criterion applies to Conservation management category wetlands, their vegetation (including fringing vegetation) and associated upland vegetation; streamline/riverine/estuarine fringing vegetation; and to coastal vegetation within the accepted coastal management zone.

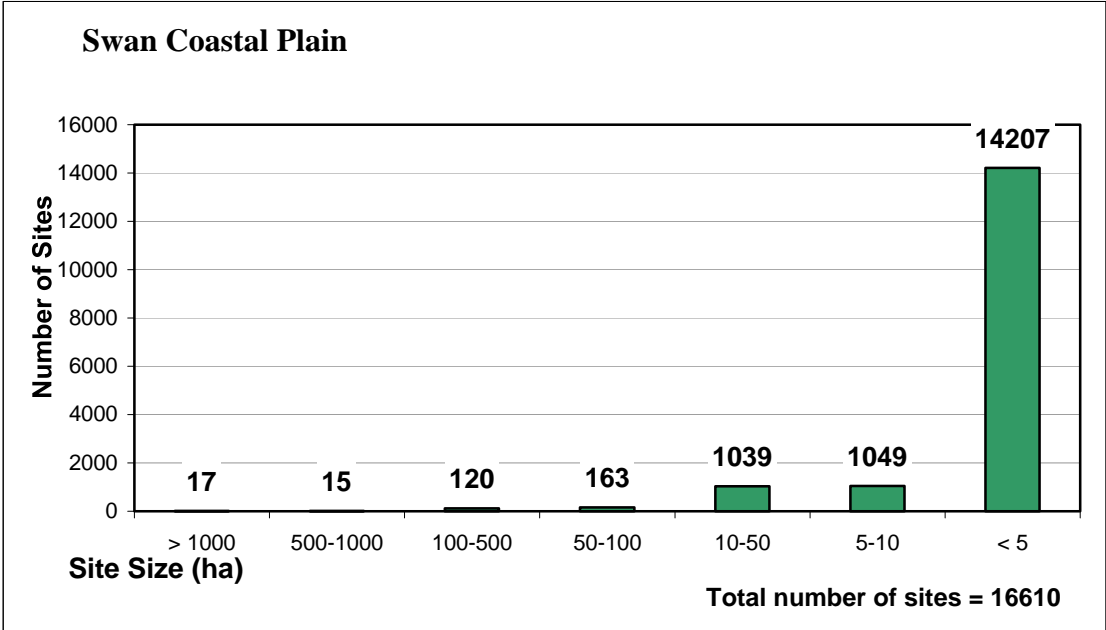
Inclusion Guidelines

- Conservation category wetlands and their native vegetation (including fringing vegetation) and associated upland vegetation.
- Streamline/riverine (channel wetlands) and estuarine fringing native vegetation.
- Coastal vegetation and natural landform units within the accepted coastal management zone. These areas may also be included in regionally significant natural areas that go beyond the coastal zone.
- Streamline/riverine (channel wetlands), estuarine and coastal areas that are part of a regional linked (or potentially linked) sequences of communities.

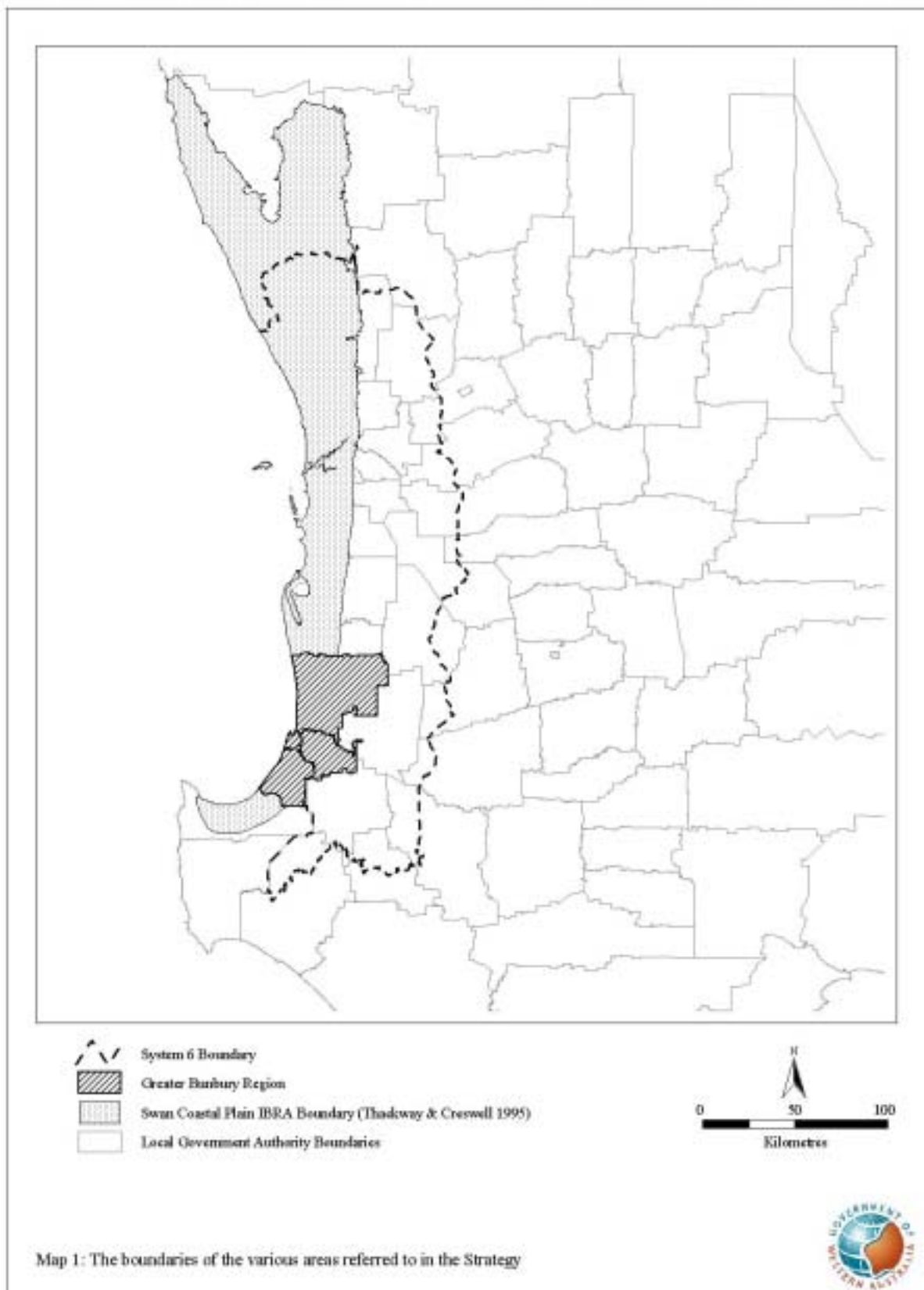
Exclusion Guidelines

- Significantly altered wetlands, such as Resource Enhancement and Multiple Use management category wetlands. At times, altered wetlands, may be considered to be regionally significant natural areas under other criteria.
- Cleared or developed coastlines.

Figure 1: Number of vegetated remnants against area size classes occurring on the Swan Coastal Plain (SCP) and occurring in the Greater Bunbury Region SCP



Map 1: The Boundaries of the Various Areas Referred to in the Strategy



Map 2: Previously Identified Regionally Significant Natural Areas in the Greater Bunbury Region

