Part A – Setting the scene

Part A of the Guidelines aims to provide important background information to assist Local Governments to prepare and develop a Local Biodiversity Strategy. Part A discusses the importance of biodiversity and relevant legislation as well as describing the ecological criteria required to set the objectives and targets for a Local Biodiversity Strategy. Guidelines for viability assessment and ecological linkages are also provided.

1. All about biodiversity

1.1. What is biodiversity?

Biodiversity is another term for the variety of nature. A more technical definition, as provided in The National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) is:

> *The variety of life forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity; species diversity; and ecosystem diversity.*

The concept of biodiversity embraces the various living parts of the world around us. The three levels of biodiversity – species, genetics and community – are interrelated and interdependent. A population of a species is dependent on the genetic variation within it and upon its **habitat** (ecosystem) for survival, and an ecosystem is dependent on the full variety of the species that comprise it (Williams et al. 2001).

Species diversity

Most people are familiar with biodiversity at the species level. Species diversity is "the variety of species on earth" (Commonwealth of Australia 1996) where a species is defined as "a group of plants, animals or micro-organisms that have a high degree of similarity and generally can interbreed only among themselves to produce fertile offspring, so that they maintain their 'separateness' from other such groups" (Williams et al. 2001). In Australia and in south-western Western Australia in particular, new species are frequently being discovered and the taxonomy (naming and description) of species is constantly changing. Over time, our knowledge of species diversity will continue to grow and so will our understanding of what is required to protect these species.

In the past, biodiversity conservation has focused on the protection of individual species, especially those that have currently been determined to be naturally rare or threatened with extinction from a range of processes. Governments compile lists of various species of plants and animals (and occasionally fungi) that are considered rare or threatened, for special protection under legislation or policy. These lists reflect various levels of concern and proposed protection mechanisms. For example, in Western Australia the most rare or threatened species are listed as **Declared Rare Flora** (DRF) or **Specially Protected Fauna** and are protected under the Wildlife Conservation Act 1950. At the Commonwealth level, threatened species and communities are listed and protected under the Environment Protection and Biodiversity Conservation Act 1999. The challenge of local biodiversity planning is to look beyond the rare and keep the common, common.

Genetic diversity

Genetic diversity is "the variety of genetic information contained in all of the individual plants, animals and micro-organisms that inhabit the earth. Genetic diversity occurs

within and between the populations of organisms that comprise individual species as well as among species" (Commonwealth of Australia 1996). Genetic diversity within species can be documented by the designation of races, variants, subspecies, varieties or forms of a particular species. For example, jarrah is known to have a green-leafed form on the coastal plain and a blue-green form on the Darling Plateau (Powell 1990). Genetic diversity is discovered through detailed studies and there is much work still to be done in this area.

Ecosystem diversity

These Guidelines focus primarily on ecosystem diversity which is, "the variety of habitats, biotic communities and ecological processes" (Commonwealth of Australia 1996) present across the landscape. The conservation of ecosystem diversity is the most strategic way to conserve all levels of biodiversity (genetic, species and ecosystem) and aims to prevent these elements of biodiversity reaching the point where they become threatened. A method used to describe ecosystem diversity is the ecological community concept.

Ecological communities and vegetation complexes

An ecological community is "a naturally occurring biological assemblage that occurs in a particular type of habitat" (English & Blyth 1997, 1999). The scale at which ecological communities are defined depends on the level of detail in the information source, therefore no particular scale can be specified (Environmental Protection Authority 2003b). For a given region, ecological communities need to be interpreted at the level of the most detailed regional studies available. In addition, the areas and percentages originally present and currently remaining for each ecological community need to be determined within the boundary of the natural region across which these ecological communities occur.

In the **Perth Metropolitan Region** (PMR) the most common way to interpret and quantify ecological communities based on area are the **vegetation complexes** (and their groupings into major landform elements) defined and mapped by Heddle, Longeragan and Havel (1980) and Mattiske and Havel (1998). These vegetation complexes are based on the patterning of vegetation at a regional scale reflected by the underlying key determining factors of landform, soil and climate. There are respectively 26 and 18 vegetation complexes represented within the **Swan Coastal Plain** (SCP) and **Jarrah Forest** portions of the PMR. In the PMR, ecological communities are also defined as **floristic community types** (Gibson et al. 1996, Department of Environmental Protection unpub. 1996), **forest site types** (Havel 1975a, 1975b) and **Threatened Ecological Communities** (English and Blyth 1997, 1999). However these have not been mapped across the region in a way that allows them to be used for quantitative targets based on area.

1.2. Measuring and describing biodiversity

In these Guidelines, Local Governments are encouraged to measure biodiversity using the variation and condition of **native vegetation**, **wetlands** and **waterways**. Information on the diversity of species (plants and animals) will also be available. In the PMR, vegetation complex mapping can be used to measure broad scale variations in biodiversity. The Keighery (1994) or Kaesehagen (1994) methodology is used to describe and measure **vegetation condition**. Wetland values are assessed using the methodology developed in Environmental Protection Authority (EPA) Bulletin 686 (Environmental Protection Authority 1993) and channel wetlands/waterways can be assessed using Shepherd and Siemon (1999).

It is important to realise that these are surrogate measures of biodiversity and that we will not fully measure biodiversity until we can see and identify every type of living organism present on this planet, its genetic variation and the ecosystems they form. Most life on Earth, and the most diverse life forms, are inconspicuous or microscopic and most are as yet unknown. For example, because of the huge diversity of fungi species, only 10% of the estimated 250,000 species of Australian fungi have been discovered and described so far (Bougher 1998).

These surrogates (vegetation complex, vegetation condition, wetland value and watercourse condition) can be used to broadly measure and describe biodiversity for the purposes of local biodiversity planning.

1.3. Other key definitions

Natural areas

These Guidelines cover all natural areas, and not just **bushland**. The term **natural area** is used to describe any physical area that contains native species or ecological communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open wetlands (lakes, swamps) or **waterways** (rivers, streams, creeks and estuaries - often referred to as channel wetlands), springs, rock outcrops, bare ground (generally sand or mud), caves, coastal dunes or cliffs (adapted from Environmental Protection Authority 2003a). Basically, a natural area is any area that living organisms indigenous to that area have naturally colonised. Areas of **rehabilitated** or **fabricated** landscape are not considered natural areas and are not included in the definition of 'natural area' for the purposes of these Guidelines. Even when these areas are carefully designed to support a range of local native species they can never contain the same level of biodiversity as the natural community that would have once been present in that area, especially in an ancient and diverse landscape like Western Australia.

Local Natural Areas

The term **Local Natural Area** (LNA) has been created to define natural areas that exist outside:

- Department of Conservation and Land Management (CALM) Managed Estate
- Regional Parks
- **Bush Forever Sites**.

All LNAs, along with those Regional Park areas and Bush Forever Sites managed by Local Government, are the focus of these Guidelines and should be included in the scope of each Local Government's Local Biodiversity Strategy.

The extent of native vegetation within LNAs, **CALM Managed Estate**, Regional Parks and Bush Forever Sites in the PMR is outlined in Figure 1. The extent of non-vegetated wetlands and waterways within LNAs can be obtained from the Geomorphic Wetland Database maintained by Department of Environment (DoE).

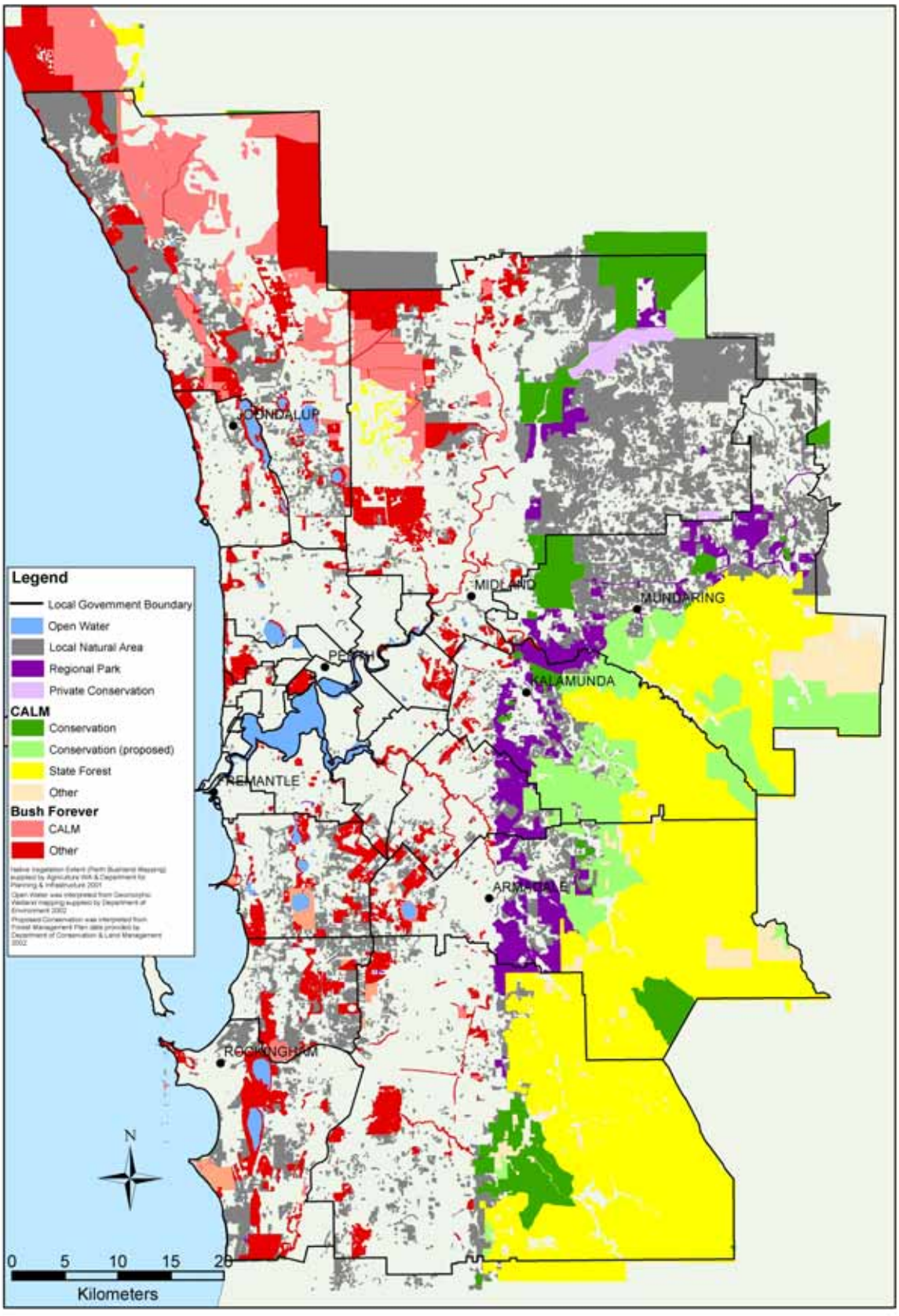


Figure 1 Native Vegetation Extent by Administrative Planning Category

Regionally significant natural areas

Regionally significant natural areas within the Jarrah Forest portion of the PMR are those natural areas that meet one of a range of specific criteria for regional significance (outlined in Appendix 3 Environmental Protection Authority 2003a) and collectively aims to form a **comprehensive, adequate** and **representative** system of conservation areas (Environmental Protection Authority 2003a). They may be either part of an existing or proposed conservation system or meet, in whole or in part, a range of criteria which are outlined in Appendix 3 of Guidance Statement No. 10 by the Environmental Protection Authority (2003a). Within the Swan Coastal Plain portion of the PMR bushland of regional significance is identified by the criteria in **Bush Forever** (Government of Western Australia 2000a & b). Regionally significant bushland that is to be protected has been designated within Bush Forever Sites or identified as any bushland of a vegetation complex with only 400 ha or 10% or less (whichever is the greater) remaining in the **Bush Forever Study Area** (Government of Western Australia, 2000a). Other natural areas of regional significance (eg. wetlands, watercourses) have not yet been formally designated by the State Government within the Bush Forever Study Area.

Potentially Locally Significant Natural Areas

A dataset of **Potentially Locally Significant Natural Areas** (PLSNAs) has been developed by the Perth Biodiversity Project using remotely collected, regional **GIS** information to identify those Local Natural Areas likely to meet one or more ecological criteria for local significance. **Local Significance Criteria** are listed and described in Section 5 and include local representation, diversity, rarity and maintenance of natural systems. It is important to remember that GIS information is not available to address all Local Significance Criteria and this GIS dataset is indicative only of the values of LNAs. Field verification is required before a natural area can be identified as 'locally significant'.

Locally Significant Natural Areas

Locally Significant Natural Areas (LSNAs) are Local Natural Areas that meet one or more ecological criteria for local significance and have been verified in the field. A LNA should only be recognised as locally significant after the site has been surveyed on-ground. LSNAs can be confirmed during or after the finalisation of a Local Biodiversity Strategy. The fact that a natural area is confirmed as 'locally significant' does not necessarily mean that it must and can be protected.

Bushland and native vegetation

The term 'bushland' is frequently used interchangeably with 'native vegetation' but in these Guidelines and other work relevant to the PMR these terms have specific definitions and should not be confused. 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" (Government of Western Australia 2000a, p1).

In Perth, specific definitions exist for 'bushland' and 'native vegetation'. This photograph shows bushland of tall open Tuart woodland in excellent condition. Neerabup National Park. Photo: J Cullity.

In practical terms, bushland is basically any native vegetation in good or better condition based on the vegetation **condition scale** of Keighery (1994). **Regionally significant bushland** is a component of native vegetation that meets one of a range of specific criteria for regional significance (that are outlined in Appendix 3 in Environmental Protection Authority 2003a). Regionally significant bushland can be considered a subset of regionally significant natural areas.

Native vegetation refers to any patch of vegetation made up of local native species, that is, those that occur naturally at that given locality and are still growing in the area they occupied prior to European settlement. The condition of the vegetation is not important in this definition. Areas could be classed as completely degraded on the vegetation condition scale (Keighery 1994) and still be considered natural areas of native vegetation. For example, a local park with the original local native trees still present within a lawn (or with perhaps a few native shrubs in the understorey) could be considered native vegetation. This is particularly relevant to inner metropolitan Local Governments that may have few or no natural areas in good condition but may still retain native vegetation in patches or perhaps along roadways. This native vegetation is very important for the survival and movement of flora and fauna and for maintaining a local sense of place in the community.

This photograph shows completely degraded Tuart woodland in Manning Park, which is classified as native vegetation. Note the difference from the Tuart bushland in the previous photograph. Photo: J Cullity.

Retention and protection of natural areas

These Guidelines commonly use the terms **'retention'** and **'protection'** (or similar) in Part B in discussing the biodiversity resource and the local biodiversity planning process. It is important the distinction is made between natural areas that are identified to be retained through a distinct process (such as application of a Local Planning Policy) and natural areas that are retained and have an identified protection mechanism (such as provisions in the Town Planning Scheme). A good example of the difference between these two terms is a natural are may be 'retained' through Council refusing or conditionally approving a development application. However this same natural area cannot be considered 'protected' until a protection mechanism (such as a conservation covenant through application of an incentives strategy) has been identified and implemented.

1.4. What is a Local Biodiversity Strategy?

A **Local Biodiversity Strategy** consists of the following elements:

- identification of the extent of the biodiversity resource within the Local Government area
- development of a vision, objectives and **targets** for biodiversity retention, protection and management (Natural Area Condition [NAC] targets will provide

the opportunity for Local Government to formalise ecological criteria for determining which Local Natural Areas are locally significant)

- formalise policies and processes to ensure biodiversity considerations are integrated into the assessment of development proposals
- develop and provide incentives to encourage private land conservation
- plan for the management of local reserves and other Local Government lands to conserve biodiversity
- determine the protection status of all LSNAs.

A Local Biodiversity Strategy provides a process for assessing the ecological significance of Local Natural Areas and for determining their protection status by assessing constraints and opportunities for protection. A checklist outlining the various components and milestones of a Local Biodiversity Strategy is provided in Section 20.

By preparing a Local Biodiversity Strategy, Local Governments will fulfil the requirements of Federal and State government legislation and policies addressing biodiversity (Section 3). For example, it will contribute to meeting the requirements of the Statement of Planning Policy No. 2: Environment and Natural Resources (Government of Western Australia 2003b). It will also address bushland protection within the wider biodiversity conservation context (natural areas, **connectivity**, protection of species, ecosystems and genetic variability).

A Local Biodiversity Strategy will ensure that each Local Government can integrate biodiversity conservation into its business, rather than trying to address it at the end of the decision-making processes. This brings multiple benefits, in the short and long term, for the Local Government and its community such as:

- addressing legislative and policy requirements
- strategic, consistent and well-informed decision-making
- enhanced land use planning and design
- better biodiversity and sustainable development outcomes
- strategic allocation of public and private resources
- linking Local Governments to broader strategies and funding sources
- more efficient management of Local Government lands for biodiversity
- involving and raising the awareness of the community and landholders.

1.5. Local Government's role in conserving biodiversity

Local Governments are land managers, land use planners, decision-makers, developers and play a key role in influencing public behaviour. Therefore, they have substantial responsibilities and potential to conserve biodiversity.

In their report Beyond roads, rates and rubbish: opportunities for local government to conserve native vegetation, Binning et al. (1999) demonstrate that:

> *Whilst strategic policies may be developed by higher levels of government, it is Local Government that must make detailed decisions that balance ongoing development with the need to protect natural resources. It may be argued that Local Government is the most significant sphere of government in regulating land use.*

As an indication of the investment that Metropolitan Local Governments made to biodiversity conservation in 2000–01, it was found that Perth's 30 Local Governments spent $5.14 million to manage, assess and protect natural areas on local reserves and freehold lands (Perth Biodiversity Project unpub. 2002). This represents 0.58% of those Local Government's total operating expenditure.

Many of the activities and services that Local Government carry out have potential to conserve or degrade biodiversity. These are some examples:

- Strategic planning
  - Council Strategic Planning
  - Principal Activities Plan
- Corporate and financial services
  - annual budgets
  - rating
- Land use planning
  - Town Planning Scheme Reviews and Amendments
  - Local Planning Policies
  - consideration of subdivisions
  - planning and provision of active Public Open Space and conservation reserves
  - approval of development applications
- Operations, engineering and parks and reserves
  - road building, maintenance
  - provision of walking tracks and trails
  - bushland management including weed control, dieback control
  - drainage planning and works
  - drainage reserve management
  - purchase of raw materials (e.g. timber, quarried materials)
  - streetscaping and landscaping
  - fire management
  - water abstraction and groundwater draw-down
  - turf management
  - community education
  - Local laws e.g. recreation, pet management.

Earthmoving activities, road maintenance and construction have the potential to impact on adjacent natural areas. Photo: K Savage.

The capacity of individual Local Governments to conserve biodiversity will vary greatly. It will depend upon the values and priorities of the Local Government and its community, the skills set of its staff, its annual income and numerous other factors.

Local Governments must demonstrate to their communities that they are able to address the biodiversity conservation agenda strategically and with sufficient commitment and resources. A key challenge to all Local Governments undergoing substantial growth is to invest in natural area protection before and during periods of high growth. Failure to do this will result in costly measures to protect natural areas once development has made the remaining natural areas highly valuable from a financial and ecological point of view (City of Mandurah 2003).

1.6. Guiding principles for local biodiversity planning and conservation

Nine guiding principles for biodiversity planning and conservation are listed below. The principles are supported by research, policy and legislation and are reflected throughout the Guidelines. Specifically, they should be reflected in the vision, objectives and targets for Local Biodiversity Strategies developed by Local Governments.

Principle 1. Retention of at least 30% of the pre-European extent of each ecological community is required to prevent an exponential loss of species and failure of ecosystem processes

Central to biodiversity conservation is the aim of retaining an adequate representation of the original extent of the ecological community present across the landscape (across all land **tenures**). Research indicates that at least 30% of each ecological community strategically located across a landscape is required to maintain sustainable levels of biodiversity. Whilst biodiversity conservation thresholds will vary between different ecosystems and among different groups of organisms, multiple studies on the relationship between plant communities and the diversity of species have identified common thresholds beyond which biodiversity decline accelerates exponentially (see Section 17) . The trend appears to be that the loss of biodiversity caused by **habitat fragmentation** is significantly greater once a community type falls below 30% of its pre-European extent (Miles 2001) (refer to Figure 2).

It is now widely accepted that to conserve biodiversity in Australia at least 30% of the pre-European extent of each ecological community needs to be retained to prevent exponential loss of species and failure of ecosystem processes required for long-term **viability** (Smith & Siversten 2001). Where only 10% or less of the pre-European extent of an ecological community remains that community is considered threatened (Department of Natural Resources and Environment 2002). Further background on the research on biodiversity conservation thresholds is provided in Section 17.

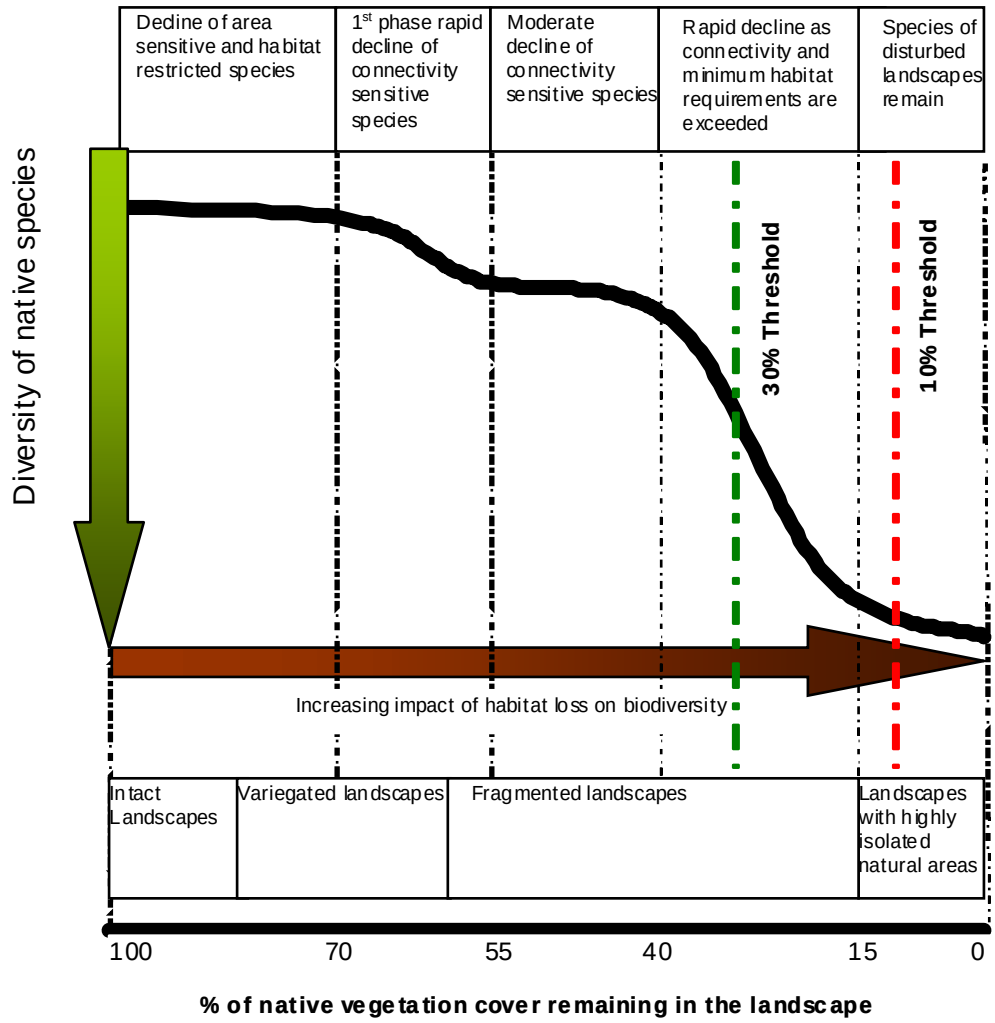


Figure 2. Biodiversity loss in relation to native vegetation loss (Smith & Siversten 2001)

Principle 2. Protect regionally significant and Locally Significant Natural Areas

The protection of regionally significant natural areas as well as LSNAs is essential to the conservation of biodiversity. Within the PMR, many regionally significant natural areas are protected within existing secure reserves or identified to be protected by Bush Forever or the Forest Management Plan 2004 – 2013 (Conservation Commission 2003). Local biodiversity planning is designed to provide the framework to identify natural areas that meet criteria for local significance and then determine the protection status of these areas.

The protection of LSNAs is important for three primary reasons:

- to maintain a basic level of natural diversity (by adding to and complementing areas identified to be protected by State and regional processes, thus moving towards 30% retention and protection where this is possible within existing constraints)
- to buffer and provide connectivity between protected regionally significant natural areas
- for benefits at the local community level (passive recreation, sense of place and amenity, local environmental services).

The Bush Forever target of protecting "…at least 10% of each vegetation complex" (Government of Western Australian 2000a. p viii) is now well recognised as inadequate to provide effective conservation of biodiversity (Environmental Protection Authority

2003a, 2003b). The long-term viability of Bush Forever Sites relies on them being set within a matrix of LSNAs that provide buffering and linkage to prevent loss of biodiversity.

LSNAs can have significant conservation value in their own right. Many may meet the ecological criteria for regionally significant bushland but were not included in Bush Forever due to socio-economic criteria and the minimum targets used. The Urban Bushland Strategy (Government of Western Australia 1995) established criteria for distinguishing between regionally and locally significant bushland (Table 1), which were based on the same factors assessed at a regional and local scale. The regionally significant areas are considered the best examples of their given type. However, socio-economic constraints have left some very significant areas outside of Bush Forever Sites and included others (ones that already had some level of protection) that are not necessarily the best ecological examples.

Table 1. Urban Bushland Strategy criteria for identifying regionally and locally significant bushland (Government of Western Australia 1995)

Regionally Significant	Locally Significant
*Example of regional vegetation type which is threatened or poorly reserved or a site with special value for flora or fauna conservation	One of the better examples of a local vegetation type
*Having considerable biodiversity or supports a population of Declared Rare Flora, priority listed flora or threatened fauna	Having biodiversity value but unlikely to include Declared Rare Flora. May include geographically **significant species** at the limit of their range.
*Vegetation in good condition or better. Threatened vegetation types may be regionally significant even if in poor condition.	Vegetation may be in poor condition but if poor, capable of regeneration.
*Usually greater than 20 ha but may be smaller in the case of threatened or poorly reserved vegetation types, or areas with special significance for other purposes.	Ideally greater than 4 ha but smaller areas may be of significance depending on how much remains in the locality
Suitable for passive recreation by people from both within and beyond the locality.	Suitable for passive recreation by the local community
Regional use or potential for scientific or educational study.	Use or potential for use by local schools
Having cultural heritage values of a regional or greater significance	Having local heritage value
Regular shape is desirable unless the area functions as a significant corridor linking other remnants.	Shape not critical but remnant should be capable of ongoing management.

**essential criteria for bushland to be regarded as regionally significant*

Quite apart from ecological reasons, the protection of LSNAs is an essential part of maintaining a sense of place in the areas we live and providing opportunities for everyone to experience nature first hand, within walking distance of their homes and places of work. The importance of natural areas for passive recreation and relaxation cannot be underestimated. Perth is envied the world over for its natural setting and lifestyle opportunities. An important part of this is that natural areas allow people to encounter native plants and animals, often in their own backyard. Most people strive hard to create green, tranquil places on their own property or value such areas in public parks. Retaining natural areas that provide these values as well as protecting biodiversity is a cost efficient way to meet human needs for an aesthetic living environment, places for passive recreation and a connection with the land (Seddon 1971). Natural areas cost relatively little to 'develop' and cost far less to maintain than landscaped parks (Kaesehagen 2001) (See Section 10.4).

Principle 3. Biodiversity is best conserved in-situ – protect what you have before revegetating

Biodiversity is best conserved in its natural state. Conserving viable natural areas of native vegetation, wetlands and waterways is by far the most effective way to conserve biodiversity from both an ecological and an economic perspective. Once lost, these ecosystems are impossible to re-create. Therefore **revegetation**, although it can be important for management, buffering and linking natural areas, will always be of limited value in conserving biodiversity. Another way of stating this principle is that you cannot create or manufacture biodiversity.

The highest priority is the protection of existing natural areas and the management of threats to these areas. Many resources are currently being directed into **rehabilitation** or fabrication of habitat or revegetating very degraded areas, whilst existing natural areas in good or better condition are being cleared or degraded. Some of these resources would be more effectively invested in protecting those natural areas in good condition that are under threat or by providing incentives to private landholders with significant natural areas. All land managers need to look critically at reducing the loss of natural areas where this is a significant issue in their districts.

This principle also means that the protection, management and buffering of existing natural areas within an **ecological linkage** is a higher priority than revegetation of cleared portions of the link.

Weed control in Bold Park. An important principle for biodiversity conservation is protecting existing natural areas in good condition and managing the threats (such as weeds) to these areas. Photo: R Boykett.

Principle 4. Regeneration is a higher priority than revegetation

Where degradation has occurred, natural **regeneration** should first be encouraged (by activities such as weed control) before direct seeding and revegetation is attempted. Where seeding and planting occurs, **local provenance** species must be used.

Principle 5. Prioritise protection and management of the highest biodiversity value natural areas

Resources should be prioritised to those natural areas that have the highest biodiversity value and are viable. This principle will ensure that Local Governments obtain the best biodiversity outcome for monies spent in protecting and managing natural areas. Natural areas should be prioritised according to the biodiversity value of

the natural area, as well as the **threats** to biodiversity conservation that will need to be addressed through management. This is covered in Sections 10.4 and 10.6.

Principle 6. Community involvement in helping conserve biodiversity

The best biodiversity outcomes are often achieved with strong community involvement and consultation. Engaging the local community to help identify, protect and manage important natural areas will lead to support and ownership within the community of any biodiversity outcomes. Involving and communicating with the community when difficult decisions need to be made will ensure that the local biodiversity planning process remains transparent and accountable.

Principle 7. Biodiversity values must be made transparent in decision-making processes

Only when biodiversity values are fully recognised can the community and land managers fully comprehend the loss or gain associated with the removal or retention of natural areas. These Guidelines encourage the identification of biodiversity values prior to any decision-making relating to the fate of natural areas. This will ensure that any potential trade-offs made between development and biodiversity are accountable and transparent to the community. Transparency is a key principle of sustainability and good governance. In the very least, it ensures that records of biodiversity resources are kept.

Principle 8. Site-specific field survey is essential to understand biodiversity value

It is recognised that desktop surveys alone are not adequate to identify the biodiversity value of a particular area and that assessment on site by an appropriately skilled person is required. However a lack of full knowledge should not be an excuse for postponing action to conserve biodiversity. Field assessments need to collect information relating to an area's ecological values, the condition of the area and the threats to its values as well as document the existence of any management infrastructure.

Principle 9. Natural area conservation is a legitimate land use

The protection of natural areas is a legitimate land use within all land zonings, including urban zoned land. Natural areas have intrinsic values and provide key environmental infrastructure to underpin all types of land use. In rural settings natural areas stabilise soils and buffer water resources from agricultural land uses. In urban settings, natural areas provide habitat for local fauna, recreational opportunities, environmental monitoring sites, moderation of local climate, and local suburb definition.

1.7. Factors influencing the protection and management of Perth's biodiversity

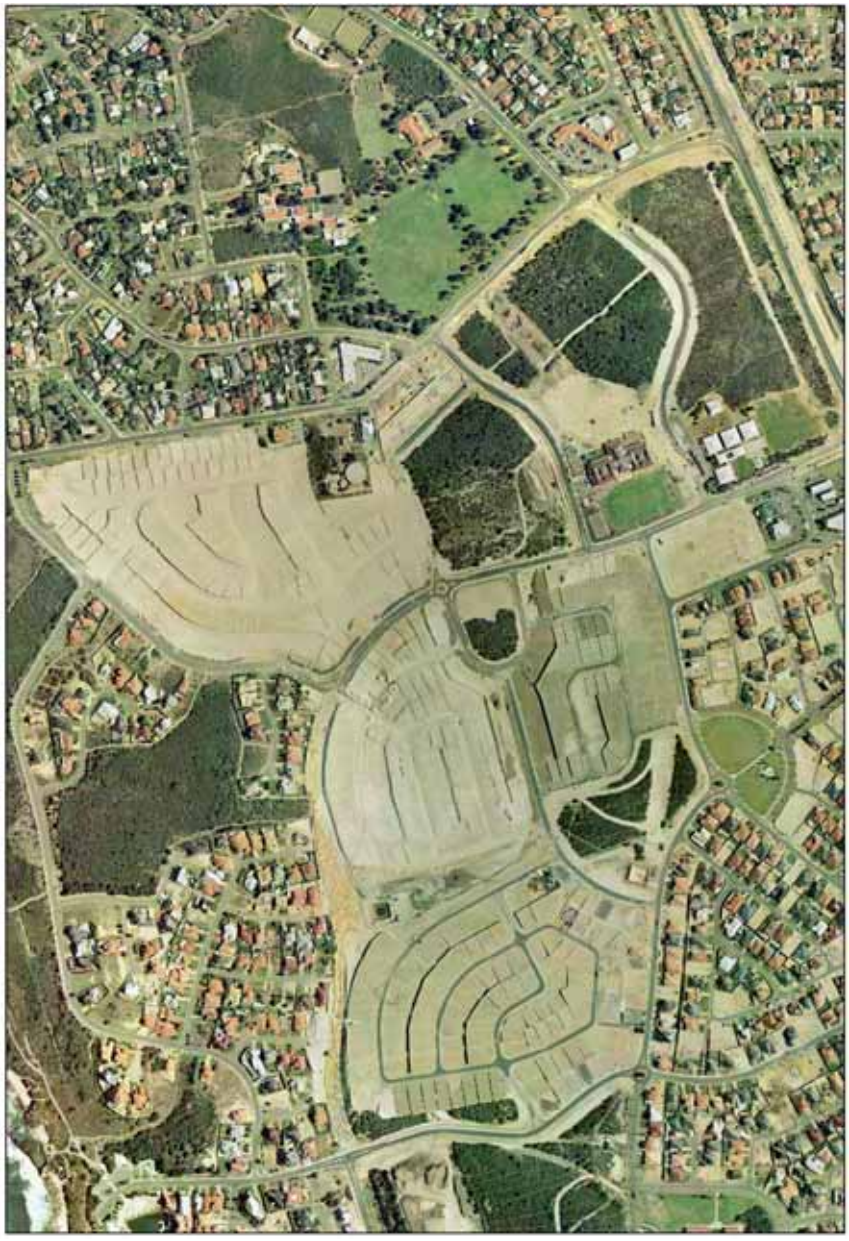
An important part of the local biodiversity planning process is to identify and analyse threats to the protection of biodiversity in the Local Government area so that they can be reduced and controlled. Another aspect is the proactive management of natural areas to address these threats and ensure the ongoing viability of those areas.

1.7.1. Barriers and threats to protection

Land use planning and development

The land use planning and development process represents a threat to the retention and protection of biodiversity, with the threat being greatest for those natural areas occurring on land with legitimate development expectations created through zonings under the **Metropolitan Region Scheme** (MRS). MRS zonings and/or reservations that pose a significant threat to biodiversity include: Urban; Urban Deferred; Commercial and Industrial; Public Purposes; and Regional Roads. Approximately 11,000 ha of native vegetation was mapped on private and public lands as remaining in

these **zones** in 2001. The greatest opportunity to conserve the natural areas in these zonings is at the earliest stages of the land development process (structure planning) rather than the later stages (subdivision, development applications).



Clearing for urban development is one of the major threats facing Perth's biodiversity. Photo: 2000 aerial photography sourced from Department of Land Information.

Government policy and economic disincentives

The fact that most State and Local Government taxes do not differentiate between natural areas and cleared areas is a significant impediment to conservation. It encourages landholders to value their land more for its economic development potential than its ecological value (Binning & Young 1999). For example land zoned 'Conservation' under a local Town Planning Scheme (TPS) still remains ineligible for exemption from land tax (a State Government tax), whereas primary producers are exempt.

It is also of concern that land valuation processes create a land speculation environment by increasing unimproved land values near urban areas, based not on land zoning and the Government's regional development plans, but on the proximity to existing urban zoned land. This increases local rates and land tax charges and creates

an expectation that landholders nearby to development have a 'right' to similar levels of development. An issue bigger than any one Local Government, this should be addressed at a regional and State level.

Lack of protection mechanisms in urban zonings

Relative to the rapid expansion of Perth and high land values, there are currently very few mechanisms to protect LSNAs. Some LSNAs have been protected under legislation (for example, DRF or Federally listed Threatened Ecological Communities [TECs]) or Government policy (for example, Conservation Category Wetlands [CCW]). Otherwise, most LNAs have been protected through the local Public Open Space (POS) contribution (or portion thereof) at the time of subdivision. Historically, POS has been limited to 10% of the subdivisible area. The State Government's Public Open Space policy focuses on meeting recreational needs, provision of community facilities and protection of foreshores (Western Australian Planning Commission 2002). Protection of **upland** vegetation for biodiversity conservation purposes is not included within the POS policy objectives. This has resulted in most public open spaces created during urban subdivision being vested for purposes of Public Recreation or similar. It could therefore be argued that any natural area existing as part of the POS network has a tenuous long-term existence.

The weakness of these mechanisms has led to small natural areas with poor viability being protected at the local level because the focus has either been on active recreation or meeting specific legislative requirements (for example, protection of TECs and/or DRF). New incentive mechanisms such as tax deductions for landholders that donate land (Section 15) may provide alternative mechanisms to encourage protection of LSNAs.

Lack of knowledge, understanding and awareness

There is substantial work to be done to increase community awareness of the values of biodiversity and natural areas in the PMR. On-ground, our knowledge of the biodiversity of individual LNAs varies considerably. Field assessment of these areas is needed so that informed decisions can be made about their future use and management. An understanding of natural area management techniques is required to ensure the long-term health and viability of protected natural areas.

Clearing of natural areas without the appropriate approvals

The clearing of native vegetation without the necessary approvals can significantly impact on the biodiversity resource of many natural areas in Perth. The legislation regulating clearing across Western Australia is described in more detail in Section 3. Although **restoration** measures can be implemented in instances where it is found that the necessary approvals to clear have not been sought, it is recognised that it is very difficult to replace biodiversity once it is lost.

Appropriate resourcing

Insufficient funds for the protection, management and ecological assessment of natural areas is currently a key threat to biodiversity conservation. In an environment where there is fierce competition for funds, each Local Government should determine local objectives of biodiversity conservation and provide sufficient resources to achieve these objectives.

1.7.2. Threats to management and ongoing viability of natural areas

There are a number of threats to the management and ongoing viability of natural areas. They range from factors that can be controlled (such as weed invasion, pest animals) to factors that are global or exist outside the realm of the land manager's control (such as global climate change, indiscriminate use of fire). Possible threats to the management and ongoing viability of natural areas are discussed below.

Weeds

Environmental weeds that compete with (and displace) local native plant species are a significant threat to natural areas. Weeds compete with local native plant species for space and light and deprive local fauna of suitable habitat. Controlling weeds in natural areas is a significant cost to the management of these natural areas.

Weed infestation (Morning Glory) at Yagan wetland in Bullcreek.
Weeds are one of the major threats to Perth's biodiversity. Photo: J Cullity.

Pest animals

Pest animals are introduced animals that compete with and predate on native local fauna. They can also alter the structure, density and floristic composition of natural areas through grazing and soil disturbance.

Habitat fragmentation

Habitat fragmentation reduces habitat for individual species and isolates the species that live in an area. It interferes with the ability of populations to disperse and re-colonise areas after disturbance or mortality. Population sizes may decrease below the threshold where they can be self-sustaining through reproduction. The negative impact of surrounding land uses **(edge effects)** is magnified in comparison to corresponding areas of habitat that are not fragmented.

Changed water regimes and/or water quality

Changed water regimes and hydrological imbalances have a significant effect on vegetation as the types of plants and plant communities in a given area are strongly influenced by water availability. Discharging stormwater into a vegetated **dampland** can have significant impacts on plant communities, habitat and thus fauna. Wetlands are especially vulnerable to changes in water regime, as is evident in the death of wetland vegetation around seasonally inundated areas that become permanent following urbanisation. Upland vegetation can also be affected by human-induced changes in water regime, such as the death of banksias caused by the abstraction of groundwater, below-average rainfall and long hot summers.

Similarly, excessive nutrients, sediments and pollutants can have a significant effect on native vegetation, wetlands and waterways. Excessive nutrients and pollutants

contribute to algal blooms, death of aquatic life in wetlands and promote the spread of weeds in both upland and wetland natural areas.

Erosion

Erosion contributes to sedimentation and eutrophication of wetlands as well as leading to a physical decline in (upland) natural areas due to changed soil processes. Erosion also contributes to dune blowouts with the loss of stabilising vegetation in coastal ecosystems.

Inappropriate fire regimes

Inappropriate fire regimes can alter the structure, density, and floristic composition of natural areas. Floristic communities and even individual flora species respond very differently to fire and it is important that enough information is gathered on the vegetation present to determine what fire regimes are appropriate. Fauna is also impacted through direct mortality or through a lack of refuge areas during and in the recovery period after fire.

Inappropriate propagation material

Using inappropriate propagation material in revegetation can have a damaging effect on the genetic integrity of natural areas. Local provenance propagating material should be collected and used, resources should be identified and mapped, and local seed orchards can be established. The City of South Perth's seed orchard and seed bank are good examples of positive action in this regard.

Diseases

Diseases (for example, Phytophthora Dieback, canker) can alter the structure and floristics of natural areas through causing the death of native vegetation. The **resilience** of native vegetation to disease is reduced when impacted by other threats.

Inappropriate human use

Human use of natural areas including inappropriate access, recreational activities and firewood collection can have a detrimental effect on a natural area. Inappropriate or uncontrolled recreational activities can directly disturb the vegetation (through damage from vehicles and motorcycles or the creation of walking tracks) that may result in erosion, and allows the introduction of weeds and disease. Firewood collection can have an incremental but devastating effect on wildlife habitat through the removal of dead and fallen trees.

2. Important considerations in developing a Local Biodiversity Strategy

This section addresses a number of key questions that Local Government and stakeholders may have before commencing a local biodiversity planning process. Many of the issues raised in this section are discussed in detail in Part B, 'Developing a Local Biodiversity Strategy'.

2.1. Difference between a biodiversity strategy and a bushland strategy

The Draft Statement of Planning Policy: Bushland Policy for the Perth Metropolitan Region (Western Australian Planning Commission in prep) supports the preparation of **Local Bushland Strategies** by Local Governments, whereas these Guidelines promote the development of a Local Biodiversity Strategy. As the name suggests, a Local Bushland Strategy only focuses on bushland, which is basically defined as native vegetation in good or better condition based on the Keighery (1994) condition scale. Conversely, Local Biodiversity Strategies recognise the importance of 'natural areas'. Natural areas include bushland, as well as non-vegetated areas or vegetated areas that may not fall under the definition of 'bushland', such as some wetlands and/or degraded native vegetation. All of these areas are important in providing a mosaic of natural areas to maintain and/or improve the viability of protected bushland areas, and therefore biodiversity. Currently, the Draft Statement of Planning Policy: Bushland Policy for the Perth Metropolitan Region indicates that a local bushland strategy should be prepared as part of a wider Local Biodiversity Strategy.

The focus of a local bushland strategy is on the protection of locally significant bushland. Local Biodiversity Strategies will focus on the retention, protection and management of natural areas identified as being locally significant, as well as those other natural areas under Local Government management identified in Bush Forever or forming part of Regional Parks.

2.2. Who to involve?

A local biodiversity planning process will be initiated by a Local Government. The process must be open and accountable to the local community and all stakeholders.

Most Local Governments will benefit from having the project guided by a Steering Committee of Local Government staff, Councillors, State Government biodiversity and land planning experts, relevant non government organisations and the community.

Key stakeholders in the local biodiversity planning process include:

- Councillors
- senior Local Government staff
- Local Government service teams
  - Strategic planning
  - Environmental management
  - Engineering, Assets Management, Parks and Reserves
  - Statutory Planning
- State Government agencies
  - Department for Planning and Infrastructure (DPI)
  - Department of Conservation and Land Management (CALM)
  - Department of Environment (DoE)
- Regional natural resource management (NRM) organisation (for example, Swan Catchment Council)

- local community representatives, including local landholders
- non-government environmental organisations
- indigenous land owners and Native Title representative bodies.

The Strategy should be given strategic importance by the Local Government's executive management and prepared with the involvement of all key sections within the Local Government. The process is best initiated and managed by the strategic planning team of a Local Government.

Consultation with the regional NRM organisation (either the Swan Catchment Council or the South West Catchment Council) will become increasingly important as Government environmental funding programs are delivered through regional structures.

2.3. The importance of community consultation

It will be important to engage the community in the local biodiversity planning process to encourage their support and ownership of the Local Biodiversity Strategy. The community should, in particular, have a good understanding of the objectives and targets of a Strategy. It is recognised that many difficult decisions will have to be made as part of a local biodiversity planning process regarding the extent of natural areas that can be retained and protected. It is important the community recognises these decisions need to be made, and that community representatives are part of the decision-making process through involvement on the Steering Committee. In this regard, community consultation is recommended to commence with the formation of the Steering Committee and continue throughout the local biodiversity planning process. Further information relating to community consultation is provided in Section 18.

2.4. The importance of ecological expertise

Expert ecological survey and assessment is one of the key foundations of biodiversity planning. Such expertise has generally been undervalued in local and state decision-making to date and independent advice can be difficult to obtain.

The input of experienced ecologists is essential for the Strategy to be soundly based and defensible. Consultants must be experienced not only in surveying the Perth region, but demonstrate that they can analyse data in the regional and local context. It is important that such expertise is used to help achieve the Strategy objectives and the identification of those natural areas required for regional and local ecological linkages. Professional ecological expertise should complement the knowledge held among community members and groups.

Ecological assessment by experts ensures adequate information is collected on natural areas prior to decisions being made affecting these areas. Here, volunteers collect important ecological information in Koondoola bushland. Photo: A Stubber.

2.5. Can a Strategy cover more than one Local Government area?

It is recommended that a Local Biodiversity Strategy should only cover a single Local Government area. This is to ensure that the Strategy is able to be implemented through the Local Government's corporate and land use planning processes and policies.

In some circumstances, Local Governments may work collectively on a Strategy. However, it should be demonstrated that this is appropriate to achieve better biodiversity conservation. These Local Governments will also need to keep in mind that some of the Strategy's recommendations will need to be integrated into each Local Government's Town Planning Scheme (TPS), policies and procedures.

Collective plans may be appropriate in inner metropolitan areas where securing the protection of natural areas is a less widespread issue and the focus is on management, and increasing the viability of natural areas. Rural or remote Local Governments may also find that working collectively with neighbouring Local Governments provides them with the resources to prepare a Strategy.

It must be recognised that while the boundaries of existing Local Government areas are not necessarily the most suitable for dealing with environmental issues, it is expensive to resource formal regional Local Government structures. However, Local Government may be supportive of resource sharing with other Local Governments (e.g. Ecologist, Bush Regeneration Officer) (Perth Biodiversity Project unpub. 2002).

2.6. Embracing biodiversity throughout the organisation

It is very important that biodiversity is recognised at the highest levels within each Local Government, such as the Council's Strategic Plan and vision statements. A Local Biodiversity Strategy needs to be linked and implemented through numerous existing and new Local Government plans, policies and procedures. These include land use plans, budgets, **Principal Activities Plans** and corporate plans.

Significant policy components of a Local Biodiversity Strategy are the development of a Local Planning Policy for Biodiversity Conservation and the offering of incentives to encourage landholders to manage biodiversity resources in private ownership. These Guidelines also recommend that some Local Biodiversity Strategy actions are given force through amendments to the Town Planning Scheme (e.g. introduction of conservation zones and special control areas to conserve biodiversity).

To implement a Local Biodiversity Strategy, Local Governments may have to look at reallocation of existing resources and staff, and training staff in new skills such as ecological assessment procedures, ecological **on-ground works** and natural areas management. These considerations should be incorporated into the Local Government's Corporate Plan and staff training plans and position descriptions. Local Biodiversity Strategies may have resourcing implications for Local Governments and should include budget forecasts that can be used in the forward financial planning process (e.g. Principal Activities Plan).

2.7. Resourcing the development of a Local Biodiversity Strategy

The preparation of the Strategy will require the allocation of sufficient funds and time commitment of various departments within the Local Government. As mentioned above, regardless of whether the Strategy is prepared by Local Government staff or others, resources will be required to have access to ecological expertise. This may make up a significant portion of the budget requirement.

A cost estimate for the local biodiversity planning process is provided in Section 21 and depends on the extent of natural areas remaining in the Local Government area. The local biodiversity planning process is staged over four Phases: scoping; preparation of a Discussion Paper; preparation of a Strategy; and implementation.

Associated with each of the Phases are key milestones that should be achieved upon completion of each Phase.

Outsourcing the entire planning process is a less preferable option, as it is more likely to result in the skills and expertise built up over the process remaining outside the organisation.

For the life of the Perth Biodiversity Project, financial and technical assistance may be available to assist with the preparation of Local Biodiversity Strategies. However, Local Governments have a responsibility to plan for the protection of biodiversity and will inevitably be required to demonstrate sound planning and strategic approaches to biodiversity conservation.

2.8. What about existing greening plans, corridor strategies and other related information?

Local Governments may consider that they have already prepared a Local Biodiversity Strategy or a large part of it through a previous project. As at 2002, 63% of Local Governments had a Greening or biodiversity-related plan for their local area, most of which were being implemented (Perth Biodiversity Project unpub. 2002). However, many of these plans focus solely on Local Government land or revegetation of cleared land to create **corridors**.

In contrast, a Local Biodiversity Strategy should be a strategic document which covers all local biodiversity (private and public lands) and sets out a clear path for the Local Government over a five- to 10-year period. The Strategy should set out Natural Area Condition (NAC) targets that are scientifically based (on ecological criteria) and integrated into Council's planning and decision-making processes.

Existing greening plans, corridor strategies, reserve inventories, Local Government environment plans, reserve management plans and flora and fauna surveys will give Local Governments undertaking a Local Biodiversity Strategy a head start but are not a substitute for a Local Biodiversity Strategy.

2.9. Can a Local Biodiversity Strategy be produced as part of a larger plan?

Generally, Local Biodiversity Strategies cannot be produced as part of a larger plan, such as a greening plan or NRM plan. Local Governments are strongly encouraged to produce a Local Biodiversity Strategy as a first step to increasing the awareness, information and status of local biodiversity in their Local Government area. The biodiversity of the Perth Metropolitan Region (PMR) and the greater South West is particularly high on a world scale and its protection and management is becoming increasingly more important as intensive development pressure and land use change affect natural areas and new information on biodiversity resources is documented (Myers et al. 2000). Combining biodiversity into a larger NRM plan has the strong potential to compromise biodiversity outcomes if sufficient time is not devoted to the process.

3. Legislation and policies

There are numerous international arrangements, as well as Federal, State and Local laws and policies that are linked to biodiversity conservation. Local biodiversity planning will enable Local Governments to meet their responsibilities under these laws and policies as well as achieve sustainable development and natural resource management (NRM) objectives. The key message is that the 'bar' is being lifted: all land owners, planners, managers and developers and Local Governments will need to perform to a higher standard to meet expectations created by legislation and policy as well as the expectations of the community.

Legislation and policies particularly significant for the preparation of Local Biodiversity Strategies is discussed in more detail below.

3.1. Federal Government legislation and policies relating to biodiversity

3.1.1. Federal Government legislation

The most significant Federal Government legislation relating to biodiversity is the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides for the assessment of actions, which, if implemented, may significantly impact on a matter of national environmental significance. There are seven matters of national environmental significance that are triggers for Commonwealth assessment and approval (Department of the Environment and Heritage 2003). These are:

- World Heritage properties
- National Heritage places
- wetlands which are listed as **Ramsar** wetlands of international importance
- nationally threatened species and communities which are listed under the EPBC Act (note that these species may not be the same as those listed under State legislation)
- migratory species that are listed under the EPBC Act (these are migratory species protected under international agreements)
- nuclear actions, including uranium mining
- the Commonwealth marine environment (which is generally Australian waters beyond the 3 nautical mile limit of State waters).

Under the EPBC Act a person must not take an action that has, will have or is likely to have a significant impact on any of these matters of national environmental significance without approval from the Commonwealth Environment Minister. There are penalties for taking such an action without approval (Department of the Environment and Heritage 2003).

Listings of Threatened Ecological Communities under the Federal EPBC Act are about two years out of date with current State of Western Australia listings. In addition, only those ecological communities in Western Australia identified as 'critically endangered' are identified under the Act. The communities within the Perth Metropolitan Region (PMR) currently listed under the EPBC Act are presented in Section 16.4.

3.1.2. Federal Government policies

Federal level biodiversity conservation policy includes:

- The National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) produced as part of the Commonwealth/State/Territory intergovernmental agreement on the environment and signed by the Federal Government and all States and Territories
- Natural Heritage Trust (NHT) Partnership Agreement (Commonwealth of Australia & State of Western Australia 1997)
- National Local Government Biodiversity Strategy (Berwick & Thorman 1999)
- National Framework for the Management and Monitoring of Australia's Native Vegetation (ANZECC 2000b)
- National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001b) produced as part of the Review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2000c) and signed by the Commonwealth and five State and Territory Governments, including Western Australia. The National Objectives and Targets for Biodiversity Conservation 2001–2005 recognise that the retention of 30% or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. This level of recognition is in keeping with the targets set in ANZECC (2000c)
- The National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance (ARMCANZ, ANZECC & Forestry Ministers 1997).

The Federal Government has also supported the preparation of a Local Government Biodiversity Toolbox, which provides advice for all Councils on biodiversity conservation, especially those in rural and regional Australia. The Toolbox promotes eight key outcomes for Local Governments that are reflected in these Guidelines. The Toolbox can be accessed through the Department of the Environment and Heritage's website http://www.deh.gov.au/biodiversity/toolbox/index.html.

3.2. State Government legislation and policies relating to biodiversity

3.2.1. State Government legislation

Wildlife Conservation Act 1950

The Wildlife Conservation Act 1950 is the primary State legislation directly protecting native flora and fauna in Western Australia. The Act contains general controls for the protection of all native species, with specific measures designed to protect rare or threatened species. The legislation does not provide protection for Threatened Ecological Communities (TECs) or recognise threatening processes. It is anticipated that the proposed Biodiversity Conservation Act will replace this legislation (Government of Western Australia 2002a).

Environmental Protection Act 1986

There are various ways in which the Environmental Protection Act 1986 (EP Act) protects biodiversity. Primarily, the EP Act enables Environmental Impact Assessment (EIA) and refusal or modification of all proposals that are likely to have significant environmental impacts.

Section 38 of the EP Act deals with the referral and assessment of proposals that are likely to have a significant impact on the environment. Any decision-making authority, such as a Local Government, must refer such proposals to the Environmental Protection Authority (EPA) (Clement et al. 2001).

Environmental assessments of Town Planning Scheme (TPS) Amendments are carried out under Part IV (sections 48A – 48F inclusive) of the EP Act. This provides the opportunity for a strategic assessment of significant environmental impacts identified on land affected by the TPS Amendment. These offer the best opportunity to identify and protect a site's biodiversity values.

The EP Act also gives the State power to develop **Environmental Protection Policies** (EPPs) to prevent, control or abate pollution or to protect any portion of the environment. The Act also regulates industries and activities likely to pollute the environment. EPPs of relevance to Local Governments in the PMR are the Environmental Protection (Swan Coastal Plain Lakes) Policy **(EPP Lakes)** (Government of Western Australia 1992b), the Swan and Canning Rivers Catchment EPP (Government of Western Australia 1998a), the Peel Inlet–Harvey Estuary EPP (Government of Western Australia 1992a) and the Western Swamp Tortoise EPP (Government of Western Australia 2002b).

The EPA, through the powers given to it under the EP Act can provide advice and guidelines to assist proponents, and the public generally, on environmental matters. In this regard, the EPA issues advice and information in the form of Guidance Statements, Position Statements or advice under section 16 of the EP Act (see EPA policy and guidance for assessing planning schemes below).

Soil and Land Conservation Act 1945

Under the Soil and Land Conservation Act 1945 proponents intending to clear native vegetation over 1 ha on any land must submit a Notice of Intent to Clear to obtain approval from the Commissioner for Soil and Land Conservation at least 90 days prior to clearing. In issuing an approval or refusal, the Commissioner for Soil and Land Conservation considers whether land degradation will occur as a result of the clearing. A Memorandum of Understanding also exists with other State Government agencies to allow impacts on biodiversity values to be assessed. Proposed amendments to the Environmental Protection Act 1986 to address clearing will supersede the clearing provisions in the Soil and Land Conservation Act 1945 once regulations have been passed by Parliament (see below).

Town Planning and Development Act 1928

The Town Planning and Development Act 1928 (as amended) (TPD Act) is the primary Act regulating the use, development and subdivision of land in Western Australia. The key provisions of the TPD Act include the creation of Statements of Planning Policy, the preparation and Review of Town Planning Schemes, subdivision control, compensation and betterment, and appeals against planning decisions. Decisions and approvals made under the TPD Act are subject to the provisions of the Environmental Protection Act 1986.

The principal means of controlling land use and development in the State is by means of Town Planning Schemes and Local Planning Policies, which are prepared in accordance with the provisions of these schemes. These are administered by the 142 Local Governments in Western Australia and the administration of the national territories of Christmas Island and Cocos (Keeling) Islands. As a result, Local Governments have an important role to play in ensuring that these planning instruments reflect local environmental, social and economic objectives.

The Metropolitan Region Scheme (MRS) and other region schemes are enacted under other legislation.

A layperson's description of the land planning system is included in Section 14 to show the sequence of plans and decisions that ultimately lead to development and clearing or retention and protection of natural areas.

Aboriginal Heritage Act 1972 and the Native Title Act 1993

Many natural areas may constitute an Aboriginal site as described in Section 5 of the Aboriginal Heritage Act 1972. Anyone planning to develop land in a way that might disturb an Aboriginal site should be aware of the legal obligations and all reasonable

efforts must be made to find out if any sites exist in the development area. Under the Aboriginal Heritage Act 1972, it is an offence to disturb any Aboriginal site without consent from the Minister for Aboriginal Affairs. The Aboriginal Heritage Act 1972 applies to:

- places of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of Aboriginal people, past or present
- any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent
- any place which, in the opinion of the Registrar, is or was associated with Aboriginal people and which is of historical, anthropological, archaeological or ethnographic interest and should be preserved because of its importance and significance to the cultural heritage of the State
- any place where objects to which the Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

In Western Australia, information regarding the consultation process with the Indigenous community for Aboriginal sites can be obtained from the Department of Indigenous Affairs (DIA). The process requires wide consultation with all Indigenous communities/ groups that may have an interest (i.e. Aboriginal sites) in the natural area.

A separate consultation process may be required under the Native Title Act 1993, where proponents should consult with the claimants of Native Title. The Native Title Act 1993 protects native title to some extent by allowing claimants certain consultation rights depending on the nature of the development on the land (Aboriginal and Torres Strait Islander Commission, 1999). Further information on this process in the south-west of Western Australia (including the PMR) can be obtained from the South West Aboriginal Land and Sea Council.

Proposed State legislation

Amendments to the Environmental Protection Act 1986 and a proposed Biodiversity Conservation Act will significantly increase the State Government's power to conserve biodiversity, and will largely bring Western Australia into line with the Federal EPBC Act and biodiversity conservation legislation in other States. This legislation or proposed legislation is described below.

Land clearing controls included in amendments to the Environmental Protection Act

Amendments to the Environmental Protection Act 1986 will introduce comprehensive clearing controls across the State once the associated Regulations are passed by Parliament. These clearing controls will replace the existing process under the Soil and Land Conservation Act 1945. The legislation is due to come into force in 2004 and introduces the requirement to obtain a clearing permit before any clearing can take place, unless exempted under the Environmental Protection Act 1986. Local Governments and others undertaking clearing will be required to prepare Vegetation Management Plans (VMPs) for those lands affected by the clearing to demonstrate how the impacts of clearing will be minimised.

Local Governments will also be requested by the Department of Environment (DoE) to provide comment on relevant proposals to clear during the assessment process under the clearing permits system. Local Biodiversity Strategies should enable Local Governments to more easily meet the requirements of the legislation and provide strategic and comprehensive advice on proposals where requested.

An application to clear may be refused by DoE where the proposed clearing does not comply with the principles set out under the Environmental Protection Act 1986 (See Appendix 5 for a copy of the Principles). Detailed criteria based on these principles are currently being developed by DoE for the assessment of land clearing applications. The

principles in the Act are environmental principles, and only the Department's Chief Executive Officer is able to take into account social or economic considerations.

Proposed Biodiversity Conservation Act

A consultation paper (Government of Western Australia 2002a) prepared by the State Government proposes that a new Biodiversity Conservation Act be introduced to protect all listed rare or threatened species and ecological communities and incorporate listing of threatening processes so that threat abatement plans can be developed.

The consultation paper also provides that the Minster for Environment may approve or recognise bioregional plans. An approved or recognised bioregional plan would need to be taken into consideration in making relevant decisions under the proposed Act (Government of Western Australia 2002a). A State Biodiversity Strategy is also proposed as part of the Biodiversity Conservation Act.

3.2.2. State Government policies

There is an expectation that Perth's Local Governments can and will reinterpret regional policy and apply it to the local situation. This becomes challenging given the range of regional strategies and policies and the reality of achieving on-ground multiple objectives (environmental, social, economic) at the local level. Most existing regional policy and law deals with specific components of biodiversity – bushland, wetlands or forest. Future policy is likely to be more encompassing of all biodiversity.

On the Swan Coastal Plain (SCP) portion of the PMR, the most significant existing regional policy to influence Local Governments preparing Local Biodiversity Strategies is Bush Forever and related bushland policies.

At the State level, Local Governments should be aware of the following policies when preparing Local Biodiversity Strategies:

- Bush Forever (Government of Western Australia 2000a, 2000b & 2000c) and related bushland policies (e.g. Urban Bushland Strategy)
- Environmental Protection Authority (EPA) Guidance Statement No. 10: Guidance for the Assessment of Environmental Factors – Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region (Environmental Protection Authority 2003a)
- EPA Guidance Statement No. 33 (Draft): Policies, Guidelines and Criteria for Environmental Impact Assessment - Guidelines for Environment and Planning (Environmental Protection Authority 1997)
- Forest Management Plan 2004 – 2013 (Conservation Commission 2003)
- System 6 report (Department of Conservation & Environment 1983) and the System 6 Update program (Department of Environmental Protection unpub. 1996)
- Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997)
- EPA Position Statement No. 4: Environmental Protection of Wetlands (preliminary) (Environmental Protection Authority 2001)
- EPA Position Statement No 2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority 2000b)
- State Weed Plan (State Weed Plan Steering Group 2001);
- Draft Policy Statement No. 9 Conserving Threatened Species and Ecological Communities (Department of Conservation and Land Management 2003a)
- EPA Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia. (Draft) (Environmental Protection Authority 2003c)

- EPA Guidance Statement No. 56: Guidance for the Assessment of Environmental Factors – Terrestrial fauna surveys for environmental impact assessment in Western Australia. (Draft) (Environment Protection Authority 2003d)
- Draft Statement of Planning Policy: Bushland Policy for the Perth Metropolitan Region (Western Australian Planning Commission in preparation)
- Western Australian State Sustainability Strategy (Government of Western Australia 2003a)
- Environment and Natural Resources Statement of Planning Policy No. 2 (Government of Western Australia 2003b)
- Peel-Harvey Coastal Plain Catchment Statement of Planning Policy No. 2.1 (Government of Western Australia 1992d)
- Jandakot Groundwater Protection Policy Statement of Planning Policy No. 2.3 (Government of Western Australia 1998b)
- Public Drinking Water Source Policy Statement of Planning Policy No. 2.7 (Government of Western Australia 2003g).
- Development Control Policy No. 2.3 Public Open Space in Residential Areas (Western Australian Planning Commission 2002)
- Position Statement: Wetlands. (Water and Rivers Commission 2001)
- Wildlife Conservation (Rare Flora) Notice 2001 (Government of Western Australia 2001b)
- Wildlife Conservation (Specially Protected Fauna) Notice 2001 (Government of Western Australia 2001c)
- Statement of Planning Policy No. 2.6: State Coastal Planning Policy (Government of Western Australia 2003c).

Most of these policies are reflected in regional level policy described below.

The Environmental Protection Authority (EPA) releases Position Statements and Guidance Statements for various environmental issues and the Western Australian Planning Commission (WAPC) prepares Statements of Planning Policy to guide various aspects of land use planning. State policies also exist for regional areas (for example, PMR, Swan Coastal Plain [SCP]) and some of these are described in more detail below.

Bush Forever and the Urban Bushland Strategy

The State Government's expectation that Local Governments will prepare Local Bushland Strategies has been public policy since 1995, as documented in the Urban Bushland Strategy (Government of Western Australia, 1995) and re-enforced in the Bush Forever policy released in 2000.

The Urban Bushland Strategy together with the System 6 report (Department of Conservation and Environment 1983) and the System 6 Update Program (Department of Environmental Protection unpub. 1996) led to a focus on the SCP portion of the PMR, and culminated in the release of the Bush Forever policy documents in 2000 (Government of Western Australia 2000a, 2000b, 2000c). In this process, the term 'bushland' was given a specific definition (see Glossary) that identified native vegetation in good or better condition based on the Keighery (1994) condition scale. This was as a result of a process to focus on selecting the best examples of the native vegetation present on the SCP and designating them as regionally significant areas for protection.

Bush Forever is the primary mechanism for implementing the State Government's commitment to conserve regionally significant bushland in Perth. It replaces the original 1983 System 6 report recommendations (Department of Conservation and Environment 1983) for the SCP portion of the PMR. It is a 10-year strategic plan to protect some 51,200 ha of regionally significant bushland in 287 Bush Forever Sites,

representing, where achievable, a target of at least 10% of each of the original 26 vegetation complexes of the SCP portion of the PMR.

Of the 26 vegetation complexes in the PMR, seven fall below the minimum 10% target for retention of each complex in the Perth Metropolitan Region. These are mainly in the highly cleared areas on the **eastern side of the Swan Coastal Plain** (equating to the Pinjarra Plain and Ridge Hill Shelf major landform elements). Where more than 10% remains, Bush Forever will protect the target 10% in all but three complexes (see Section 16.2) due to past development commitments and approvals. Bush Forever recognises that there may be opportunities outside the PMR to secure additional or substitute sites for these complexes.

Much of the vegetation on the eastern side of the Swan Coastal Plain is under intense threat from clearing for urban development. The vegetation shown in this photograph is typical of the Beemullah complex where only 6% of its pre-European extent remains. Photo: K Savage.

It is important to note that Bush Forever contributes only partly, although significantly, to the achievement of the core objective of the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996). Since the development of the Bush Forever target of protecting at least 10% of each ecological community in the PMR (based on IUCN/UNEP/WWF (1991) guidelines), research has clearly shown that at least 30% of each ecological community needs to be retained to begin to adequately protect biodiversity and maintain ecosystem processes (Sections 1.6 and 17). This 30% target is now reflected in the National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia 2001b). Achieving this target in the PMR will be a challenge.

Criteria for the selection of areas containing regionally significant bushland were developed in accordance with the Urban Bushland Strategy through the Urban Bushland Advisory Group (UBAG) and the System 6 Update Program (Department of Environmental Protection unpub. 1996). In conjunction with identifying those areas that met ecological criteria for regional significance, the Bush Forever Site selection process took into account the wider social and economic values of a particular site or resource, including land use zoning and the wider financial considerations of government. While no categories of land were automatically excluded from consideration, where lands were significantly constrained by existing zoning or development approvals, alternative choices were made where possible. All bushland with some existing level of protection was automatically included assuming it already

met ecological criteria for regional significance by virtue of the fact that efforts had already been made to protect these areas in the past.

Bush Forever is based on the concept that the protection of regionally significant bushland is the responsibility of State Government and the protection of other natural areas is primarily the responsibility of Local Government (with the support of State Government). Bush Forever's focus on regionally significant bushland does not detract from the importance of conserving Locally Significant Natural Areas (LSNAs). The Urban Bushland Strategy outlines that Local Bushland Strategies are required to identify bushland areas and the significance of these areas, and demonstrate how they are to be protected. Further, as stated in Bush Forever, it "does not include locally significant bushland sites, but the Government is committed to fulfilling its undertakings in the Urban Bushland Strategy to support Local Government in developing local bushland protection and greenway strategies" (Government of Western Australia 2000a pp ix). There is a high expectation from Local Governments and the Western Australian Local Government Association (WALGA) that local biodiversity planning will be given due regard by State Governments in their decision-making processes.

Local Governments, communities and developers must appreciate that Bush Forever excluded some sites of regional significance based on ecological value because of the social and economic constraints that existed at the time of Bush Forever. By virtue of the criteria that have been developed for these Guidelines to identify LSNAs, some of these sites will also meet regional significance criteria but may still be difficult, if not impossible, to protect because of land use planning constraints. It is important that the community appreciate this reality, and that we learn from the experience.

Bush Forever's strong support for Local Bushland Strategies will be given effect through the Draft Statement of Planning Policy: Bushland Policy for the Perth Metropolitan Region (Western Australian Planning Commission in preparation). This Statement of Planning Policy is currently being prepared by the Western Australian Planning Commission and provides a framework for Local Governments to prepare local bushland strategies. The Statement of Planning Policy indicates that local bushland strategies should be prepared as part of a wider Local Biodiversity Strategy that is based on agreed metropolitan-wide guidelines.

Wetlands, waterways and catchments

Wetlands, including swamps, damplands, rivers and estuaries, have been given special consideration in the PMR due to their special values and the past high impact of development on them in urban and rural areas. The Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) identified the need to protect wetlands of international (Ramsar wetlands), national and regional conservation value. The challenge now for Local Governments is to link wetland biodiversity to the protection of upland native vegetation.

Specified open water wetlands on the coastal plain are currently protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy (EPP Lakes) (Government of Western Australia 1992b). The policy has the force of law and makes it an offence to fill, excavate, mine, deposit effluent into, or construct or alter any drainage works associated with any lakes to which the policy applies (Government of Western Australia 1992b). The Policy is under review and may be expanded to cover vegetated Conservation Category Wetlands (CCW).

In the PMR, a preliminary assessment of wetland values has been conducted and wetlands have been placed in one of three management categories according to their values: Conservation, Resource Enhancement or Multiple Use. A Position Statement (Environmental Protection Authority 2001) has been developed outlining how wetlands in these categories should be addressed where development is proposed. There is also a basic assumption that all new development around wetlands will meet water sensitive urban design principles (Water and Rivers Commission 2003).

Local Governments in the Swan–Canning River **catchment** will also need to integrate the Swan and Canning Rivers Environmental Protection Policy (EPP) (Government of

Western Australia 1998a) into their Strategies and the requirements of the **Swan River Trust** (SRT) for the SRT area. This is best achieved through identifying actions that can be adopted at the local level in the Comprehensive Management Plan and Implementation Strategy (Riverplan), which are being produced by the State Government under the Swan and Canning Rivers Policy (Government of Western Australia 2003d).

Forests

Local Governments in the eastern portion of the PMR also need to be aware of the Forest Management Plan 2004 – 2013 (Conservation Commission 2003). The plan revokes the Forest Management Plan 1994 – 2003 (Department of Conservation and Land Management 1994) and those parts of the three Regional (Southern Forest, Central Forest and Northern Forest) Management Plans (Commonwealth of Australian & State of Western Australia 1999) that were current during the life of the Forest Management Plan 1994 – 2003 (Conservation Commission 2003).

The Forest Management Plan 2004 – 2013 makes recommendations for the use and management of forest ecosystems and lead to changes to land tenure and vestings. For example, the Forest Management Plan 2004 – 2013 makes recommendations (endorsed by the State Government) for 4 new National Parks in the PMR. The Department of Conservation and Land Management (CALM) is currently managing these areas as if they are already designated National Parks. These new Parks have made significant changes to the representation of vegetation complexes in protected areas.

EPA Policy and guidance for assessing Planning Schemes

In 1997 the EPA released draft Guidance Statement No. 33 Policies, Guidelines and Criteria for Environmental Impact Assessment (EIA) (Environmental Protection Authority 1997). This Guidance Statement was issued as a guide to assist Local and State Government planning agencies in the EIA process of planning schemes under Section 48 of the Environmental Protection Act 1986 (Environmental Protection Authority 1997). Guidance Statement No. 33 identifies the areas of highest conservation value of interest to the EPA and provides policy advice on the management of environmental impacts of proposals that could have a significant impact on the environment.

A final version of these guidelines was not released and the 1997 draft is still a key document informing planning agencies of the expectations of the EPA with regard to management of environmental impacts. However, a substantial review of Guidance Statement No. 33 is in preparation and due for release in 2004. This will significantly update the information available to Local and State Government planning agencies with regard to environmental planning. Since 1997 there have been substantial changes in the approach of the EPA to the protection of natural areas and the new version of Guidance Statement No. 33 will document these increased expectations for protection of significant natural areas and minimisation of environmental impacts.

Guidance Statement 10 - level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region

Guidance Statement 10 was prepared by the EPA in 2003 to provide guidance to proponents planning and designing proposals potentially impacting on regionally significant natural areas, threatened communities or species within the System 6 region and the Swan Coastal Plain portion of the System 1 region (Environmental Protection Authority 2003a). Guidance is provided on the criteria that must be met for a natural area to be recognised as regionally significant. Proponents are encouraged to revise/redesign or manage proposals to avoid impacts on regionally significant natural areas and where these impacts cannot be resolved the proposal should be referred to the EPA.

LSNAs are outside the scope of Guidance Statement 10 but the EPA expects that proposals impacting on LSNAs throughout System 6 and the Swan Coastal Plain

portion of System 1 will be dealt with in a manner that is consistent with the intent of the actions in Bush Forever regarding locally significant bushland (Environmental Protection Authority 2003a). It is important to note that the ecological criteria developed for these Guidelines (to identify LSNAs) also include the regional significance criteria summarised in Guidance Statement 10. Consequently there will be some LSNAs that will be subject to the requirements and process outlined in Guidance Statement 10.

3.3. Regional Natural Resource Management Strategies

The Commonwealth Government established the Natural Heritage Trust (NHT) in 1996 to help fund environmental activities at the National, State, Regional and Local level and in May 2001 the Government committed further funds to the program until 2006. Regional investment strategies are now the principle delivery mechanism for the NHT where investments are made on the basis of a regional NRM plan, incorporating the major natural resource management issues in the area. Under this structure, regional communities, comprising landholders, industries, non-government organisations, Local and State or Territory Governments and other interested parties, are involved in the development of regional plans, to be called Accredited NRM Strategies to decide which are the most important issues for action and funding.

In this process, **Regional Accredited NRM Strategies** are being prepared for all regions of Western Australia to identify priorities for NRM investment by the Commonwealth and State Governments and the private sector. Biodiversity conservation is a major objective of each of these plans. A Swan NRM Strategy will cover most of the Local Governments located in the PMR, except for those in the southern portion of the PMR that fall within the Peel–Harvey sub-region of the South West NRM region (see Figure 3).

It is important that Local Governments are engaged in the preparation of these regional plans, so that they can influence the priorities for future NRM works and bid for future public environmental funding.

The biodiversity conservation component of the Swan NRM Strategy is the first step towards a regional biodiversity strategy. This was supported in the Local Government Survey (Perth Biodiversity Project unpub. 2002), where 80% of Perth's Local Governments called for a regional biodiversity strategy. The biodiversity conservation component of the Swan NRM Strategy aims to provide overarching regional objectives and targets to assist in promoting consistency in biodiversity conservation planning, to identify Regional Ecological Linkages and local ecological linkages and to provide a context for combining the aims of Bush Forever and local level actions.

3.4. Other formal protection mechanisms for Perth's natural areas

In addition to Bush Forever and legislative mechanisms requiring biodiversity and natural area protection, some natural areas are formally recognised and protected by one or more of the following:

- CALM Managed Estate
- Regional Parks
- Local Government reserves and other public reserves
- conservation covenanted and conservation zoned lands
- System 6 areas.

CALM Managed Estate

The CALM Managed Estate includes State Forest, Nature Reserves, National Parks, Conservation Parks and a variety of other land purpose categories. CALM manages these lands on behalf of the Conservation Commission of WA and the public of

Western Australia. The management of Nature Reserves and National Parks is guided by specific management plans and State Forest management is directed under a 10-year Forest Management Plan (e.g. 2004 – 2013 Forest Management Plan). All management plans provide opportunities for the public and Local Government to contribute to the management of these areas.

Regional Parks

Regional Parks are areas of Regional Open Space that are identified as having outstanding conservation, landscape and recreation values. There are eight regional parks in the PMR:

- Yellagonga Regional Park
- Herdsman Regional Park
- Canning River Regional Park
- Beeliar Regional Park
- Woodman Point Regional Park
- Jandakot Regional Park
- Rockingham Lakes Regional Park
- Darling Range Regional Park.

These parks are made up of lands vested in a variety of agencies, and include some privately owned lands covered by Parks and Recreation reservations in the MRS and Local Government managed reserves. Regional Parks allow a coordinated planning and management strategy to be applied across important, keynote regional landscapes.

The role of CALM in regional park management is two-fold. Firstly to manage those areas of Regional Parks that are vested in the Conservation Commission of WA and land vested or owned by the WAPC, and secondly, to coordinate the management of Regional Parks in their entirety. Numerous Local Government managed reserves are included in Regional Parks and will need to be considered in a Local Biodiversity Strategy. Community involvement in the ongoing management of regional park lands is important and encouraged.

Local Government reserves

There are approximately 7800 ha of native vegetation in Local Government reserves in the PMR.

Local Governments are given responsibility to manage reserves by Management Orders issued by the Department of Land Information (DLI). The purpose for which the reserve is to be managed is specified in the Management Order and includes purposes such as drainage, protection of indigenous flora and fauna, or recreation. The purpose of the reserve can be altered with the approval of DLI, and can include any reasonable objective of the reserve, such as stream-course protection or protection of native fauna habitat.

The specified purpose of the reserve does not necessarily restrict management of the reserve to that use or value. Under the Land Administration Act 1997 (LA Act), Local Governments can manage a reserve for other values that are "ancillary or beneficial" to the formal purpose [Section 46 (1)]. However, the formal recognition of the purpose of a reserve is a clear indication to land managers, surrounding landholders and the community of why the reserve is valued and how it can be used.

Local Governments are strongly encouraged to reflect biodiversity values in the formal purpose of reserves where it is the Council's intention to conserve biodiversity. Failure to formally recognise biodiversity values and ecosystem services in reserve purposes will provide another barrier to public investment for biodiversity conservation in these reserves. This is discussed in more detail in Section 10.4.

Conservation covenanted lands

Covenants can provide formal protection of natural areas. There are three covenanting programs available to public and private land mangers in Western Australia operated by:

- the National Trust
- CALM
- Department of Agriculture Western Australia.

All these covenants are voluntary agreements between the landholder and the covenanting organisation. Stewardship and expert management advice are provided with covenants with the National Trust and CALM. When a conservation covenant is applied, the land should be zoned consistent with the conditions of the covenant (i.e. conservation zoning) because determinations relating to inconsistencies between the TPS and a covenant will rule in favour of the TPS.

Town Planning Scheme (TPS) zoning provisions to protect biodiversity

Local Governments can use their local TPS to recognise and protect natural areas. Schemes may recognise natural areas by zoning (for example, conservation zoning) or by overlays (for example, landscape protection overlays or special control areas). For lands that are subject to conservation covenants Local Governments should aim to formally recognise this commitment (between the landholder and the covenanting body) through the TPS.

Schemes can also contain general provisions for the protection of natural assets, such as those applying to special rural areas or trees. However, these provisions have limited value given the difficulty of enforcement and the fact that they only apply to a small part of the landscape or vegetation. See Section 15 for more detail on protection mechanisms for Locally Significant Natural Areas.

System 6 areas

Some System 6 areas recommended for protection in the Jarrah Forest portion of the PMR are still current (outside CALM Managed Estate) and at some stage in the future the State Government will be reviewing these. These recommendations can be considered to have the equivalent status for the protection of natural areas as Bush Forever Sites on the Swan Coastal Plain (SCP).

3.5. Local Government legislation and policies

Before a Local Government produces a Local Biodiversity Strategy, it will be important to identify it's laws and policies that already deliver some aspects of biodiversity protection. Examples of such legislative mechanisms include:

- TPS Zonings – conservation zones, conservation living zones, rural landscape protection zones, subdivision for conservation
- TPS provisions – vegetation protection areas, prohibition of grazing, tree preservation clauses
- Local laws, for example, for the control of cats; or the listing of Pest Plants for which the Local Government has the power to require land owners to control or eradicate specified species (Clement et al. 2001).

Examples of Local Government policies that deliver a biodiversity conservation outcome include:

- Greening or Wildlife Corridors Plans
- Municipality-wide Environmental Plans or Strategies
- Reserve Management plans
- policies for environmental assessment of development

- Local Weed Strategy
- Local Planning Policies.

Local Governments that have some or all of the above, will still not be able to demonstrate that they are achieving local conservation of biodiversity. To do this, they will need to prepare a comprehensive, long-term strategy based on scientifically derived biodiversity conservation objectives and Natural Area Condition (NAC) targets. It will also need to have sound ecological assessment integrated into their land planning systems and decision-making processes. This is what Local Biodiversity Strategies are designed to achieve.

4. Status of Perth's natural areas

The Perth Metropolitan Region (PMR) falls within the **South West Botanical Province** of Western Australia, which is recognised as one of the world's top 25 **biodiversity hotspots** due to the large number of flora and fauna species, the extent to which they are restricted to the region and the significant threats to the region's biodiversity (Myers et al. 2000). This province covers south-western Western Australia from Shark Bay in the north to east of Esperance in the south. It supports an estimated 8000 **taxa** (species, subspecies and varieties) of vascular plants, representing two-thirds of the estimated plant taxa in Western Australia (Hopper et al. 1996; Beard, Chapman & Gioia 2000). Over 80% of the plant taxa are **endemic** to the South West Botanical Province (that is, they occur nowhere else in the world) (Beard, Chapman & Gioia 2000).

The PMR intersects two distinct natural regions, the Swan Coastal Plain (SCP) and the Darling Plateau (and its associated escarpment, the Darling Scarp). The boundaries for these regions are defined in the Interim Biogeographical Regionalisation of Australia **(IBRA)** as the 'Swan Coastal Plain Bioregion' and the 'Jarrah Forest Bioregion' (Commonwealth of Australia 2001a). They are two of the seven bioregions within the South West Botanical Province. Within the Swan Coastal Plain Bioregion, the Dandaragan Plateau (and its associated scarp, the Gingin Scarp) is recognised as a distinct subregion. The Jarrah Forest Bioregion is also split into two subregions, the Northern (JF1) and Southern Jarrah Forests (JF2) (see Figure 3).

The PMR comprises an area of 290,000 ha of the Swan Coastal Plain Bioregion and 244,000 ha of the Jarrah Forest Bioregion. In 2001, only 80,000 ha (28%) of native vegetation was mapped on the SCP portion of the PMR with 53,000 ha (18%) currently protected or proposed for protection. In the Jarrah Forest Bioregion of the PMR, 186,000 ha (76%) of native vegetation was mapped in 2001, of which 138,000 ha (56%) is currently protected or proposed for protection (Table 2).

Of the total amount of native vegetation mapped (266,000 ha) in the PMR, 191,000 ha is located in Bush Forever Sites, Department of Conservation and Land Management (CALM) Managed Estate and Regional Parks. The remaining 75,000 ha are considered to be Local Natural Areas (LNA) and are the focus of these Guidelines (Table 2). The long-term retention of LNAs is threatened by the fact that 58,000 ha of native vegetation is located on private land and 12% of this amount is zoned under the Metropolitan Region Scheme (MRS) for intensive development (Urban, Urban Deferred, Industrial, Special Industrial, Central City Area). Bush Forever Sites and Regional Parks that are under the control and/or management of Local Government should also form part of a Local Biodiversity Strategy.

Table 2. The extent of native vegetation within the Swan Coastal Plain and Jarrah Forest portions of the Perth Metropolitan Region (PMR)

Perth Metropolitan Region	Total Area	2001 Native Vegetation Remaining (ha)	%	2001 Native Vegetation 'Protected' (CALM Managed Estate, Bush Forever Sites, Regional Parks) (ha)	%	2001 Native Vegetation 'Unprotected' (ha)	%
Swan Coastal Plain	290 000	80 000	28	53 000	18	27 000	10
Jarrah Forest	244 000	186 000	76	138 000	56	48 000	20
TOTAL	**534 000**	**266 000**	**50**	**191 000**	**36**	**75 000***	**14**

**Of the unprotected native vegetation remaining in the PMR, approximately 58 000 ha (77%) is on private land and of this, 8 900 ha (12%) is zoned by the Metropolitan Region Scheme for intensive development (Urban, Urban Deferred, Industrial, Special Industrial, Central City Area)*

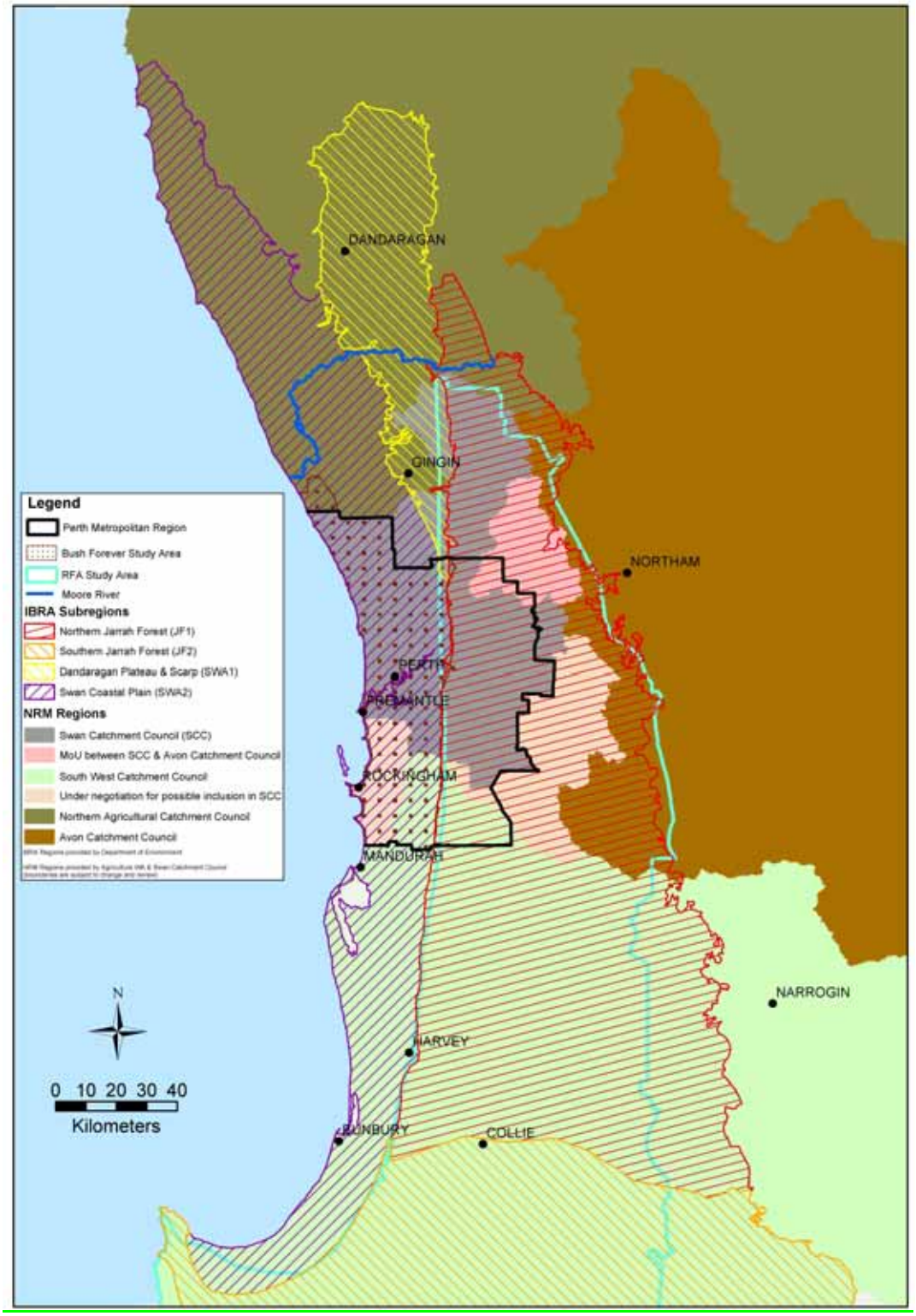


Figure 3. Natural Resource Management, Biogeographical, Administrative and Study Regions relevant to local biodiversity planning in the Perth Metropolitan Region.

Within the PMR, there are 26 vegetation complexes represented in the SCP portion and 18 vegetation complexes represented in the Jarrah Forest portion. Nine vegetation complexes have 10% or less of their pre-European extent remaining within the SCP IBRA bioregion and are therefore considered to be threatened (see Section 16.1). A further nine vegetation complexes on the SCP portion have between 10% and 30% of their pre-European extent remaining within the IBRA bioregion (see Section 16.1).

Native vegetation on the SCP Bioregion is significantly more fragmented than that of the Jarrah Forest Bioregion in the PMR. For example, of the 5800 different parcels of mapped native vegetation in the PMR, 4200 were mapped in the SCP portion and 1600 were mapped in the Jarrah Forest portion. A parcel is defined as a single mapped area of native vegetation (it may straddle properties and other boundaries).

The fragmentation of native vegetation in the PMR has contributed to a number of species and communities being listed by CALM as Declared Rare Flora (DRF) or Threatened Ecological Communities (TECs). There are currently 302 occurrences of DRF and 401 occurrences of TECs. The number of occurrences of DRF and TECs within the PMR are likely to increase as more ecological communities are assessed for listing as TECs and as more natural areas are surveyed (see Section 16.4 for listing of TECs as of August 2003).

Wetlands are an important feature on the Swan Coastal Plan. Not all wetlands have surface water. This photograph shows a well vegetated dampland in Gosnells. Photo: K Savage.

This photograph shows the flooded claypans during winter at Brixton Street in Kenwick. This wetland is described as a sumpland. Photo: Greg Keighery (supplied by Urban Nature).

Wetlands and waterways are also an important and characteristic feature of the Swan Coastal Plain. Approximately 80,000 ha of the PMR is mapped as wetland (based on the Department of Environment's geomorphic wetland mapping dataset0. These wetlands have also been assigned into preliminary management categories of conservation, resource enhancement and multiple use based on wetland condition and values). There are about 14,000 ha of native vegetation associated with these wetlands. The protection of native vegetation associated with wetlands should be a high priority as it has been estimated that at least 80% of the wetlands on the SCP have been lost or irreversibly degraded (Environmental Protection Authority 1991). Native vegetation of seasonally waterlogged wetlands (for example, damplands and **palusplains**) is some of the most floristically diverse of all vegetation in the PMR. In addition to the native vegetation associated with Perth's wetlands there is approximately 10,000 ha of native vegetation located within 50 m of waterways that provide important ecological linkage functions and other ecological services.

5. Ecological criteria to identify Locally Significant Natural Areas

One of the most important parts of local biodiversity planning is to establish the ecological criteria for assessing the biodiversity conservation value of natural areas. These criteria identify the natural areas that are of greatest value for biodiversity conservation.

While all natural areas have some value in conserving biodiversity, determining these values and assessing the condition and viability of each area is the best way to determine the most strategic investment of resources on public and private land. Although setting priorities for the retention, protection and management of natural areas must be based on socio-economic criteria and other environmental criteria as well as ecological criteria, it is important to first establish a clear picture of the biodiversity resource. This will allow a transparent, accountable and defendable position for decisions affecting natural areas. It is also important to establish a vision, objectives and targets for biodiversity retention, protection and management.

Natural Area Condition (NAC) targets allow Local Governments to formalise the ecological criteria for determining which Local Natural Areas are locally significant. The NAC targets should be developed and reviewed with close community consultation to ensure the process remains transparent as well as ensuring the community fully understands the objectives and targets set. The setting of a vision, objectives and Natural Area Condition targets is discussed in more detail in Part B (Section 9.2) and ideas for community consultation are discussed in more detail in Part C (Section 18).

Once NAC targets are established Local Governments can then implement the necessary framework and processes required to retain and protect natural areas to meet these targets. The ecological criteria provided in these Guidelines have been designated a level of priority, either **Essential criteria** or **Desirable criteria** (see Section 5.2), consistent with existing legislation and policies. This allows an initial prioritisation of Local Natural Areas (LNAs) before further considering social and economic constraints (Section 5.2 and 10.6). A prioritisation process (based initially on ecological factors) of all Locally Significant Natural Areas (LSNAs) may have to occur in some Local Government areas to ensure the NAC targets being set are achievable where significant socio-economic constraints (such as urban or industrial zoning) exist. These Guidelines promote the development of a range of NAC targets that reflect high, medium and low targets based on the ecological criteria discussed below. Community consultation will be important in this process to determine the most suitable level of biodiversity target that will be adopted in a Local Biodiversity Strategy.

5.1. Ecological criteria

The intent and rationale of the ecological criteria must be understood as widely as possible during the preparation of the Strategy and explained during public consultation. Setting standard ecological criteria for use by all Local Governments ensures that the natural areas required to maintain biodiversity within each Local Government area, as well across the region, are retained and where possible protected and appropriately managed.

Local Government boundaries are administrative and do not relate to the biological processes and factors that affect the distribution of native species and communities. Therefore, standard criteria must be used by each Local Government to contribute to regional biodiversity conservation.

The ecological criteria to identify LSNAs in the Perth Metropolitan Region (PMR) are an adaptation of the Bush Forever ecological criteria plus the original local significance criteria proposed in the Urban Bushland Strategy (Government of Western Australia 1995).

The standard ecological criteria for local biodiversity planning are grouped under the following themes:

- Representation of ecological communities
- Diversity
- Rarity
- Maintaining ecological processes or natural systems – connectivity
- Protecting wetland, streamline and estuarine fringing vegetation and coastal vegetation.

Two other key criteria groupings used in Bush Forever have not been included in these Guidelines:

- Scientific or evolutionary importance
- Criteria not relevant to determination of regional significance, but which may be applied when evaluating areas having similar values.

The Bush Forever scientific or evolutionary importance criterion has not been adopted as it is unlikely to apply to LNAs. Natural areas meeting this Bush Forever criterion should be picked up by processes identifying areas of International, National, State or Regional conservation value.

The remaining Bush Forever criteria grouping incorporate a number of factors "not relevant to determination of regional significance, but which may be applied when evaluating areas having similar values" (Government of Western Australia 2000a). These are socio-economic and other environmental factors that add value to natural areas and were used in Bush Forever when choices were made between areas of similar ecological value to determine which site/s would be protected. The Environmental Protection Authority (EPA) in its latest approaches to identifying regionally significant natural areas (Environmental Protection Authority 2003a, 2003b) has not subsequently used this criterion. These factors are best assessed after ecological values are established.

Many of the criteria (discussed below) use the term 'ecological community'. As discussed in Section 1.1, in the PMR the most common way to interpret ecological communities for quantitative targets based on area are the vegetation complexes (and their groupings into major landform elements) as defined and mapped by Heddle et al. (1980) for the Swan Coastal Plain and Mattiske and Havel (1998) for the Jarrah Forest. In the PMR, ecological communities are also defined as floristic community types (Gibson et al. 1996, Department of Environmental Protection unpub. 1996), forest site types (Havel 1975a, 1975b) and Threatened Ecological Communities (English and Blyth 1997, 1999). However these have not been mapped in a way that allows them to be used for quantitative targets based on area. The criteria in this document are therefore based on using vegetation complexes as a means of measuring the broad scale patterning of ecological communities. If more detailed, appropriate information exists to interpret ecological communities, Local Governments are encouraged to use it.

5.1.1. Representation of ecological communities

Any Local Natural Area confirmed as meeting one or more of the following criteria is referred to as a Locally Significant Natural Area.

Criterion 1a. Regional representation

Criterion 1a) i). Any natural area with recognised International, National, State or Regional Conservation Value (outside Bush Forever Sites and Department of Conservation and Land Management [CALM] Managed Estate) that is not yet protected and/or managed for conservation (Essential).

These areas are identified in the following documents and databases:

- areas protected under or containing species protected under the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and its amendments (Department of the Environment and Heritage GIS database, undated). As well as **threatened flora, threatened fauna** and Threatened Ecological Communities, this includes areas such as Ramsar listed wetlands (Ramsar Convention on Wetlands) and areas supporting populations of migratory birds protected under international agreements (for example, Japan Australia Migratory Bird Agreement [JAMBA] and China Australia Migratory Bird Agreement [CAMBA])
- System 6 recommendation areas outside the Bush Forever Study Area and CALM Managed Estate (Department of Conservation and Environment, 1983). In the Jarrah Forest some natural areas outside the CALM Managed Estate are recognised for their regional conservation value as System 6 areas (these sites include both public and private land)
- other regionally significant natural areas outside the Bush Forever Study Area (yet to be formally recognised through the System 6/part System 1 Update program) (Environmental Protection Authority 2003b). Contact the Department of Environment for current information
- Wetlands in the Directory of Important Wetlands in Australia (Department of the Environment and Heritage, undated)
- additions to the Conservation Estate through the Forest Management Plan 2004 – 2013 (Conservation Commission 2003).

This criterion ensures all areas with regional or greater conservation value are identified within each Local Government area and any natural areas not already protected by the State or Federal Government are afforded protection in conjunction with Local Government. There are unlikely to be many LNAs that meet this criterion as these areas should already be adequately protected. In some cases Local Government may already be involved in partnerships with State or Federal government and the community for management of these areas.

Regional Representation – This vegetation complex (Southern River) is recognised as being of regional significance. Only 17% of its original extent on the Swan Coastal Plain portion of the Perth Metropolitan Region remains and only 10% is proposed to be protected through Bush Forever. Photo: J Cullity.

Criterion 1a) ii). Natural areas of an ecological community with only 1500 ha or 30% or less (whichever is the greater) of their pre-European extent remaining in the Interim Biogeographical Regionalisation of Australia (IBRA) subregion (Essential – Jarrah Forest, Desirable – Swan Coastal Plain).

This criterion (Table 3) is based directly on the National Targets and Objectives for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001b). It aims to retain the minimum amount of native vegetation cover needed to prevent exponential loss of species and failure of ecosystem processes across the landscape (Section 1.6).

For the Swan Coastal Plain south of the Moore River, these statistics should be calculated for the SWA1 and SWA2 IBRA subregions for the major landform elements and vegetation complexes defined by Heddle, Longeragan and Havel (1980) (Section 16.1). For the Jarrah Forest, the vegetation complexes defined by Mattiske and Havel (1998) should be used within the JF1 IBRA subregion (Department of Environment 2003). Table 3 provides the major landform elements and vegetation complexes which currently meet this criterion (based on circa 1997 statistics and taking into account the limitations of these statistics).

Table 3. Vegetation complexes that currently meet Criterion 1 a) ii) based on circa 1997 statistics

IBRA Region	Major Landform Element	Vegetation Complex
Jarrah Forest	None due to area retained in CALM Managed Estate	
Swan Coastal Plain	Dandaragan Plateau	Mogumber South
	Gingin Scarp	Reagan
	Foothills (Ridge Hill Shelf)	Forrestfield
	Pinjarra Plain	Guilford Swan Dardanup Serpentine River Beermullah Yanga
	Combinations of Bassendean Dunes/ Pinjarra Plain	Cannington Southern River
	Bassendean Dunes	Bassendean Central and South
	Spearwood Dunes	Karrakatta North Karrakatta Central and South
	Quindalup Dunes	Quindalup
	Wetlands	Herdsman Pinjar
	Marine (Estuarine and Lagoonal) Deposits	Vasse

Criterion 1a) iii) large (greater than 20 ha), viable natural areas in good or better condition of an ecological community with over 30% of its pre-European extent remaining in the IBRA subregion (Desirable).

Where more than 30% of an ecological community remains, this is an opportunity to retain and protect a network of natural areas that are large, viable and in good or better condition that provide the conditions necessary to maintain biodiversity. The 30% threshold is a generalisation based on the range of studies conducted to date and may not be adequate to prevent the exponential loss of species for all ecological communities (see Sections 1.6 and 17). Even at the 30% threshold there will already

have been a moderate decline in the diversity of species that are sensitive to fragmentation.

It is also important to remember that current statistics on the extent of ecological communities in the PMR (measured by using vegetation complexes) relies on data gathered remotely via satellite imagery or aerial photography. Therefore once a community is recorded as reaching the 30% threshold, the on-ground reality will inevitably be a much smaller extent of a community that is intact, viable and in good condition and thus able to maintain biodiversity. It is therefore essential to select the most viable areas in the best condition and with the greatest potential for connectivity to other areas in good condition to meet the 30% target.

In addition, higher thresholds for native vegetation cover may be required for objectives other than biodiversity conservation. The maintenance of natural hydrological cycles to prevent salinisation of land and water and to maintain ground and surface water quality and quantity depends heavily on native vegetation extent and condition. In some catchments a minimum of 70% native vegetation cover is required to prevent or begin to bring salinity under control (Government of Western Australia 1992c). Perth's major water catchments in the Jarrah Forest are already being affected by salinity and other water quality problems (Government of Western Australia 1992c) and salinisation of land is occurring on the SCP (Angell 2000).

Setting criteria for the retention and protection of natural areas to maintain environmental services is beyond the scope of these Guidelines but needs to be considered as part of the assessment of the future of any natural area.

Criterion 1a) iv). Natural areas of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for conservation in the Jarrah Forest IBRA subregion (Desirable).

While at least 30% of a given ecological community needs to be retained to conserve biodiversity, it is recognised that a certain proportion of this must occur in areas designated specifically for conservation. These areas are to be secured from future conflicting land uses and actively managed for conservation (i.e. they are protected).

Under the Regional Forest Agreement (RFA) process a minimum of 1500 ha or 15% (whichever is the greater) was set as a criterion for protection in secure tenure of forest ecosystems (ANZECC/ MCFFA 1997). This precedent of aiming to protect 15% of an ecological community has since been adopted by the EPA and applied to vegetation complexes (Environmental Protection Authority 2003b).

For preparation of the new Forest Management Plan, Havel (2002) conducted an analysis of the current extent and protection levels (existing and proposed) of the vegetation complexes within the RFA study area as mapped by Mattiske and Havel (1998). This analysis showed that two complexes, Darling Scarp and Dwellingup 1, were below the 15% protection level even after including the proposed changes to the formal and informal conservation reserves system, as documented in the Draft Forest Management Plan 2003 - 2013 (Conservation Commission 2002). In addition, Havel (2002) noted that for the Darling Scarp complex in particular, the opportunities to improve the protection level through reservation of State Forest was very limited because the majority of the remaining areas of this complex are in private ownership or on public lands not managed by CALM.

The Forest Management Plan 2004 – 2013 (Conservation Commission 2003) has now been finalised and creates a number of new formal and informal conservation reserves as part of the CALM Managed Estate. However, the Darling Scarp vegetation complex still remains poorly represented within CALM conservation reserves (Conservation Commission 2003 and Department of Conservation and Land Management unpub. 2003). Therefore, this complex is a priority for protection in local biodiversity planning in consultation with relevant State Government agencies.

The analysis of vegetation complexes across the original extent of the RFA study area also presents problems as some of the complexes extend beyond the RFA study area. To more accurately determine the extent and protection levels of vegetation complexes occurring within the PMR an ecologically based sub region of the JF1 IBRA sub region

needs to be used where the vegetation complexes are fully mapped. This type of analysis is currently being undertaken for the PMR by State Government for the Perth Biodiversity Project and will be forwarded to Local Governments when available.

Criterion 1a) v). Natural area of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in the Bush Forever Study Area (Essential).

For the PMR portion of the SCP, Bush Forever has set a protection target of 400 ha or 10% or less (whichever is the greater) for each ecological community. LNAs may not meet the Bush Forever criterion for designation as regionally significant bushland to be protected, but they can still contribute to maintaining this protection target. To maintain the biodiversity of the SCP portion of the PMR it is important to at least aim for a 10% protection target even if this is achieved through a combination of large regionally significant Bush Forever Sites and smaller, LSNAs protected by mechanisms put in place by Local Government. The major landform elements and vegetation complexes that currently meet this criterion (based on 1997 statistics published in Bush Forever (see Section 16.2) and taking into account the limitations of these statistics) are listed in Table 4.

Table 4. Vegetation complexes that currently meet Criterion 1 a) v) based on 1997 statistics

IBRA Region	Major Landform Element	Vegetation Complex
Swan Coastal Plain	Dandaragan Plateau	Mogumber South
	Gingin Scarp	Reagan
	Foothills (Ridge Hill Shelf)	Forrestfield Coonambidgee
	Pinjarra Plain	Guilford Swan Dardanup Serpentine River Beermullah Yanga
	Combinations of Bassendean Dunes / Pinjarra Plain	Cannington Southern River
	Bassendean Dunes	Bassendean Central and South
	Spearwood Dunes	Karrakatta Central and South
	Marine (Estuarine and Lagoonal) Deposits	Vasse

Criteria 1b. Local representation

Criterion 1b i). Natural area of an ecological community with 10% or less of its pre-European extent remaining within the Local Government area (Essential).

The aim of this criterion is to conserve local biodiversity and local sense of place at a bare minimum level (Section 1.6). This criterion ensures that there is a level of natural area retention in Local Government areas where there are few areas already protected in CALM Managed Estate or Bush Forever Sites. Local Government should aim to ensure that all natural areas meeting this criterion are secured and protected for conservation. The Perth Biodiversity Project has provided each Local Government with the information required to set NAC targets for this criterion based on the 2001 mapping of remnant vegetation in the PMR undertaken for this project (see section 16.3 Table 21).

Criterion 1b ii). Natural area of an ecological community with 30% or less of its pre-European extent remaining within the Local Government area (Essential – Jarrah Forest, Desirable – SCP).

This criterion directly addresses the need to conserve local biodiversity and local sense of place at an adequate level for biodiversity conservation within the Local Government area. It aims to ensure that the minimum amount of native vegetation cover needed to prevent exponential loss of species and failure of ecosystem processes across the Local Government area is retained (Section 1.6).

Local Government should aim to ensure that a pre-determined proportion of the natural areas meeting this criterion is secured and protected for conservation using appropriate mechanisms. These areas need to be the best condition, most viable examples of each community available with the greatest potential for connectivity to other good or better condition areas.

The proportion protected needs to be determined in consultation with the local community but should not be less than 10% of an ecological community's whole extent across the Local Government area. This criterion ensures that there is a level of natural area retention and protection in Local Government areas where there are few areas protected in CALM Managed Estate or Bush Forever Sites. The Perth Biodiversity Project has provided each Local Government with the information required to set NAC targets for this criterion based on the 2001 mapping of remnant vegetation in the PMR undertaken for this project (see section 16.3 Table 21).

Patersonia occidentialis *is a common species throughout the south-west. Common species (local representation), and not the rare and unusual, are the backbone of all natural areas. Protecting and managing these natural areas ensure we keep the common, common. Photo: K Savage.*

Criterion 1b iii). Large (greater than 10 ha), viable natural areas in good or better condition of an ecological community with more than 30% of its pre-European extent remaining within the Local Government area (Desirable).

As explained under regional representation Criterion 1a iii), where more than 30% of an ecological community remains the opportunity exists to retain and protect a network of natural areas that are large, viable and in good condition to provide the conditions necessary to maintain biodiversity. Also as discussed under Criterion 1a iii), higher thresholds may be required to provide other ecosystem services.

5.1.2. Diversity

This criterion relates to the diversity of ecological communities within a natural area.

Detailed criteria for diversity, and in particular species diversity, have not been included in these Guidelines due to the extensive ecological work that is required to document diversity in a way that allows comparisons between natural areas. Information exists on the diversity of flora and fauna for a number of natural areas in the PMR but considerable expertise would be needed to interpret this information to assess natural areas against diversity criteria.

Although this expertise was available in State Government for the development of Bush Forever, the resources required to provide it to Local Government are not likely to be available in the near future. Central to this problem is the lack of opportunities for ecologists to develop expertise in biodiversity conservation and assessment methodologies to be able to deliver these services to Local Government. However, Local Governments are encouraged to consider the diversity of their natural areas using the following simple diversity criterion. Only one diversity criterion is set in these Guidelines for use by Local Government, due to its importance in influencing the diversity of natural areas and its ease of measurement.

Criterion 2 i). Natural areas in good or better condition that contain both upland and wetland structural plant communities (Essential).

Upland and wetland communities are quite different at an ecological level and contain a range of species and habitats that are complementary. The transitional habitats between these communities are also particularly diverse. Therefore, any natural area still in good or better condition that contains both upland and wetland communities will have a high diversity of living organisms.

Local Governments are encouraged to seek professional advice in setting other diversity criteria relevant to their local area where this advice is available and knowledge of diversity of their LNAs can be documented and interpreted for use. The criteria being developed for the land clearing permit system to operate under the 2003 amendments to the Environmental Protection Act 1986 will provide a useful guide to developing other diversity criteria.

5.1.3. Rarity

Under these criteria, rarity refers to the scarcity or lack of abundance of ecological communities measured at the vegetation complex level or the floristic community level (eg Threatened Ecological Communities) or at the individual species level. All areas meeting rarity criteria are, at the very least, regionally significant in conservation value, except for small, less viable areas meeting only criteria iv) and v) below. Natural areas meeting rarity criteria do occur outside Bush Forever Sites and CALM Managed Estate where it has not been possible to date to include them in large, consolidated protected areas or where new occurrences have been documented recently.

Criterion 3 i). Natural areas of an ecological community with only 1500 ha or 10% or less (whichever is the greater) of their pre-European extent remaining in the IBRA subregion (Essential).

The vegetation complexes currently meeting this criterion based on circa 1997 statistics (taking into account the limitations of these statistics) (Section 16.1) are given in Table 5.

Table 5. Vegetation complexes that currently meet Criterion 3 i) based on circa 1997 statistics

IBRA Region	Major Landform Element	Vegetation Complex
Swan Coastal Plain	Foothills (Ridge Hill Shelf)	Forrestfield
	Pinjarra Plain	Guilford Swan Dardanup Serpentine River Beermullah Yanga
	Combinations of Bassendean Dunes / Pinjarra Plain	Cannington Southern River

Criterion 3 ii). Natural areas of an ecological community with only 400 ha or 10% or less (whichever is the greater) of their pre-European extent remaining in the Bush Forever Study Area (Essential).

The vegetation complexes currently meeting this criterion based on 1997 statistics published in Bush Forever (Volume 1) (Government of Western Australia 2000a) (taking into account the limitations of these statistics) are given in Section 16.2 and Table 6.

Table 6. Vegetation complexes that currently meet criterion 3 ii) based on 1997 statistics

IBRA Region	Major Landform Element	Vegetation Complex
Swan Coastal Plain	Dandaragan Plateau	Mogumber South
	Gingin Scarp	Reagan
	Foothills (Ridge Hill Shelf)	Forrestfield Coonambidgee
	Pinjarra Plain	Guilford Swan Dardanup Serpentine River Beermullah Yanga
	Combinations of Bassendean Dunes / Pinjarra Plain	Cannington
	Marine (Estuarine and Lagoonal) Deposits	Vasse

Criterion 3 iii). Natural areas classified by CALM as containing Threatened Ecological Communities (TECs) (English & Blyth 1997, 1999; CALM TEC GIS database, undated) (Essential).

There is currently an expectation in land use planning that TECs will be protected but at present there is only legislation in place to protect the most severely threatened of these listed communities under the Federal EPBC Act. The Biodiversity Conservation Act currently being drafted for Western Australia proposes statutory protection for all listed TECs. The new land clearing controls proposed under amendments to the State's Environmental Protection Act 1986 are also likely to seek to prevent clearing of all listed TECs.

TECs listed by CALM (as of August 2003) are found at the website http://www.calm.wa.gov.au/plants_animals/critical_communities.html (Department of Conservation and Land Management 2003c). This list is updated regularly. The list as of August 2003 has been used to generate a listing of TECs by Local Government area (Section 16.4). Specialist knowledge is required to identify TECs. When a Local Government is advised that a TEC may be present in a natural area, it should contact the WA Threatened Species and Communities Unit (WATSCU) at CALM's Woodvale Research Centre for advice.

This sedgeland at Port Kennedy is a Threatened Ecological Community listed under the Environmental Protection and Biodiversity Conservation Act 1999. It occurs here on private land. Photo: V English.

Criterion 3 iv). Natural areas containing Declared Rare Flora (DRF), Specially Protected Fauna (SPF) or significant habitat for Specially Protected Fauna (Essential).

Significant habitat is habitat that provides resources (breeding, resting, feeding), connectivity or habitat that is critical for a species survival (Safstrom unpub. 2002). DRF and Specially Protected Fauna are protected under the State's Wildlife Conservation Act 1950. Lists of these protected species are regularly updated and published in the Government Gazette. Most of these species are also listed for protection under the EPBC Act. The Biodiversity Conservation Act currently being drafted for Western Australia will update the statutory protection of these species. The new land clearing controls proposed under amendments to the State's Environmental Protection Act 1986 should also provide protection for these species.

Criterion 3 v). Natural areas containing Priority or other significant flora or fauna or significant habitat for these fauna (Essential).

Priority flora are plant taxa that are under consideration as threatened flora but need further survey to adequately determine their status, or are adequately known but require monitoring to ensure that their security does not decline. Priority Flora lists are maintained by CALM. The process of researching and listing species for statutory protection under the Wildlife Conservation Act 1950 and the Federal EPBC Act is a detailed and lengthy process and statutory lists do not necessary reflect the current state of knowledge. A more serious problem is the lack of resources available to ensure adequate survey of natural areas to determine those species that are naturally rare or threatened. Where specialists identify Priority or other significant flora or fauna in LNAs and this is the only criterion the natural area meets, then the reason for concern over these species needs to be considered and advice sought, especially if this natural area is in poor condition and of low viability.

Lists of priority flora and priority fauna species are maintained by CALM. Other significant flora and fauna are determined by regional studies where these studies exist. Bush Forever Volume 2 (Government of Western Australia 2000b) contains lists of significant flora and fauna for the SCP portion of the PMR but such listings are not currently available for the Jarrah Forest.

5.1.4. Maintaining ecological processes or natural systems – connectivity

A number of criteria can be set with the objective of maintaining ecological processes or natural systems. For the purposes of local biodiversity planning, the key issue is protecting and managing natural areas that are important for maintaining connectivity at the regional and local scale. This helps to ensure the viability of retained and protected areas and the continued survival of connectivity-sensitive species within these areas. It allows living organisms to move freely along environmental gradients in response to various threats, for example, wildfire and climate change.

The objective of ecological linkage is to connect natural areas, preferably with continuous corridors of native vegetation, in ways that allow fauna and flora (pollen, seeds etc.) to move between these areas to access resources and suitable habitat for survival and reproduction. In highly fragmented landscapes, continuous corridors of vegetation rarely exist, except perhaps along rivers and creeklines and this vegetation is often in poor condition.

Research in the ACT/NSW region has shown that the connectivity of natural areas becomes a significant factor for the distribution of many woodland birds species when areas are less than 10 ha in size (Freudenberger 1999). For areas below 10 ha there was a direct relationship between distance from other natural areas and the probability of a given species being present (Freudenberger 1999). Generally, natural areas needed to be within 500 - 1000 m of one another to maintain the diversity of woodland bird species (Freudenberger 1999). The third significant factor was the structural complexity of the vegetation in the natural area, with degraded areas with only trees and few shrubs remaining being of limited value (Freudenberger 1999). It was concluded that **stepping stones** of good condition native vegetation at least 10 ha in size located no more than 500 – 1000 m from each other provided the best connectivity across the landscape for a range of woodland bird species (Freudenberger 1999).

Several studies have found that linear corridors of native vegetation need to be at least 25 - 50 m wide to function effectively as linkage for a range of bird species (Freudenberger 1999, Barrett 2000). This width requirement is likely to provide linkage that also suits a range of other animals as well as many plants, fungi, invertebrates and microorganisms. A width of 50 m is considered the minimum required for maintaining the viability of long, linear natural areas. For linear corridors of reconstructed habitat of this width to be effective, they would also need to consist of a mix of trees, shrubs, herbs, grasses and sedges/rushes similar to the natural areas being linked to recreate the structural complexity of habitat required by a wide range of species.

Therefore, the most effective way to provide connectivity across the landscape for as many species as possible is to protect existing natural areas as stepping stones within broad bands (linkages) that connect the larger, more viable natural areas.

Criterion 4 i). Natural areas acting as stepping stones within a Regional Ecological Linkage (Essential).

All existing LNAs partly or wholly contained within a designated Regional Ecological Linkage are considered to meet this criterion. Regional Ecological Linkages have been identified by the Perth Biodiversity Project (Figure 6) based on work in:

- Bush Forever Volume 2 (Map 7, p 72, Government of Western Australia 2000b)
- Perth Greenways report (Tingay & Associates 1998)
- System 6 report (Department of Conservation and Environment 1983) (see Section 6.2).

Criterion 4 ii). Natural areas acting as stepping stones within a local ecological linkage determined by a Local Government (Essential).

All existing LNAs within 500 m of a designated local ecological linkage are considered to meet this criterion. Each Local Government is to identify local ecological linkages as part of the local biodiversity planning process (see Section 6.2 for Guidelines for identification of locally significant ecological linkages).

5.1.5. Protecting wetland, streamline and estuarine fringing vegetation and coastal vegetation

Conservation of the biodiversity characteristics of this category of natural areas is covered by the six following criteria:

Criterion 5 i). Wetlands meeting the criteria for listing as Conservation Category or Resource Enhancement Wetlands plus an appropriate buffer (minimum 50 m) in addition to the wetland dependant vegetation (Essential).

Protecting good condition wetlands with an associated buffer, ideally of upland vegetation, is already expected under existing state and regional legislation and policy (Section 3.2) for a number of reasons:

- a significant loss of wetlands has already occurred due to past development
- good condition wetlands play a crucial role in maintaining land and water quality and quantity
- the wetlands of south-western Western Australia and in particular, the SCP, contain a unique and highly diverse range of species and communities
- most of Perth's wetlands are directly connected to regional and/or local groundwater aquifers.

Criterion 5 ii). Wetlands listed under the Environmental Protection (Swan Coastal Plain Lakes) Policy (EPP Lakes) plus an appropriate buffer (Essential).

Criterion 5 iii). Riparian vegetation along rivers, creeklines and other channel wetlands plus an appropriate buffer (minimum 50 m) in addition to the riparian (wetland dependant) vegetation (Essential).

Criterion 5 iv). Floodplains delineated on the basis of ecological and geomorphic features plus an appropriate buffer (minimum 50 m) in addition to the floodplain area (Essential).

Criterion 5 v). Estuarine fringing vegetation plus an appropriate buffer (minimum 50 m) of non-estuarine vegetation (Essential).

Criterion 5 vi). Coastal vegetation on the foredunes and secondary dunes (Essential).

All wetlands meeting criteria for listing as Conservation Category or Resource Enhancement Wetlands (using the methodology outlined in Environmental Protection Authority 1993) or designated as EPP Lakes (Government of Western Australia 1992b) within a Local Government area need be protected with an appropriate buffer. The new land clearing controls proposed in the amended Environmental Protection Act 1986 are likely to provide statutory protection for Conservation or Resource Enhancement Category Wetlands. The revised Environmental Protection (Swan Coastal Plain Wetlands) Policy is also likely to provide statutory protection for Conservation Category Wetlands (CCW) as well as EPP Lakes.

Protection of wetland and riparian vegetation is a high priority in natural resource management (NRM) planning due to the pivotal role healthy waterways play in hydro-geological cycles affecting land and water quality and quantity. On many occasions, riparian vegetation will also form part of a designated Regional Ecological Linkage or local ecological linkage. The aim is to protect all riparian vegetation plus an appropriate buffer of upland vegetation, where this still exists, to ensure effective filtering of nutrients and other pollutants. Natural areas that are wetlands or areas with riparian vegetation are often long and thin. Therefore, it is important that they are wide enough to be viable and function effectively as ecological linkages.

Floodplains are generally **no-development zones** due to the risk of damage to infrastructure when flooding occurs, even if such flooding is an infrequent event. Any native vegetation occurring on or buffering floodplains is important for the stability of the soils and landform of the floodplain itself and the health of the associated river system or wetland. Floodplains, especially those that are regularly inundated, can also be important breeding and feeding sites for a wide range of fauna and important for the maintenance of life cycles of specialised plant groups. The filling of floodplains to

allow construction of buildings, roads and other development typically leads to problems downstream due to the channelling of fast flowing water down a river system or flooding elsewhere in the case of wetlands.

Estuarine fringing vegetation is fundamental to the natural ecological processes that maintain the health of the associated waterway. Estuaries are some of the most biologically productive and significant ecosystems in any natural region. The estuary and its fringing estuarine vegetation contribute significantly to the maintenance of biodiversity on land and at sea. It is, therefore, essential that all estuarine fringing vegetation be retained and protected.

Apart from its biodiversity conservation value coastal vegetation is particularly important for the stabilisation of beaches and dunes along the coast. All **foredune** and **secondary dune** vegetation needs to be retained and protected to prevent costly losses of beach, dunes and infrastructure. Many coastal Local Governments around Australia have experienced catastrophic events that could have been avoided if foredune and secondary dune vegetation had been retained. The recently released Statement of Planning Policy No. 2.6: State Coastal Planning Policy (Government of Western Australia 2003c) should be used to guide costal development along with this criterion. The policy recommends a total setback from the coast of 100 m to protect development from physical processes on the coast from the:

- the impact of a severe storm sequence
- shoreline movement
- global sea level rise
- the fluctuation of natural coastal processes.

The protection of coastal vegetation is important for dune stabilisation. Photo: K Savage.

The setback calculations outlined in this Statement of Planning Policy will not normally delineate the coastal foreshore reserve. The policy notes that factors other than physical processes will often require a greater setback than that recommended for protecting development from physical processes and these should be considered on a case-by-case basis. These factors include ecological values, landscape, seascape, visual amenity, indigenous and cultural heritage, public access, recreation and safety to lives and property.

All of the above criteria (5i – 5iv) are likely to be supported by the land clearing controls proposed under amendments to the Environmental Protection Act 1986.

5.2. Essential and Desirable criteria

LNAs that meet any one of the Essential Criteria listed in Table 7 are considered the minimum required in order to retain common species typical of disturbed landscapes and to maintain those species and communities designated rare or threatened under current legislation or policy. However, it must be remembered that all the ecological criteria (Essential and Desirable) are of equal importance in determining the minimum set of areas required for conservation of biodiversity in the PMR to prevent the rapid loss of biodiversity that occurs as native vegetation cover decreases in fragmented landscapes (Section 1.6 and Figure 2).

Threshold targets exist for the representation and rarity ecological criteria. Criteria are designated as Essential where a 10% threshold target for retention or protection exists, and Desirable where a 30% threshold target exists. Where statistics show that

clearing has already led to the ecological community being less than or equal to the percentage threshold for a given ecological criteria, then no further clearing should occur and all native vegetation of that ecological community should be retained. In some circumstances it is unlikely that all of the native vegetation meeting criteria having threshold targets will be in good or better condition and viable in the long-term. In these circumstances efforts to protect and manage LNAs meeting these criteria should focus on the best condition and most viable areas with the greatest potential for connectivity to other good or better condition areas.

Where the extent of a remaining ecological community exceeds the threshold targets set for particular criteria, an opportunity exists to retain and protect a network of natural areas that are large, viable and in good or better condition. Once a community reaches the threshold target based on remotely measured statistics using satellite imagery or aerial photography, invariably, a much smaller proportion than this remains on the ground that is intact, viable and in good or better condition and so able to maintain biodiversity. Clearing down to the threshold target and retaining only those areas required to meet the target is not supported, especially if no land development constraints exist. Until we can better predict the thresholds required to conserve the unique biodiversity of the ecological communities of the SCP and Jarrah Forest based on research in these actual ecosystems, the **precautionary principle** applies.

Table 7 provides a summary of the ecological criteria to identify Locally Significant Natural Areas, lists their priority and the appropriate assessment methods to determine the natural areas that meet each criterion. These Guidelines promote the use of two assessment methods: a desktop assessment using remotely collected information, as well as field assessment.

Table 7. Summary of ecological criteria to identify Locally Significant Natural Areas, their priority ('Essential' or 'Desirable') and the appropriate methods to determine natural areas that meet each criterion

Criteria	Priority	Assessment Method[1]
1. Representation a) Regional		
i) recognised International, National, State or Regional conservation value (outside Bush Forever Sites and CALM Managed Estate) not already protected, for example, System 6 Areas in the Jarrah Forest outside CALM Managed Estate	ESSENTIAL (also of regional or greater value)	DESKTOP (Potentially Locally Significant Natural Areas [PLSNAs]) FIELD CONFIRMATION[2]
ii) of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in the IBRA subregion	ESSENTIAL Jarrah Forest only (also of regional or greater value) DESIRABLE Bush Forever Study Area only	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iii) large (greater than 20 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the IBRA subregion	DESIRABLE (also of regional or greater value)	FIELD[3]
iv) of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for conservation in the Jarrah Forest IBRA subregion	DESIRABLE Jarrah Forest only (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION

[1] Assessment Method: refer to Sections 10.6 and 12 of the Guidelines for more information

[2] Desktop information needs to be checked in the field to determine whether the criterion is met

[3] Field information is required to determine whether the criterion is met

Criteria	Priority	Assessment Method[1]
v) Of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in Bush Forever Study Area	ESSENTIAL Bush Forever Study Area only (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
1. Representation b) Local		
i) of an ecological community with 10% or less remaining within the Local Government area The aim of this criterion is to conserve local biodiversity and local sense of place at a bare minimum level. However, 10% is not recognised as adequate for biodiversity conservation. No LNAs will meet this criterion where 10% of an ecological community is already protected in CALM Managed Estate, Regional Parks or Bush Forever Sites.	ESSENTIAL	DESKTOP (PLSNAs) + FIELD CONFIRMATION
ii) of an ecological community with 30% or less remaining within the Local Government area The aim of this criterion is to conserve local biodiversity and local sense of place at an adequate level for biodiversity conservation. No LNAs will meet this criterion where 30% of an ecological community is already protected in CALM Managed Estate, Regional Parks or Bush Forever Sites.	ESSENTIAL Jarrah Forest only DESIRABLE Bush Forever Study Area only	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iii) large (greater than 10 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within Local Government area	DESIRABLE	FIELD
2. Diversity		
i) natural area in good or better condition that contains upland and wetland structural plant communities	ESSENTIAL	FIELD
3. Rarity		
i) of an ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in the IBRA subregion	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
ii) of an ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in Bush Forever Study Area	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iii) contains a threatened ecological community (TEC)	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iv) contains Declared Rare Flora (DRF), Specially Protected Fauna (SPF) or significant habitat for these fauna	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
v) contains Priority or other significant flora or fauna or significant habitat for these fauna	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION

Criteria	Priority	Assessment Method[1]
4. Maintaining ecological processes or natural systems – connectivity		
i) natural areas acting as stepping stones in a Regionally Significant Ecological Linkage	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
ii) natural areas acting as stepping stones in a locally significant ecological linkage	ESSENTIAL	DESKTOP (PLSNAs) + FIELD CONFIRMATION
5. Protection of wetland, streamline and estuarine fringing vegetation and coastal vegetation		
i) Conservation or Resource Enhancement category wetland plus buffer	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
ii) EPP Lake plus buffer	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iii) riparian vegetation plus buffer	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
iv) floodplain area plus buffer	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
v) estuarine fringing vegetation plus buffer	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION
vi) coastal vegetation on foredunes and secondary dunes	ESSENTIAL (also of regional or greater value)	DESKTOP (PLSNAs) + FIELD CONFIRMATION

5.3. Potentially Locally Significant Natural Areas

Information collected through the Natural Area Initial Desktop Assessment template will need to be verified in the field by an appropriate expert. Photo: R Ryan.

The Perth Biodiversity Project has developed a GIS dataset of Potentially Locally Significant Natural Areas (PLSNAs) using remotely collected, regional GIS datasets to identify those LNAs likely to meet Essential and / or Desirable Criteria for local significance. This GIS dataset is indicative only of the values of LNAs. GIS information is not available to address all Local Significance Criteria (for example it impossible to accurately assess vegetation condition using current regional GIS datasets). In most cases, only field assessment can determine that a site meets one or more criteria. It is worth checking whether the required field information is already available through previous local investigations or from within the local community.

Table 8 quantifies the extent of those LNAs that potentially meet Local Significance Criteria based on the GIS dataset of PLSNAs. The extent of LNAs that meet essential and desirable criteria may increase or decrease when field assessments of LNAs are undertaken and consideration is given to additional criteria (those not measurable by GIS) and the viability of individual natural areas. Figure 4 displays the PLSNAs identified through GIS analysis.

Table 8. Area (ha) of Local Natural Areas (LNAs) predicted to meet Essential and Desirable Criteria based on desktop analysis: Potentially Locally Significant Natural Areas (PLSNAs).

		Jarrah Forest (JF) IBRA Region (ha)	% of Total LNA in JF	Swan Coastal Plain (SCP) IBRA Region (ha)	% of Total LNA in SCP	Perth Metropolitan Region PMR (ha)	% of Total LNA in PMR
Summary							
Local Natural Areas (LNA)		46,700	100	26,600	100	73,300	100
LNA meeting Essential & Desirable criteria		22,000	47	22,800	86	44,800	61
Essential		20,600	44	18,300	69	38,900	53
Desirable		3,300	7	19,600	73	22,900	31
Desirable Only		1,400	3	4,500	15	5,900	8
Essential Criteria							
Criteria	**Criteria Codes** [1]						
Regional representation i) Recognised International/ National/ State or Regional Conservation Value (outside Bush Forever Sites, Regional Parks & CALM Managed Estate) not already protected eg. System 6 Areas in the Jarrah Forest outside CALM Managed Estate	A	1,020	2	0	0	1,020	1
	B	400	1	0	0	400	0
ii) Of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in the Jarrah Forest IBRA subregion	A	0	0	0	0	0	0
	B	0	0	0	0	0	0
v) Of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in Bush Forever Study Area	A	0	0	11,600	44	11,600	16
	B	0	0	0	0	0	0

[1] Criteria codes: A = meeting this criterion and other criteria(s), that is, non-exclusive; B = meeting this criterion exclusively

Table 8. Area (ha) of Local Natural Areas (LNAs) predicted to meet Essential and Desirable Criteria based on desktop analysis: Potentially Locally Significant Natural Areas (PLSNAs).

		Jarrah Forest (JF) IBRA Region (ha)	% of Total LNA in JF	Swan Coastal Plain (SCP) IBRA Region (ha)	% of Total LNA in SCP	Perth Metropolitan Region PMR (ha)	% of Total LNA in PMR
Local Representation	A	120	0	3,530	13	3,650	5
i) Of an ecological community with 10% or less remaining within LGA	B	0	0	0	0	0	0
Rarity	A	0	0	3,800	14	3,800	5
i) Of an ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in IBRA subregion	B	0	0	0	0	0	0
ii) Of an ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in Bush Forever Study Area	A	0	0	2040	8	2,040	3
	B	0	0	0	0	0	0
iii) Contains a Threatened Ecological Community (TEC)	A	30	0	2320	9	2,350	3
	B	0	0	180	1	180	0
iv) Contains Declared Rare Flora	A	110	0	220	1	330	0
	B	50	0	20	0	70	0
iv) Contains Specially Protected Fauna		2630	6	10	0	2,640	4
		1910	4	0	0	1,910	3
v) Contains Priority or other significant flora	A	240	0	160	1	400	0
	B	40	0	0	0	40	0
v) Contains Priority or other significant fauna	A	300	0	3200	11	3,500	5
	B	90	0	1350	5	1,440	2
Maintaining ecological processes or natural systems - connectivity	A	13,200	28	4950	18	18,150	25
i) Natural areas acting as stepping stones within a regional ecological linkage	B	9,700	21	780	3	10,480	14

Table 8. Area (ha) of Local Natural Areas (LNAs) predicted to meet Essential and Desirable Criteria based on desktop analysis: Potentially Locally Significant Natural Areas (PLSNAs).

		Jarrah Forest (JF) IBRA Region (ha)	% of Total LNA in JF	Swan Coastal Plain (SCP) IBRA Region (ha)	% of Total LNA in SCP	Perth Metropolitan Region PMR (ha)	% of Total LNA in PMR
Protection of wetland, streamline and estuarine fringing vegetation & coastal vegetation	A	120	0	3550	13	3,670	5
i) Conservation or Resource Enhancement Category Wetland plus buffer	B	50	0	240	1	290	0
iii) Riparian vegetation plus buffer	A	6,430	14	570	2	7,000	10
	B	3,670	8	30	0	3,700	5
Desirable Criteria							
Criteria No's	**Criteria Codes**						
Regional representation	A	0	0	18,800	70	18,800	25
ii) Of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for Conservation in the Jarrah Forest IBRA subregion	B	0	0	4,100	15	4,100	6
iv) Of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in the Swan Coastal Plain IBRA subregion	A	0	0	2400	5	2400	3
	B	0	0	990	2	990	1
Local Representation	A	1,030	2	8,570	31	9,600	13
ii) Of an ecological community with 30% or less remaining within LGA	B	390	1	260	1	650	1

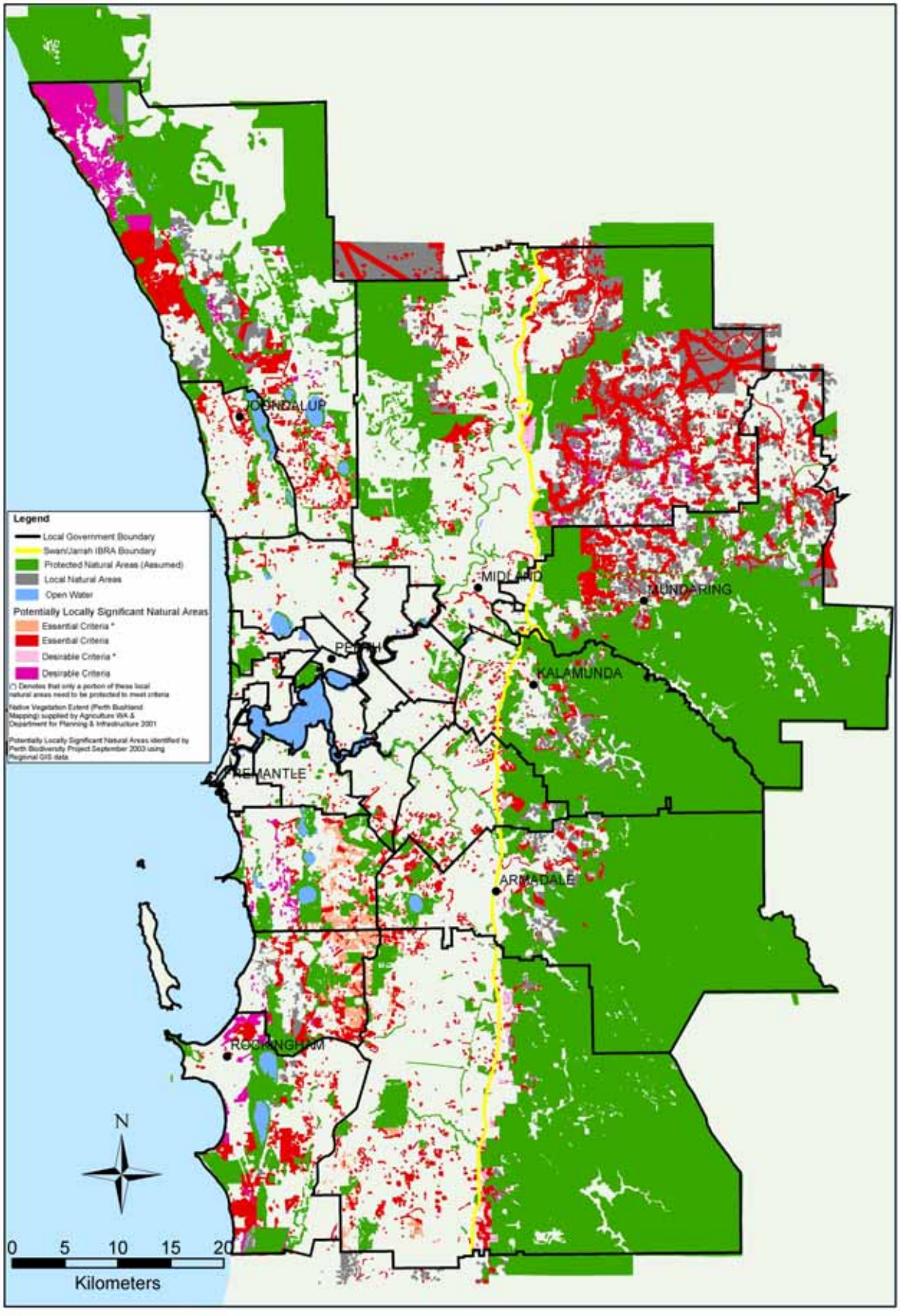


Figure 4. Potentially Locally Significant Natural Areas (PLSNAs) for the Perth Metropolitan Region.

5.4. Consideration of other environmental and social values

It is important that LSNAs are identified using the standard ecological criteria discussed in Section 5.1. Any Local Natural Area that meets at least one of these ecological criteria is considered locally significant. However, Locally Significant Natural Areas are likely to provide many other environmental values, as well as being of importance for social reasons. These other values add significance to sites that already meet ecological criteria and can help garner additional community support for the protection of LSNAs. And where there is community interest and / or support for the protection of a LSNA it is likely that this will be given considerable regard by decision-makers.

Therefore, the values described below should not be used to identify Locally Significant Natural Areas, but should be listed as part of an assessment of opportunities and constraints when considering the future of an LSNA.

Consideration of other environmental values

Biodiversity and natural areas provide **ecosystem services**, such as fresh water, clean air, soil fertility and biological pest control, on which our society is built. Failure to sufficiently protect natural areas is one of the root causes of **eutrophication** of rivers and estuaries, dryland salinity, soil acidity, soil erosion and decreased water quality. For example, the maintenance of the water quality in our major waterways, namely the Swan and Canning Rivers, is closely linked to the amount of natural area loss in their catchments. To put the value of ecosystem services in perspective, a recent report by the World Resources Institute values 'free' ecosystem services at over $30 trillion to the global economy each year (as cited in Commonwealth of Australia 2001b).

Retention of LSNAs in many circumstances will contribute towards the maintenance of natural water and nutrient cycles for the following reasons:

- natural areas are important for the trapping of rubbish, settling of sediment or for biological filtering of nutrients
- natural areas are required to protect the landscape and infrastructure from flood damage, for example, natural areas on or bordering flood plains
- natural areas are required to protect development from physical processes at the coastline
- natural areas are important for groundwater recharge to maintain water quality and quantity
- natural areas are important for maintaining surface water quality and quantity.

Many of the other environmental benefits of retaining and protecting natural areas are supported by the State Government policies listed in Section 3.2.2.

Consideration of other social values

Consideration of other social values may contribute to the opportunities for the retention and protection of a natural area. In instances where criteria are developed to reflect these values, it will be important that this is clearly stated and areas identified using these criteria are clearly distinguished from LSNAs meeting ecological criteria. Examples of some key social values are discussed below.

- Indigenous or European, heritage or cultural value
  - A natural area with Indigenous heritage or cultural value may be a registered Aboriginal Heritage Site. Consult with the local Indigenous community and for registered sites, with the Department of Indigenous Affairs (DIA)
  - A natural area with European heritage or cultural value, for example, built structure, past land use. Consult with the local community. Also consult with

the Heritage Council of WA for sites entered in the Register of Heritage Places.

- Education, community or passive recreation value
  - Active Friends/environmental group involved in protecting/managing the natural area
  - Natural area of particular value to the community. Consult with the local community
  - within walking distance (400 m) (Government of Western Australia 2000d) of the following:
    - educational facility (school, technical college, university). Determine the educational use and potential for management by faculty, students and local residents
    - retirement village. Determine use for passive recreation and potential for management by local residents
    - active recreational facility. Determine use for passive recreation and potential for management by recreation groups and local residents
    - outer edge of a residential area. Determine use for passive recreation and potential for management by local residents.
- Aesthetic value
  - natural area located on a prominent high point in the landscape, for example, local hill, ridge-line
  - natural area screening or buffering one land use from another (e.g. interface between industrial and residential)
  - natural area containing a scenic natural feature, for example, granite outcrop, open water wetland
  - natural area with general landscape value

Optional Criteria for icon species or communities – locally significant flora, fauna and/or communities

A Local Government may choose to create criteria for locally significant flora, fauna and/or ecological communities relevant to their area. Many members of the community can relate to the natural environment through identification of recognisable or significant flora or fauna species. Local Government may wish to identify icon flora and fauna through consultation with their local community. Icon species may be very common species and do not have to be unique to the Local Government area. These criteria allow a Local Government to focus on establishing a sense of place for the local community through promoting an easily identifiable species. It also allows the focus to be taken away from rare and threatened species that may not be encountered very often by the local community. The focus for locally significant fauna needs to be on protecting the habitat that supports these fauna. An example of potential icon flora and fauna species are the floral and fauna emblems used by the Shire of Denmark, the red flowering gum (Eucalyptus ficifolia) and the Splendid Blue Wren (Malurus splendens) found in south-western Western Australia (Figure 5).

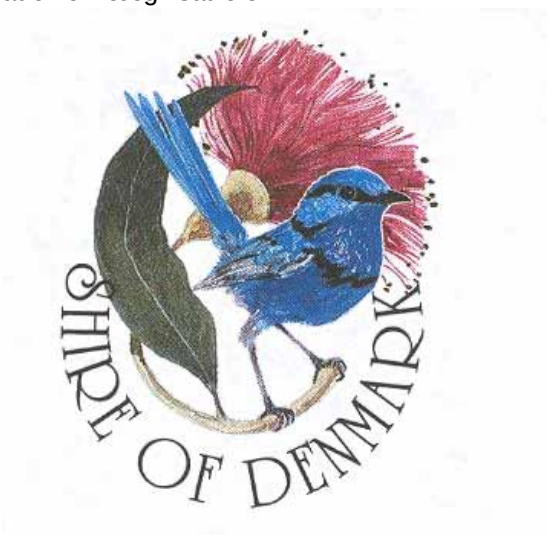


Figure 5. The red flowering gum (Eucalyptus ficifolia) and the Splendid Blue Wren (Malurus splendens) are the flora and fauna emblems of the Shire of Denmark.

6. Guidelines for viability assessment and determining ecological linkages

Many natural areas in the Perth Metropolitan Region (PMR) are small in size and fragmented or isolated from other natural areas. This has significant implications for the management as well as the long-term integrity of the biodiversity values of these areas. Even if an area meets any one of the ecological criteria (discussed in Section 5) and is locally significant, it will be important to assess whether these values can be maintained into the future. An assessment of the viability of all natural areas will need to be undertaken as this has significant impacts on the level and cost of management required for a natural area. Any assessment of viability will only ever be a relative estimate as viability assessments represent a simplification of a complex system based on a handful of easily measured viability factors.

6.1. Assessing the viability of natural areas

Viability is a measure of the ability of an ecological community to be self-sustaining in supporting and maintaining the full range of living organisms it naturally contains over a long time frame, that is for at least 50 years. Viability depends a great deal on the inherent **resilience** of an ecological community. Resilience is the natural ability of a community to resist or recover from disturbance, for example, weed invasion, fire, diseases, pests and other threats.

A very important factor influencing viability is the level of management input. Small, degraded areas may be viable with intensive management. However, it is important to consider whether the level of management required to make an area viable is worth the potential biodiversity outcomes anticipated.

It is very difficult to determine criteria for assessing viability for a given ecological community without long-term research. It is even more difficult to set criteria that apply to a wide range of communities such as those that occur across the PMR. Therefore, standard criteria for viability have not been developed, but these guidelines have been prepared to assist in the analysis of the viability of natural areas. The viability of natural areas should be assessed during the desktop and field assessment process detailed in Section 12. It is an important consideration when setting priorities during the local biodiversity planning process and, if necessary, deciding the percentage, proportions and configurations of each natural area to be protected.

The five easily measured components of viability are discussed below:

- size
- shape
- perimeter to area ratio
- condition
- connectivity.

6.1.1. Size

Size is an important factor in determining the long-term viability of a natural area: the bigger the area, the greater its capacity to retain its biodiversity, maintain ecological function and resist disturbance factors and threatening processes. However, the minimum size for a given area to be viable varies greatly between different ecological communities and depends on the presence of threats and how well these can be controlled. For example, on sandy soils banksia woodlands with a naturally dense shrub understorey may be relatively resistant to weed invasion and can be viable in small

patches of only a few hectares. Some communities on clay-based soils on the eastern side of the Swan Coastal Plain (SCP) are also viable in small areas.

Minimum size also depends on what you want the area to be viable for, as different species have different requirements. Remnants as small as 4 ha are important for retaining intact examples of reptile diversity and areas of 1 ha can retain viable populations of many reptile species if fire frequency and feral animal predation are controlled (How & Dell 2000).

Small areas that can be consolidated in Regional Ecological Linkages or local ecological linkages may be particularly important for protection. Where possible small patches should be increased in size to improve viability. Studies of various bird species in temperate woodlands on farms in Australia have determined that about 10 ha is the minimum patch size for maintenance of habitat for a range of bird species (Barrett 2000). Freudenberger (1999) found that many woodland birds in the ACT/NSW region were only found in patches of native vegetation of at least 10 ha, provided sufficient scrub cover was present. Similar studies undertaken in the Wheatbelt of Western Australia suggest a 15 ha minimum patch size for shrublands and heathlands and 50 ha for woodlands to maintain habitat-sensitive bird species (Lambeck 1998).

Studies of areas of various sizes for a given ecological community type are needed in the PMR to determine what size areas are proving to be viable on the ground, based on their ability to support wildlife, maintain their condition and resist the effects of threats that may be present.

Setting a minimum patch size to use across the PMR is difficult for local biodiversity planning, because of the multitude of factors to consider when assessing viability. A general minimum area of 20 ha was used for selecting regionally significant bushland for Bush Forever although smaller areas were included for poorly represented ecological communities.

The Urban Bushland Strategy suggested that Local Significant Natural Areas (LSNAs) should be greater than 4 ha (Government of Western Australia 1995). This would depend on areas being no smaller or less viable than a 200 m by 200 m square, the core area of which is about 2 ha, assuming edge effects (the effects of degrading processes at the edges) extend about 50 m into the area. In reality many Local Governments are already protecting and managing areas less than 4 ha and even 1 ha, where clearing has already occurred without planning for viability.

Patches of vegetation at this small end of the scale usually require intensive management and can be costly to maintain. Community expectations can be high for these areas as they are often considered the 'local patch' and voluntary community support for management may be available. Despite this, these small patches frequently degrade over time and become only trees or large shrubs over weeds. This is commonly seen in Public Open Space (POS) and golf courses where small islands of bush have been left surrounded by landscaped areas. These areas are not viable for conserving biodiversity in the long term.

The guiding principle when planning local reserves is that management costs are much lower for larger and more viable areas. Therefore, where clearing has not yet occurred, planning for local reserves of native vegetation for conservation (or passive recreation purposes) should not result in natural areas smaller than 4 ha of a compact shape. Where reserves fall below 4 ha, proponents and Local Governments should plan to increase these natural areas to the maximum size of a compact shape possible for a given site by encouraging natural regeneration processes and where necessary, by revegetation (direct seeding or planting of local provenance material). This will buffer the natural area and improve viability.

Beaumarks Park in Mindarie which contains the Declared Rare Flora Eucalyptus argutifolia*. The small size of this remnant natural area means the long term existence of the native vegetation is under threat without intensive and on-going management. Photo: K Savage.*

For small areas of marginal viability the identification and control of threats is critical and sufficient funds for active management must be allocated on a regular basis. Local Governments may chose to seek financial assistance from developers during the planning stage of new projects to cover future management costs of natural areas to be retained within the development area. Planning should recognise that small areas not designed to use natural processes to maximise viability will require ongoing active management and will cost more to maintain. Alternatively, resources could be directed to management of the larger, more viable areas within a Local Government area as a trade-off for clearing of other less viable natural areas for development.

The following size classes can be applied to LNAs as a general guide to help determine viability:

greater than 20 ha	Higher Viability	Lower management Costs
greater than 10 ha but less than 20 ha	⇩	⇩
greater than 4 ha but less than 10 ha		
greater than 1 ha but less than 4 ha	Lower Viability	Higher Management Costs
less than 1 ha	Very Low Viability	Very High Managements Costs

6.1.2. Shape

Shape influences the level of impact that threats may have on the edges of a natural area. These edge effects can be observed extending into natural areas. The degree that edge effects extend into natural areas varies greatly between different ecological

communities and depends on the types of threats and how well these can be controlled. Threats acting at the edges include weed invasion, grazing and trampling, increased sun and wind exposure, pollutant (fertiliser, pesticide, toxin, excess water) drift or runoff, air pollution from traffic or industry, noise, artificial lighting at night (affects predator-prey relationships), rubbish accumulation or dumping and exposure to feral animals, pests and diseases from surrounding land uses.

According to Safstrom and Craig (unpub. 1997) edge effects can extend up to 50 m into relatively resilient heaths and shrublands in the Wheatbelt and up to 500 m in less resilient Wheatbelt woodlands. In the Wheatbelt, natural areas less than 100 m wide primarily contain edge habitat with low viability even for relatively resilient communities (Safstrom & Craig unpub. 1997). However, it was also noted that narrow areas only 5 m wide can be viable on some soils if edge effects are managed (Safstrom & Craig unpub. 1997).

In the SCP metropolitan region, edge effects are typically observed to extend up to at least 25 m into natural areas (Karen Clarke, pers. comm. July 2003, Perth Biodiversity Project). Therefore, as a general guide, natural areas less than 50 m wide will end up containing mostly edge habitat of low viability. However, on ground research on areas of various sizes and shapes for a given community type is required to determine which areas and shapes are proving to be viable based on their condition and the threats present.

Compact areas such as circles, squares and squat rectangles have the greatest viability, as their core areas are the largest possible for a given size. Long, thin shapes have the lowest viability, as most of their area is impacted by edge effects. Research has shown that native vegetation that acts as a link between larger viable natural areas needs to be at least 25-50 m wide for use by many bird species (Barrett 2000; Freudenberger 1999). Also, birds are more likely to utilise patches of native vegetation if these patches are within 500 – 1000 m of viable natural areas (Freudenberger 1999). Therefore, long thin areas at least 50 m wide located within 500 – 1000 m of a viable natural area may have important ecological linkage value despite the low viability of the poorly shaped area itself.

The following shape criteria can be applied to LNAs as a guide in determining viability:

Circle, square or squat rectangle	Higher Viability
Oval, squat oblong or symmetrical triangle	
Irregular shape with few indentations	
Irregular shape with many indentations	
Long thin shape with large proportion of area greater than 50 m wide	Lower Viability
Long thin shape with large proportion of area less than 50 m wide	Very Low Viability

6.1.3. Perimeter to area ratio

Most impacts on natural areas occur around their edges and, as a general rule, because circular remnants have less edge relative to their area than long and narrow areas, the protected area within the natural area is greater for circles (Hawkesbury-Nepean Catchment Management Trust 2000).

Perimeter to area ratio is determined by size and shape and therefore can be a useful indicator of viability. Divide the length of the perimeter by the area (always ensure both measurements are in the same units, for example, metres and metres squared). The higher the score, the lower the viability, as the natural area will be more greatly affected by edge effects.

The following perimeter to area ratios can be applied to LNAs as a guide in determining viability:

Less than 0.01	Higher Viability
Greater than 0.01, less than 0.02	
Greater than 0.02, less than 0.04	
Greater than 0.04	Lower Viability

6.1.4. Condition

Vegetation condition is a measure of an area's similarity to what it would have looked like prior to the effects of disturbance from European settlement in Australia (Keighery 1994). This is difficult to determine with confidence without on-ground experience of what the full range of intact, undisturbed plant communities should look like for a given region. This experience can be hard to obtain in the PMR, especially for the SCP, due to the high degree of disturbance and fragmentation of the original plant communities. However, there are intact areas that can act as **reference sites**.

Various vegetation condition scales have been developed and used in Western Australia. The two most commonly used are Keighery (1994) and Kaesehagen (1994). On the SCP, Keighery (1994) has been used consistently in the assessment of over 1000 **reference plots** and to describe the 287 sites in Bush Forever. CALM and the Wildflower Society of Western Australia have also used this scale in a number of regional studies.

The Kaesehagen (1994) condition scale is taught to students in the Introduction to Bush Regeneration Course run by APACE and is often used by the community and Local Government environmental staff. It appears in a number of management plans and studies within the PMR undertaken by Ecoscape & Associates Pty Ltd. Section 12.7 shows a comparison of the Vegetation Condition Classes used in the Keighery and Kaesehagen methodologies. For comparisons with other, less commonly used scales, see Bush Forever Volume 2 (Government of Western Australia 2000b).

The various factors assessed using these condition scales are:

- plant community structure and composition
- **disturbance factors**, for example, logging, grazing, partial clearing, inappropriate fire frequency and/or intensity, soil disturbance by rabbits, predation by feral animals, impacts from surrounding land uses
- weed invasion
- vegetation health, for example, diseases, pests, threatening processes such as secondary salinisation, lowering of watertable, climate change, fragmentation.

The effects of many disturbance factors and threatening processes take years to become obvious. If an area is in Very Good or better condition, based on the Keighery (1994) condition scale, then the time since isolation from other natural areas should be determined to give an idea of how resilient the area is to disturbance. If an area has been isolated for a long time (>20 years) and is still in Very Good condition, the viability of that area is likely to be high assuming the severity of disturbance factors and threatening processes is the same in the future as in the past.

The condition of some non-vegetated natural areas can be assessed using established methodologies. Wetlands should be assessed using the methodology outlined in Environmental Protection Authority (1993) and the methodology developed by Shepherd and Siemon (1999) for assessing foreshore areas along waterways should be used in these areas.

6.1.5. Connectivity – proximity and linkage to other natural areas

The viability of any natural area depends on its proximity to other natural areas and the quality of the linkage between them. These two factors influence the movement of individual living organisms and the flow of genetic material between natural areas. In turn this determines the long-term survival of species, their genetic variation, their

ability to adapt to changes in the environment (including re-invasion following local extinction) and the maintenance of ecosystem processes. The viability of a given natural area will increase:

- the closer it is to other protected natural areas (for example, CALM Managed Estate, Bush Forever Sites and Regional Parks)
- the greater the number of protected natural areas within close proximity
- the better the condition of the surrounding natural areas.

If the surrounding natural areas are degraded and are basically only trees and large shrubs over weeds, only a limited number of species will use these areas for linkage or as habitat to live in. The better the condition and structural complexity of surrounding natural areas, the more effective they will be as links to larger natural areas and as habitat.

6.2. Regional and local ecological linkages

Habitat fragmentation is a key threatening process leading to loss of biodiversity. Once a given habitat type falls below about 30% of its original extent, there is a rapid decline in the number of species that can survive in the landscape as connectivity is lost and minimum habitat requirements for a number of species are not provided (Smith & Silvertsen 2001 see Figure 2). This rapid decline may occur at higher levels of retention of original habitat if the habitat is of poor quality and exposed to continued threats that are degrading it over time (Department of Natural Resources and Environment 2002). When habitat types become fragmented to this level, the spatial arrangement of natural areas across the landscape becomes critically important for maintaining biodiversity (Smith & Sivertsen 2001).

Much of the landscape in the PMR, especially on the SCP, is now fragmented to such an extent that substantial loss of biodiversity has or is already occurring and the survival of remaining species even in large, consolidated, regionally significant areas will depend on well-planned and managed ecological linkages in conjunction with careful management of the protected areas that are being linked. Thus, the long-term viability and conservation values of Bush Forever Sites, CALM Managed Estate and Regional Parks depend in part on an effective network of Regional Ecological Linkages. LNAs immediately adjacent to regionally significant areas are particularly valuable for buffering the effects of threats on these regionally significant areas.

6.2.1. Regional Ecological Linkages

Regional Ecological Linkages link protected Regionally Significant Natural Areas by retaining the best condition LNAs available between them that can act as stepping stones for flora and fauna. This increases the long-term viability of the Regionally Significant Natural Areas as well as the LNAs in the link. The regional linkages also need to connect to Regionally Significant Natural Areas that are protected outside the study area. To be effective the linkages should incorporate the major variation in plant communities and fauna habitat typical of the region so that the widest range of flora and fauna possible can use the links (John Dell, pers. comm. May 2003, Department of Environment). For example, only using waterways as Regional Ecological Linkages will limit the movement of flora and fauna to only those species that utilise riparian habitat. A range of linkages are needed connecting habitats of similar type.

The Darling Scarp forms a distinct geomorphological region of its own and fauna and flora move primarily north–south within the various scarp habitat types, utilising the adjacent Darling Plateau or SCP habitats to a much lesser extent (John Dell, pers. comm. May 2003, Department of Environment). Within the Darling Scarp, habitats typical of the top of the scarp need to be linked to others at the top of the Scarp. Similarly, granite outcrops need to link with other granite outcrops. On the Darling Plateau linking areas of similar topography will provide a good network of ecological linkages as habitat types here are strongly influenced by topography.

Regional Ecological Linkages for the PMR have been identified by the Perth Biodiversity Project with input from Department of Environment (DoE), CALM and

Department for Planning and Infrastructure (DPI) as documented in the following sections. A GIS dataset is available titled PMR – Regional Ecological Linkages and is represented spatially in Figure 6. Linkage lines were drawn to be broadly reflective of the intended direction of the ecological link. A distance of 250 m either side of the linkage lines was created, resulting in a 500 m wide ecological linkage. A 500 m wide linkage was considered to be the minimum required to promote the inclusion of more viable LNAs within the ecological linkage.

The ecological linkage represents the first step in the process of identifying those LNAs that can act as stepping stones to form the Regional Ecological Linkages. These Regional Ecological Linkages will provide the framework within which each Local Government can identify local ecological linkages that aim to link their Locally Significant Natural Areas (LSNAs) to each other, to regionally significant natural areas and to the Regional Ecological Linkages.

Any LNAs identified as stepping stones need to be retained in their entirety, rather than just the portion of these areas within the mapped 500 m wide linkage. Those LNAs that are contiguous with the regional linkage identified in Figure 6 represent approximately 60,000 ha of native vegetation. The viability of each of the stepping stones needs to be considered before designating it part of the linkage. As the linkage lines in Figure 6 have been drawn using remotely collected regional datasets, the condition of each LNA and its suitability to provide resources for flora and fauna are unknown and need to be assessed in the field. Once on-ground assessment has occurred, it may be necessary to move the linkage.

When undertaking field assessment the specific purpose or need for the linkage or stepping stone should be considered. Different fauna and flora species will have different needs for connectivity and linkage. These needs will depend on the characteristics of the species, (D. Mitchell & J. Kaub, pers. comm. May 2003, Department of Conservation and Land Management) which may include:

- species mobility (high, low, none)
- availability of pollinators and seed dispersal mechanisms for flora
- life history (for example, bandicoots might disperse as juveniles through a corridor or gap that they would never use as part of an established home range)
- frequency of genetic connectivity (for some species genetic connectivity may only need to occur every few generations rather than continuously).

During the review of the opportunities and constraints associated with protecting each natural area it may be necessary to further refine these linkages if there are alternative areas of equal ecological value for linkage that provide greater opportunities for protection. The aim is to provide a network of good or better condition stepping stones linking like habitat with a maximum distance of 500 m to 1000 m (preferably 500 m) between them to connect the Regionally Significant Natural Areas joined by the original linkage shown in Figure 6.

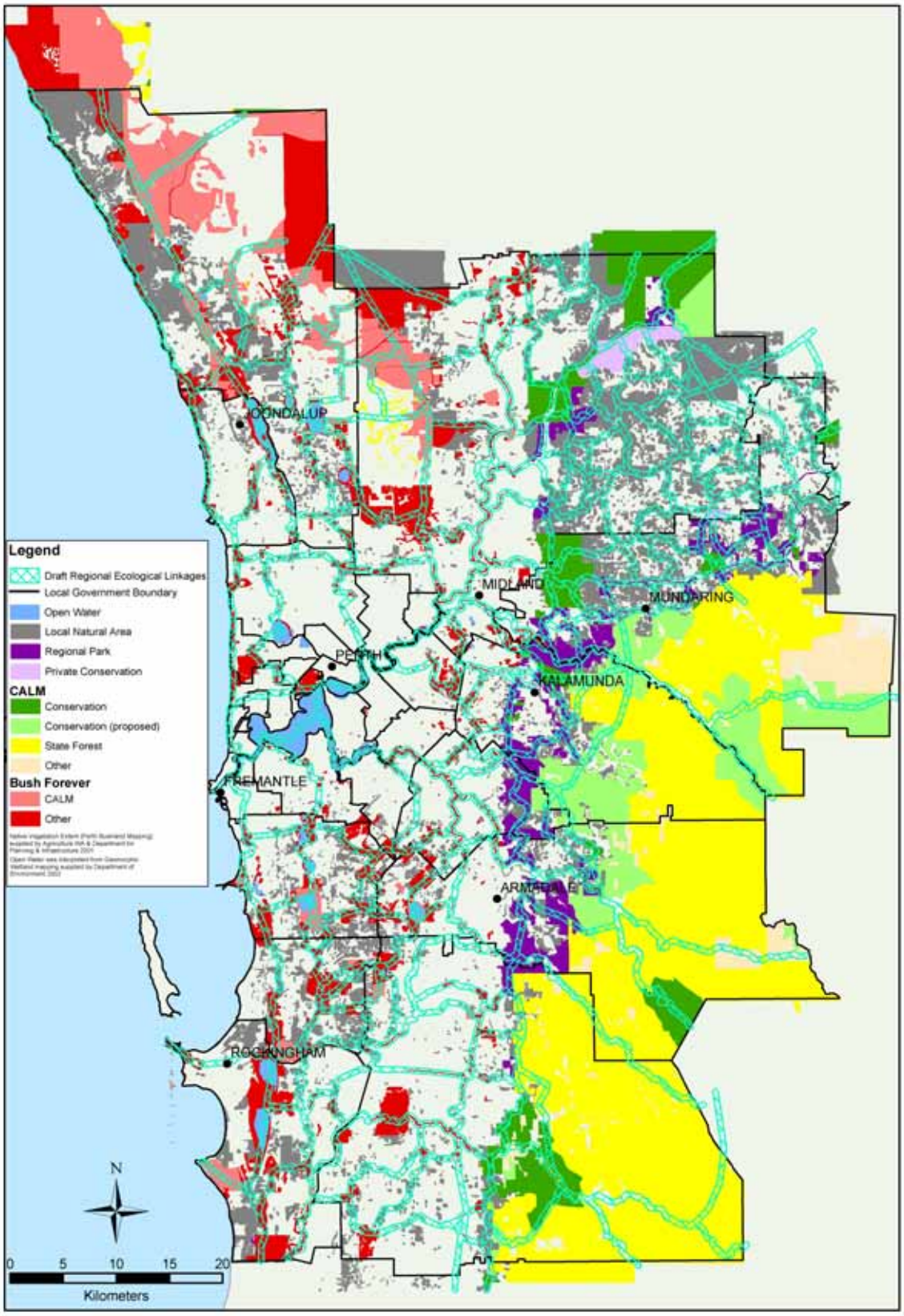


Figure 6. Draft Regional Ecological Linkages for the Perth Metropolitan Region.

Background to the identification of Regional Ecological Linkages

Swan Coastal Plain

Regional Ecological Linkages were identified in Bush Forever Volume 2 for the SCP portion of the metropolitan region (Map 7, p 72, Government of Western Australia 2000b). These linkages were reinterpreted by the Perth Biodiversity Project at a scale of 1:20,000 using the Perth Bushland Mapping dataset and year 2000 aerial photography. This ensured that the digital dataset provided to metropolitan Local Governments was mapped at a scale compatible with the baseline native vegetation mapping (the Perth Bushland Mapping dataset was captured at a scale of 1:20,000) and more accurately followed actual remaining Local Natural Areas.

A number of adjustments to the original mapping were required and these were checked by the State Government agencies involved in Bush Forever prior to finalisation of the dataset. For example, when viewed at a scale of 1:20,000 the linkage that was intended to follow the Serpentine River was in some cases up to 500 m from the actual river. In other cases, the original linkages needed to be adjusted to maximise the instances where the linkage passed through mapped native vegetation.

Jarrah Forest

Regional Ecological Linkages had not previously been identified for the Jarrah Forest portion of the PMR. Therefore, the Perth Biodiversity Project reviewed the information available on Regionally Significant Natural Areas in this region, the existing proposals for linkages, and proposals for linkage in the surrounding region, to develop a network of draft Regional Ecological Linkages for peer review and public comment.

These Regional Ecological Linkages were identified by the Perth Biodiversity Project at a scale of 1:20,000 using the Perth Bushland Mapping dataset and year 2000 aerial photography to link the following:

- formal conservation reserves (existing and proposed) identified in the Forest Management Plan 2004 – 2013 (Conservation Commission 2003)
- System 6 recommendations for non-CALM managed land (Department of Conservation and Environment 1983)
- existing regional parks (CALM GIS dataset)
- the large private conservation reserves such as Paruna and Karakamia Sanctuaries.

Linkages proposed in the Perth Greenways report (Tingay & Associates 1998) and the Environmental Protection Authority's (EPA) System 6 report (Department of Conservation and Environment 1983) were also considered. The linkages proposed for the surrounding region in the Avon Arc Regional Strategy (Government of Western Australia 2001a) were used to ensure connectivity beyond the region.

The purpose of the Regional Ecological Linkages identified by the Perth Biodiversity Project was to link protected natural areas with other areas of mapped native vegetation. Priority was given to identifying linkages through those areas having the greatest assumed protection and to those areas that maximised opportunities to form continuous corridors of native vegetation.

6.2.2. Local ecological linkages

Local Governments need to identify local ecological linkages to apply Local Significance Criteria 4 ii) (Section 5.1.4).

Local ecological linkages aim to link protected LSNAs to other LSNAs, protected regionally significant natural areas and Regional Ecological Linkages. Local ecological linkages are an important part of improving the viability of natural areas that may be too small or in too poor shape or condition to be viable on their own if isolated. The viability of all areas will be improved by including as many natural areas within each link as possible and maximising the number of connections to each area.

Regeneration and revegetation activities and **reconstruction** can then be prioritised in less viable areas to improve their condition and increase their size to buffer them as part of the overall objective of linking all natural areas. Revegetation to physically connect natural areas within the ecological linkage is of a much lower priority than protecting natural areas from threats and/or undertaking regeneration activities to improve the viability of existing natural areas within linkages.

Guidelines for identifying local ecological linkages

To determine local ecological linkages, prepare a map of the Local Government area and surrounding areas using the latest aerial photography available overlaid with the following GIS datasets.

- Perth's Bushland Mapping 2001
- Native Vegetation Extent by Administrative Planning Categories
  - Bush Forever
  - CALM Conservation
  - CALM State Forest
  - CALM Other
  - Regional Parks (Bush Forever and CALM)
  - Other Regional Parks
  - LNAs
- Local Government managed lands currently designated or proposed for conservation (obtained from the dataset Native Vegetation Extent by Ownership Category)
- System 6 areas outside of CALM Managed Estate, for the Jarrah Forest
- Regional Ecological Linkages
- Any existing corridor / linkage proposals with the Local Government
- existing local ecological linkages determined by surrounding Local Government areas
- LNAs within 500 m of a Bush Forever Site, CALM Managed Estate, System 6 area, other areas of regional value or a large, protected LSNA (>10 ha)
- wetlands and waterways
- Perth Greenways (Tingay & Associates 1998)
- major roads and railway routes.

A map containing the above layers and a transparent overlay should be used to draw in linkages that best fit the principles outlined below. Be prepared to modify the linkages as you progress. Peer review and public comment on the resulting map are important to ensure that the best linkages have been chosen. Expect to revise the map at least once before it is finalised as part of the ecological criteria. Ecological linkages may also need to be refined once LSNAs identified for protection are determined.

General principles for identifying local ecological linkages

The following points are the general ecological principles that should be used for identifying local ecological linkages:

- Choose continuous corridors of native vegetation with a minimum width of 500 m where these are available. Thin corridors along roads mainly consisting of trees over a highly disturbed understorey are of little value except for already highly mobile species.
- If suitable continuous corridors of native vegetation are not available, choose a linkage made up of natural areas that form stepping stones between larger intact

areas. Aim for a linkage where the maximum distance between natural areas is no more than 500 m to 1000 m on average (the closer the natural areas, the better) and where most of the natural areas are at least 1 ha to 4 ha in size. Avoid crossing major regional roads or transport routes as these are significant barriers to fauna movement.

- Include as many natural area stepping stones within each linkage as possible.
- Include the widest range of habitat types as possible within the linkages, with similar habitats no more than 500 m to 1000 m on average apart.
- Maximise the number of linkages to any given natural area as this improves overall connectivity across the landscape and long-term viability of individual natural areas.
- Aim to maximise the width, connectivity and structural complexity of vegetation in linkages as much as possible to make them suitable for a broad range of fauna and flora.

Consider the following areas as a high priority for inclusion in a linkage:

- Natural areas forming the most direct linkages with Regionally Significant Natural Areas or Regional Ecological Linkages
- Natural areas that form a network of linkages across the north-south and east-west gradients of variation in ecological communities within a Local Government area (due to soils, geology, landform and climate)
- Natural areas located within 500 m of a Bush Forever Site, CALM Managed Estate, System 6 area, other areas of regional value, protected LSNA (>10 ha); These areas buffer the large, viable, already protected natural areas and improve viability of both the large sites and the natural area acting as a buffer
- Riparian vegetation along waterways (including an appropriate buffer of non-riparian vegetation)
- Natural areas at high points in the landscape that are in the line of sight of other natural areas. These are important for the movement of song birds and butterflies (John Dell, pers. comm. May 2003, Department of Environment)
- Perth Greenways that conform to the general principles listed above; Perth's Greenways are "networks of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use" (Tingay & Associates 1998). Determine their suitability for ecological linkage function by considering where they are and how well vegetated they are before adopting them as part of a local ecological linkage network.

To improve connectivity once the local ecological linkages are identified:

- Focus management on improving the condition and hence viability of existing natural areas (through **assisted natural regeneration**) within the linkage before putting resources into reconstruction or creation of continuous corridors on disturbed land.
- Use bush regeneration techniques as much as possible to increase the size of natural areas within the linkage to a minimum area of 4 ha.
- Where reconstruction or creation of habitat is undertaken, aim to form continuous vegetated linkages (that is, corridors) at least 100 m wide. If this is not possible, ensure stepping stones of reconstructed or created habitat are at least 2 ha to 4 ha in size, no more than 500 m to 1000 m apart in the linkage. Ensure that linkages avoid crossing major regional roads or transport routes.

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Part A – Setting the scene 1