

3.4 Biodiversity

A great gathering of spirits moved across the land, while more and more joined as they moved along. By this time the tree spirits completely dominated, as there was countless billions of them. From their point of dominance the trees stated that they believed that there should be a carer of everything. And so a process of elimination began, the tree spirits said when we become real we will only grow in one place, that means we won't be able to look after anything else. However, that doesn't stop us from making this pledge, we will provide whatever we can to help who ever wins the right to look after us, and everything else, all we ask is that we are not used until there is none of us left. Once the tree spirits made this pledge they all moved to one side.

The plant spirits quickly saw their chance and followed the trees, stating that they would not be able to care for everything and just like the trees they made their pledge, we will provide whatever we can to help who ever wins the right to look after us, and everything else, all we ask is that we are not used until there is none of us left.

Aspirational target: Conserve, maintain and enhance the biodiversity and natural habitat of all species of the Region's indigenous plants and animals, natural fungi and micro-organisms including their genetic variation, and the functionality of the ecosystems which contain these species.

3.4.1 Resource Description

The National Strategy for the Conservation of Australia's Biological Diversity defines biodiversity as the variety of all life forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part (Commonwealth of Australia, 1996). For the purpose of the Strategy this definition of biodiversity as a natural resource asset has been broadened to include the concept that biodiversity is greater than the sum of its parts and is underpinned by the concepts of evolution and ecosystem functionality.

The biodiversity of the Region is comprised of terrestrial, as well as marine and coastal elements. This section deals with terrestrial biodiversity, section 3.5 deals with coastal and marine biodiversity. It is also important to recognise the inter-relationships between land, water, biodiversity, air and sustainable management. Therefore, aspects of biodiversity are also discussed in other sections of the Strategy. Refer to Land (section 3.2) and Water (section 3.3).

A summary of the biodiversity resource asset values derived from the community consultation and stakeholder engagement process is outlined in Table 10. These are defined under the three main categories of environmental, economic and social values.

The Region lies within the south west of Western Australia, part of the South West Botanical Province and one of 25 biodiversity hot spots in the world (Myers *et al.* 2000).

The breadth of Western Australia's biodiversity is significantly demonstrated in the south west which contains approximately 50 per cent of Australia's known flowering plants, ferns and cycads. It is estimated that there are approximately 2,200 native plant species within the Region (CALM – WA Herbarium, January 2003).

The biodiversity of the whole of the south west of the State is considerably more extensive, spatially diverse and complex than previously thought. This means that many species (for example invertebrates) and ecological communities have not yet been described and the conservation status of others is unknown. Genetic diversity is only well understood for a very small number of species. In general, if the habitats and ecosystems containing native species remain viable then the inherent genetic diversity of those species remains intact. This can be described as an 'Umbrella Approach to biodiversity conservation. Whilst this approach is often supplemented by existing data on species and ecosystems, it is necessary due to limitations in the availability of data. Its successful application hinges on devising specific actions as required, including undertaking studies or monitoring in order to provide data.

Table 10: Biodiversity asset values

Environmental	Economic	Social
<ul style="list-style-type: none"> • Biodiversity is required for a sustainable future - to maintain balanced systems, the web of life, provide clean air and water • Evolutionary capacity • Intrinsic value – uniqueness of south west ecological systems on a world scale • Prevent extinction of species • Provides habitat and connectivity • Rare and unique species • High level of endemism • Buffers climate changes • Allows monitoring of human functions • Provides seed and microbial inoculum for restoration 	<ul style="list-style-type: none"> • Potential health benefits through passive recreation in natural environments • Provides ecosystem services, such as clean water, air (lungs of the city), pollination, pest control. • Provides opportunities for scientific research • Educational resource • Protects property along coastlines • Provide tourism opportunities - B&B's, retreats • Easier and cheaper to maintain than lawns and parks. Water wise compared to reticulated lawns. • Protects fisheries, commercial fishing • Potential source for new medicines and products • Source for wildflower harvesting, honey, firewood, tree harvesting, seed and microbial inoculum for restoration, genetic material for horticulture, food source • Employment 	<ul style="list-style-type: none"> • Sense of wonder of nature eg caterpillar to butterfly • Creates a sense of place and connection • Spirituality • Source of inspiration, • Builds community through group involvement in protection of biodiversity • Educational resource, photography, art, craft. • Australian environment is a unique experience • Passive recreation. Clean water has recreational benefits, eg recreational fishing • Provides quality of life, ecosystem health – human and environmental connection • Tourism • Heritage

The Region includes parts of two Interim Bio-geographic Regions of Australia (IBRA). The Hills areas of the Region falls within the Jarrah Forest IBRA and the Coastal Plain and Dandaragan Plateau portions of the Region are within the Swan Coastal Plain IBRA. As such, native plant species and communities, fauna species and other forms of biodiversity often occur across NRM and catchment regional boundaries. Given this, the NRM organisations in the south west of Western Australia need to ensure that they have strong linkages to ensure that biodiversity is managed at this scale.

In attempting to describe biodiversity there is a tendency to group assets into categories but it is important to remember the inter-relationships between the various biota present (plants, animals and microorganisms), as well as between the biota and the environmental systems that support them (including wetlands, waterways, groundwater systems and bushland).

While IBRA is a National approach for describing biodiversity, at the regional scale vegetation complexes are used as a scientifically accepted descriptive category to plan for biodiversity conservation at a regional scale. Vegetation complexes are based on the patterning of vegetation determined by key underlying factors, which include climate, landform and soil type (see Appendix 8). At a more local scale, patterns in native species can be described as ecological communities and as such the variability within (the broader scale of) vegetation complexes can be taken into account.

There are different methods of mapping or considering how species, vegetation and ecosystems are distributed over the landscape. Mapping of vegetation complexes have been carried out over the Region (Heddle et al 1980; and Mattiske and Havel 1998). At this scale, 48 vegetation complexes occur across 13 major landform elements. The Hills areas contain 20 of these complexes, the Swan Coastal Plain 18 complexes and the Dandaragan Plateau 10 complexes (Heddle *et al.* 1980; Mattiske and Havel 1998; Western Australian Planning Commission 2000). Refer to Figures 23, 24 and 25 which show landform elements, the distribution of remnant vegetation across the Region and remnant vegetation within each of the landform elements.

Flora

Flora diversity at both species and community scales is highest in the woodlands, waterways and wetlands on the Pinjarra Plain, the Foothills of the Darling Escarpment and the Bassendean Dune woodlands. Wetland diversity is particularly high, although an estimated 80 per cent of the original wetlands on the Swan Coastal Plain have been artificially drained or filled in for agricultural or urban land (Government of Western Australia, 2000).

Fauna

The Region is home to a rich diversity of fauna. Bird species are particularly well represented with over 300 species recorded from the area, 34 of which migrate to the area annually. The Region's reptile and amphibian fauna are relatively abundant and diverse, and the invertebrate and microfauna species are very abundant and diverse. The mammalian fauna, in particular the small-medium sized species have suffered significant declines associated with land clearing, altered hydrological and fire regimes and predation by introduced carnivores.

The numbers of species of invertebrate fauna are many times greater (by orders of magnitude) than flora and fauna species in the Region. It is estimated that there are at least 50,000 invertebrate species in the Region (Personal Communication, Majer 2004)

Many invertebrates are found only in small habitat ranges, and in the case of widespread species individuals or colonies of invertebrates tend to live in highly localised areas throughout their life cycles.

Micro-organisms

Native microscopic organisms that are found in the Region include fungi, bacteria, algae, water moulds, lichens and protozoa. Micro-organisms were the earliest life forms on earth, tend to be ancient in evolutionary terms, and play a very important role in the functionality and processes of ecosystems. This includes production of oxygen, soil conservation, water purification and nutrient cycling processes, which provide optimal levels of nutrition to native flora and fauna (Bougher 2003).

The numbers of species of micro-organisms in the Region are much greater, in orders of magnitude, than the flora and fauna species present. It is estimated that there are at least 15,000 species of fungi within the Region, which is more than six times the number of native plant taxa occurring in the Region (Personal Communication, Bougher 2004).

The basic structures of fungi are microscopic cobweb-like threads known as hyphae. Most fungi species are microscopic, with the most familiar fungi producing large, clearly visible spore-bearing fruit bodies, analogous to the fruits and flowers of plants. However, when macrofungi are not fruiting they cannot be detected easily. The most crucial functions of all fungi occur underground, out of sight (Bougher 2003).

The most important groups of fungi occurring in the Region are:

- ectomycorrhizal, i.e. have beneficial partnerships with native plants)
- decomposers – require logs or woody debris of large native trees and shrubs
- truffles – are both ectomycorrhizal and food for some native animals
- those found in the bark of living trees
- those found in moss swards

(Personal Communication, Bougher 2004)

A handful of soil may well contain thousands of species of bacteria and hundreds of species of fungi and protozoa (most of which are yet to be classified). Almost all of these countless soil organisms are not only beneficial but essential to the biological health of soil and functionality of ecosystems as a whole.

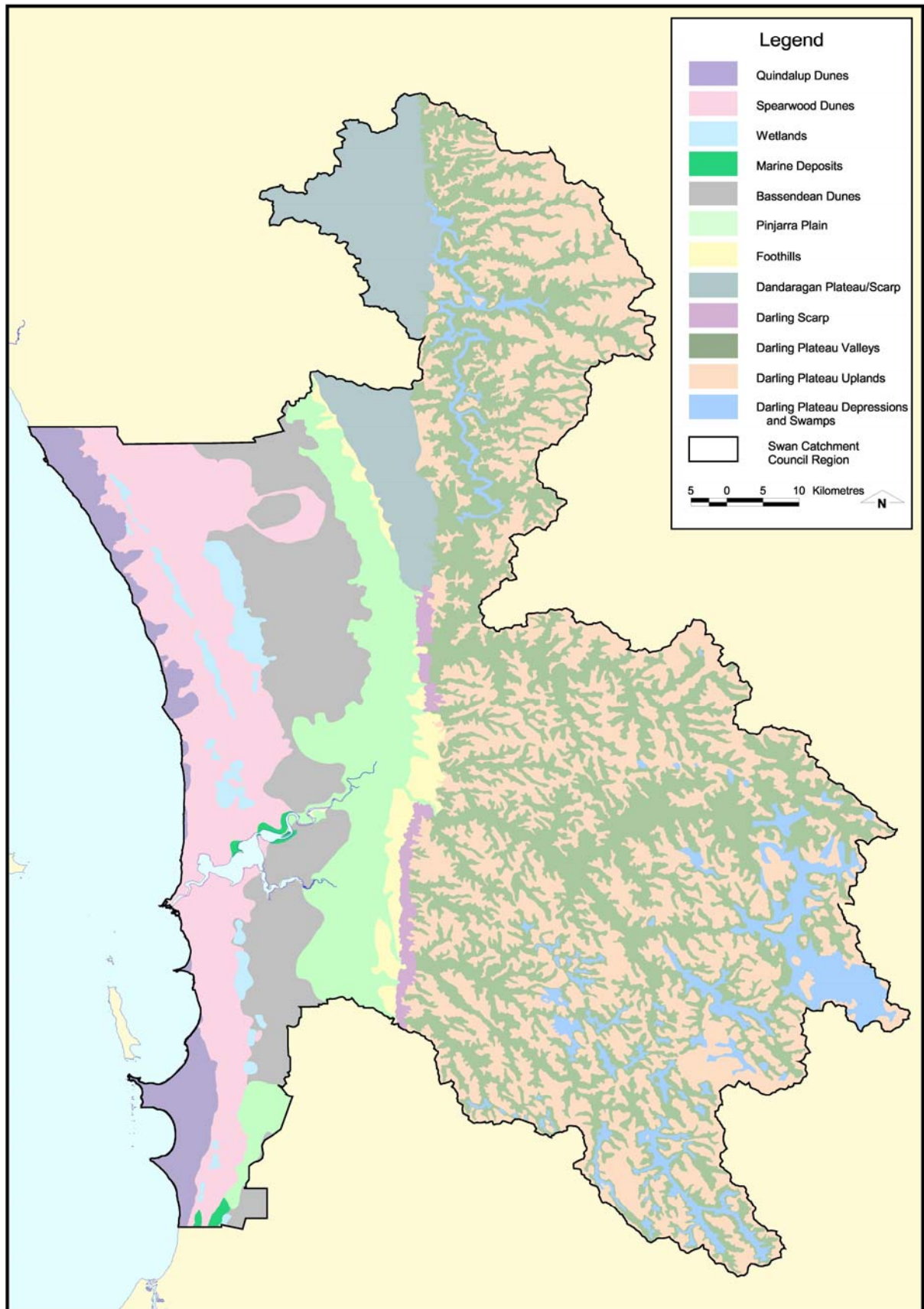


Figure 23: Major landform elements of the Swan Region

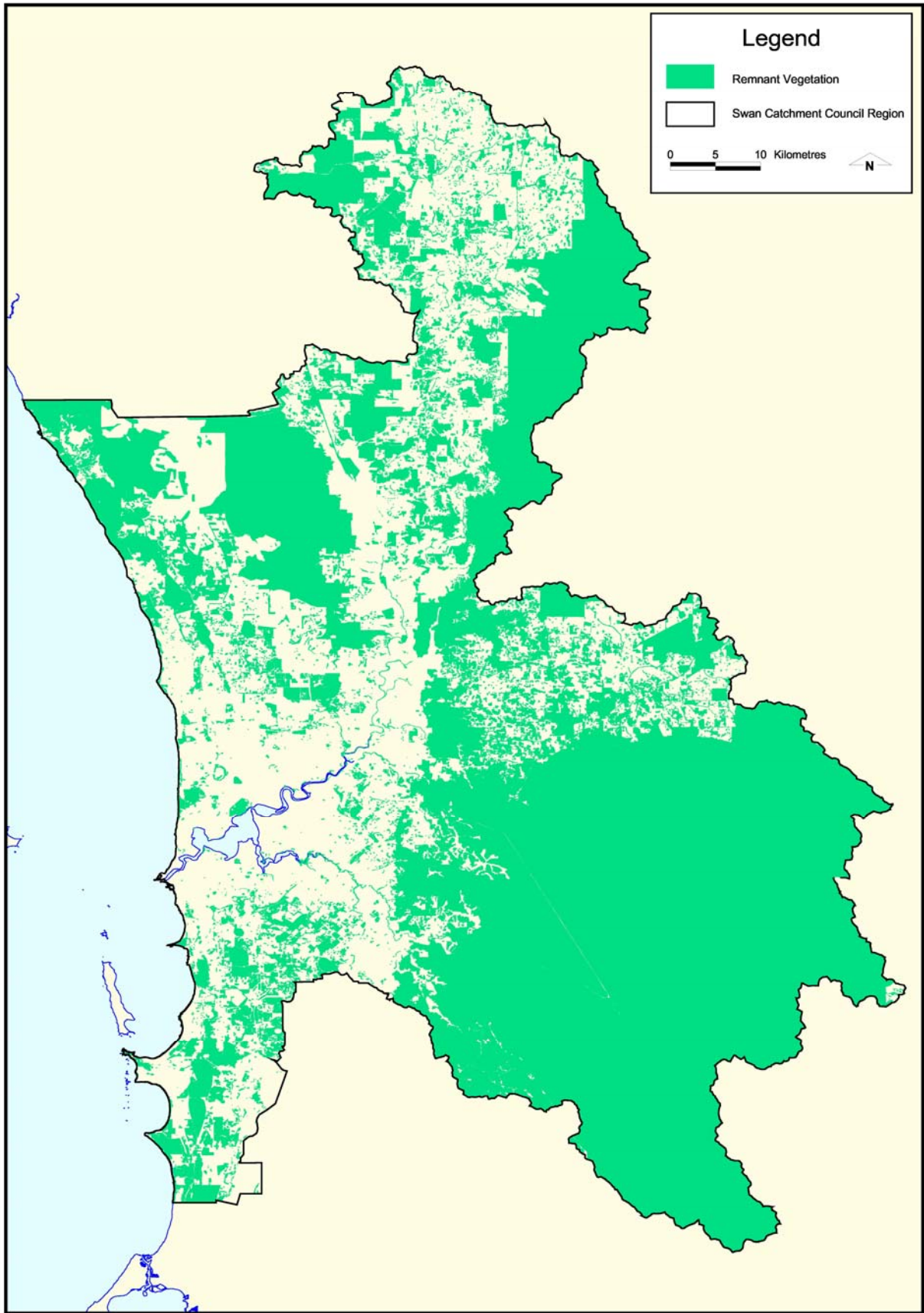


Figure 24: Remnant vegetation in the Swan Region

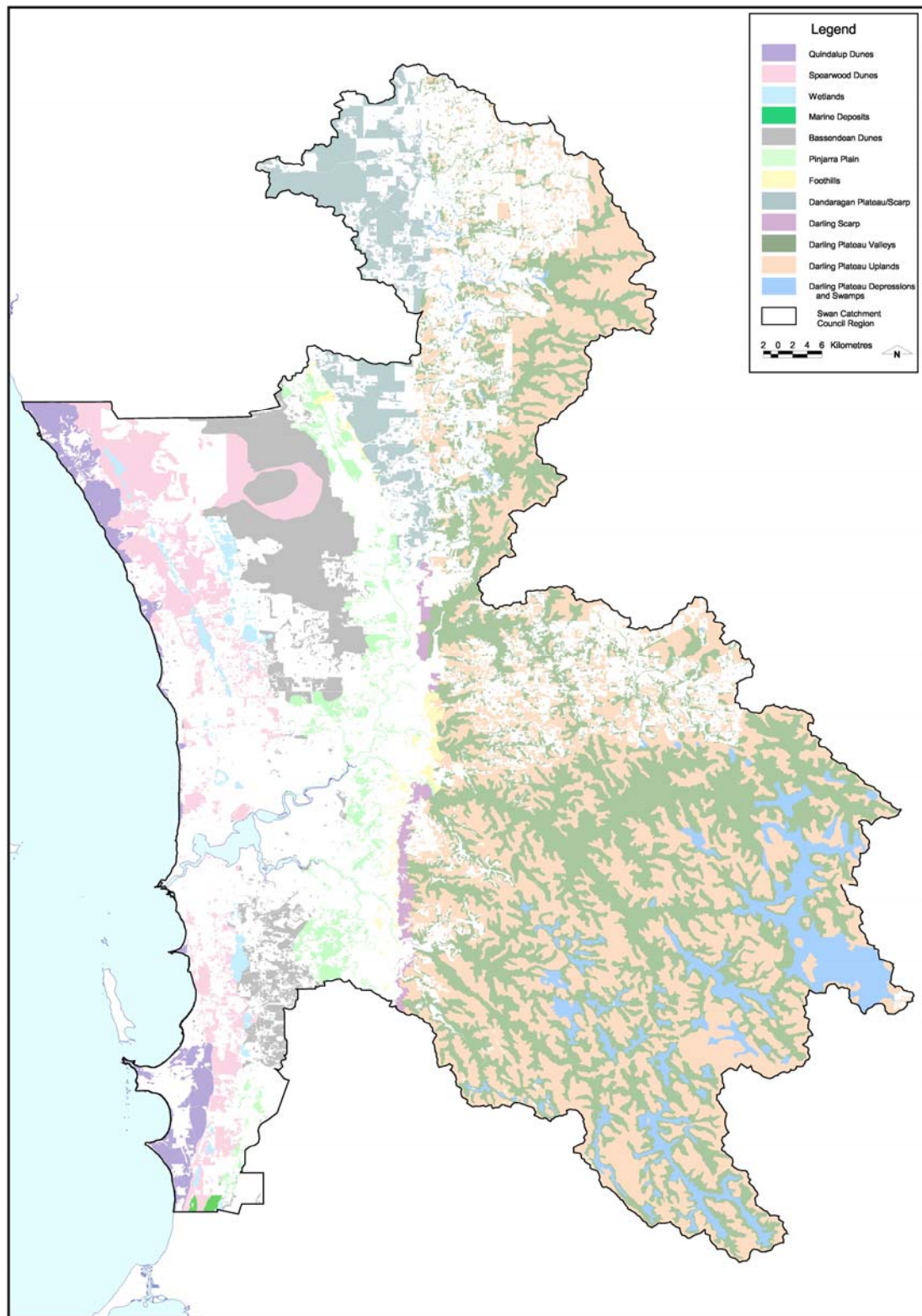


Figure 25: Remnant vegetation within each of the landform elements in the Swan Region

Ecological Communities

Ecological communities are naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth 1999) and is often applied to floristic communities, however it may be applied to any assemblage of naturally occurring organisms.

Ecological communities in the Region tend to be governed by the landforms, soils and localised climates where they occur. Residents of the Region are familiar with the typical *Banksia* woodland communities occurring in the Coastal Plain sands, the Tuart forests in limestone dominated soils near the coast, the Jarrah and Wandoo forests of the Darling Plateau and the fringing and upland vegetation of the Coastal Plain wetlands.

The concept of ecological communities and its application, as well as a traditional 'species approach', is critical for effective biodiversity conservation planning and practice'.

3.4.2 Resource Condition

Within the Region there are 34 flora species that are Declared Rare Flora, including five that are Critically Endangered according to international criteria (Figure 26). They face an extremely high risk of extinction in the wild in the immediate future. There are about 80 species of plant that are potentially threatened, but there is insufficient survey data to accurately determine their status (and so they cannot be formally declared as rare under the *Wildlife Conservation Act (1950)*). There are a further 30 species known to be rare, but not currently threatened. There are also 17 threatened floristic ecological communities in the Region (see Figure 26), many of which exist only in small remnants which collectively make up a very small percentage of the original area of those communities (Department of Conservation and Land Management, 2003).

As shown in Table 11, 10 per cent of the original vegetation of the Swan Coastal Plain IBRA Region is held in the formal conservation reserve system. These lands are managed by CALM as per internationally agreed guidelines set by the World Conservation Union (previously known as the International Union for Conservation of Nature, hence are described as IUCN Categories I-IV Conservation Estate). This total increases to 25 per cent when areas that are State Forest but are mainly managed for the sustainable use of natural ecosystems are included (IUCN Protected Area Category VI).

Many of the vegetation complexes of the Swan Coastal Plain IBRA are poorly or under-represented in the formal conservation estate (see Appendix 11). The loss of vegetation in this area is comparable to, or greater than that which occurs elsewhere in the State, such as the wheatbelt. The 34 Declared Rare Flora and over 100 Priority Flora on the Swan Coastal Plain is a reflection of the magnitude of this depletion. Bush Forever (Government of Western Australia 2000) identifies 51,200 hectares of regionally significant bushland in 26 vegetation complexes on the Swan Coastal Plain west of the Darling Scarp, and as such are recommended for protection.

Approximately 10 per cent of the Darling Range and escarpment lands within the Region (Jarrah Forest IBRA) are currently in the formal conservation reserve system. This total increases to 60 per cent when areas that are State Forest but are mainly managed for the sustainable use of natural ecosystems are included (IUCN Protected Area Category VI).

In December 2003 the State Government approved a new Forest Management Plan. This document identifies approximately 63,800 hectares of the Region's State Forest, which will become National Parks (ie. about 27 per cent of the total State Forest indicated in Table 11). When this process has been completed there will be 23 per cent of Jarrah Forest having an IUCN I-IV level of protection.

The Forest Management Plan also has recommendations relating to the Swan Coastal Plain, in particular the harvesting of pines in Gngangara State Forest and the rehabilitation of this land (to be managed and used for conservation and recreation purposes).

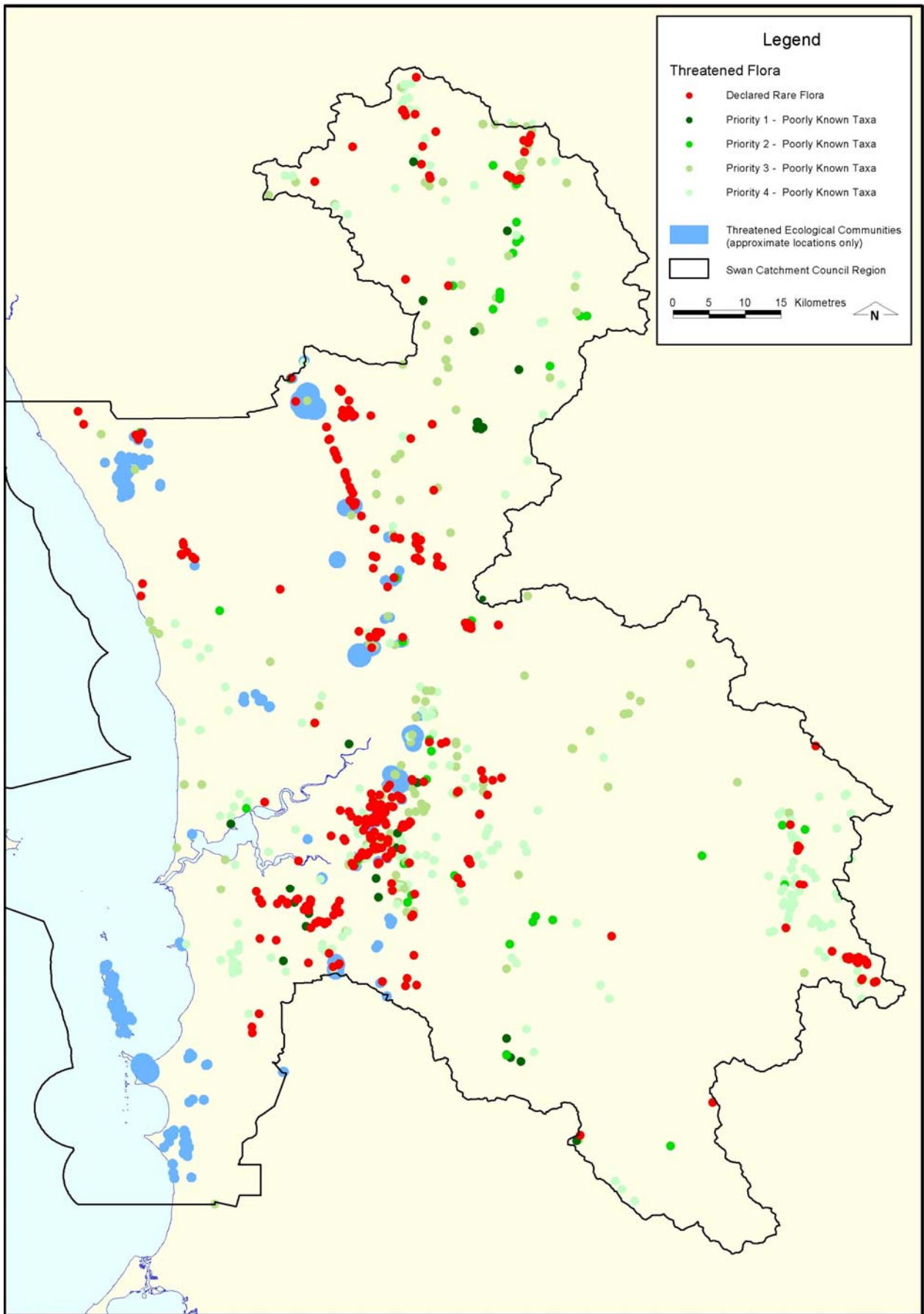


Figure 26: *Threatened Ecological Communities and Declared Rare Flora in the Swan Region*

Table 11: Remnant vegetation lands managed for nature conservation in the Region (Data provided by the Department of Conservation and Land Management)

IBRA Region	% IUCN I to IV (Nature conservation estate)	IUCN I to IV (Nature conservation estate) (ha)	% Pre-European areas within State Forest (IUCN VI) multiple use management - timber, water supply and nature conservation	Pre-European areas within State Forest (IUCN VI) (ha) multiple use management - timber, water supply and nature conservation
Swan Coastal Plain	3.9	11,855	4.2	12,679
Jarrah Forest	8.6	40,505	40	190,771

The Region's vertebrate and invertebrate (microfauna) species are abundant and diverse. However, they have been significantly depleted particularly as a result of habitat loss and predation by feral animals (Swan Catchment Council, 2002). Faunal biodiversity is directly linked to adequacy and condition of habitats (ie. generally whether there are adequate, good quality areas of bushland to support fauna species).

Many fauna species have not been described and the conservation status of others is unknown. In particular, thousands of species of insects, spiders and other invertebrates have not yet been described. Bird species are well represented with over 300 species recorded in the Region, 34 of which migrate to the Region annually. Wetlands and waterways provide the main habitat types required by these migratory birds. the Black Swan, the emblem of Western Australia, is commonly found in and around water bodies in the Region – even in highly urbanised situations.

Some fauna, particularly bird species, may utilise various habitats over wide areas and as such a cross-boundary approach is required for their conservation. For example, Carnaby's Black Cockatoo relies heavily on the coastal heathlands of the Swan Coastal Plain, and on wheatbelt woodlands during their breeding season.

Fourteen species of frogs are found in the Perth metropolitan area, comprising tree frogs and ground frogs (ground dwelling or burrowing). Species are highly adapted to habitat niches, and whilst frogs are generally found in or close to wetland areas, which they require for breeding, various species of frogs spend much of their life considerable distances from water bodies. The 'calling frogs' of the south west are renowned for the distinct calls characteristic of particular species. For example, the Quacking, Squelching, Moaning and Motorbike Frog species (Dell and Keighery 2003).

There are a number of threatened terrestrial fauna species recorded within the Region (please note marine mammals and reptiles, and oceanic birds are dealt with in the Marine Coastal section) that are listed under the *State Wildlife Conservation Act (1950)* as rare, or likely to become extinct. These include six mammal species (three of which are now extinct in the Region), eight bird species (two of which are now extinct in the Region), two reptile species and three invertebrate species. The Western Swamp Tortoise is among the world's most threatened freshwater turtles and one of Australia's most endangered reptiles and is only found on two nature reserves in the Region. A recovery program for this species is being implemented, which has included management of these reserves and the hydrology of the wetlands on the reserves, captive breeding of Western Swamp Tortoise and recently the translocation of tortoises into a recently acquired reserve to establish a third wild population. Also the Western Swamp Tortoise Environmental Protection Policy 2002, as well as planning provisions in the policy area (for that EPP) to restrict subdivision provide key protection of habitat.

Additionally, there are 29 terrestrial species (seven mammals, ten birds, three reptiles and nine invertebrates) that are included on Department of Conservation and Land Management's (CALM) priority list. This list includes those species that are apparently rare however there is inadequate information available to properly assess the status of those species. Additionally, the list includes those species that are known to be rare but are not currently threatened, and as such require ongoing monitoring.

Some parts of the Region, particularly the Quindalup Dunes of the Swan Coastal Plain, have high biodiversity due to the large numbers of reptile species present (whilst they have considerably less plant species than other areas in the Region).

Given that intact habitat is a critical factor in native fauna conservation, the Region needs to be considered on a sub-regional basis. The Jarrah Forest in the south east of the Region is predominantly State Forest,

with high connectivity between vegetated areas, and as such is highly significant for fauna conservation. The north eastern Jarrah Forest has relatively large habitat areas within State Forest, conservation estate and private property, with reasonable connectivity between these areas, however is more fragmented than the south east. The north western Swan Coastal Plain also contains relatively large habitat areas within State Forest and conservation estate. Accordingly, the north eastern forest and north western Swan Coastal Plain are significant for fauna conservation.

Other parts of the Region are highly fragmented and tend to have considerably lower faunal biodiversity than where large habitat areas are present. This means that high levels of management are often required to conserve the remaining fauna species, which tend to be birds, reptiles other than snakes, frogs and invertebrates (Dell and Keighery 2003). Projects to improve habitats and restore linkages between habitat areas are required.

Conservation and maintenance of biodiversity requires the protection and management of ecological communities and natural areas across private and public land. The Strategy addresses the need to ensure the Region's physical diversity (landforms and soils) and the range of organisms and ecological processes (the biological diversity or 'biodiversity') are conserved according to National, State and international requirements, and community aspirations. Formal reservation and management of land by CALM, under the conservation reserve system, is the main basis for this to be achieved. Other methods of managing biodiversity include private land conservation mechanisms and Local Government initiatives such as Nature Conservation Covenants, landholder management agreements and other initiatives such as Wetland Watch.

Other forms of public land including Local Government reserves, regional parks, State Forest and land held for infrastructure and the provision of utility services are also critical for the conservation of this diversity. However, continued viability and biodiversity functioning in the Region will rely on the adequate protection of regionally significant bushland and locally significant natural areas over all land tenures, including private property. This is exemplified by implementation of the Bush Forever study of remnant native vegetation on the Swan Coastal Plain. Some of these sites will be acquired for addition to the conservation reserve system however most of the sites will remain in their current tenure and ownership arrangements. (Government of Western Australia 2000). There is a range of mechanisms to deliver biodiversity conservation outcomes on land tenures other than public land in the CAR system (see 3.4.4).

Some research suggests that at least 30 per cent of each ecological community strategically located across a landscape is required to maintain sustainable levels of biodiversity (Andr n, 1994). The Bush Forever target of protecting "at least 10 per cent of each vegetation complex" alone is unlikely to conserve the biodiversity of the Region. The long-term viability of Bush Forever Sites relies on them being set within a matrix of "locally significant" natural areas that provide buffering and linkage to prevent loss of biodiversity (Del Marco *et al* 2003).

Biodiversity is, by its definition complex and varied. To define the totality of the biodiversity assets and fully protect them within the conservation reserve system is not possible, due to major gaps in both knowledge and data relating to aspects of the Region's biodiversity, the high degree of complexity involved, and limited resources for this to be achieved. As such, biodiversity conservation measures, including those used by State agencies to plan and manage the formal reserve system, are based on 'surrogates' for the whole of biodiversity (with data on remnant vegetation being the most commonly used surrogate). It is the intent of this Strategy to progressively address gaps in knowledge and data relating to the biodiversity of the Region. This will enable a more informed and definite basis to plan and implement biodiversity conservation and management, including the provision of adequate resources to achieve the outcomes sought (see 3.4.5). For example to deliver more effective management of declining and sensitive populations of fauna species.

Vegetation complexes in the Region, as defined and mapped by Heddle *et al.* (1980) and Mattiske and Havel (1998) were chosen as the planning units for biodiversity conservation in this Strategy. For planning purposes these vegetation complexes are described and represented as 12 major landform elements, or sub-assets (see Figure 23 and Appendix 11). The 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 17 floristic community and two fauna assemblages Threatened Ecological Communities (TECs) in the Region (Figure 26). Most of the Region's TECs are located either on the Pinjarra Plain or foothills, on the eastern edge of the Swan Coastal Plain. This is due to these areas having been cleared extensively in past decades, mostly for agricultural purposes (and given that the land is relatively flat it was not as difficult to clear this land as some other areas in the State). In some areas of the Region (for example, the eastern Swan Coastal Plain), threatened flora and threatened ecological communities are concentrated.

The main vehicle CALM uses for the management and recovery of TECs is the preparation and implementation of recovery plans (the plans are used by all land managers and stakeholders who may undertake management actions for these communities).

3.4.3 Issues and Pressures

Loss and fragmentation of natural areas, particularly native vegetation, is increasing through clearing for urban development. An emerging and potentially high impact threat related to land clearing is the increasing incidence and understanding of acid sulphate soils. The resilience of the environment to both natural stresses and ongoing human induced pressures such as land clearing incrementally reduces biodiversity values.

The extent of original vegetation is lowest within the urban parts of the Region. The loss of vegetation in urban areas increases the urgency to protect the remnant bushland that remains. There is a trend for increasing individual and community group awareness and action in NRM. Residents close to bushland value these areas as 'icons'.

The status of the Region's rich fauna is relatively poor. This is primarily due to habitat loss and consequential destruction of viable fauna populations. The condition, structure and optimal size and connectivity of habitat areas is under threat from both the clearing of native vegetation and wetlands and pressures on natural areas, as described above.

Decline in habitat condition is caused by a number of factors including the removal of woody debris, loss of vegetation understorey from clearing and grazing, loss of beneficial soil organisms and layers of soil, altered fire regimes, inadequate refuges from fire, introduced predators, diseases, weed invasion and loss of breeding sites.

Loss and fragmentation of habitats isolate fauna populations. This results in reductions in population sizes, genetic exchange between populations, resilience to recover from both natural and human induced stresses (such as fire events), and the risk of local extinctions. Coupled with this, there are major gaps in knowledge with respect to the Region's fauna. This means that, until such time as adequate knowledge is acquired, CALM's application of the CAR conservation reserve system, and other tools to conserve and protect native fauna populations continue to be limited in their effective application. (See Section 3.4.5.)

Knowledge is a key planning and management tool in conserving biodiversity, and a lack of knowledge has been identified as a major threat to achieving the identified Resource Condition Targets for the Region. Adequate and appropriate knowledge needs to be maintained and accessible to all stakeholders, and adequate decision-making tools required as the basis for disseminating information at local, sub-regional and regional scales.

Limited knowledge and awareness may result in inappropriate land management practices and land use planning decisions. Ultimately, this may cause losses to and impacts on biodiversity.

Large scale replacement of natural vegetation with agricultural crops and other rural land uses such as grazing have increased groundwater recharge. This has resulted in a subsequent rise of groundwater tables in some areas of the Region where salts accumulated in the soil profile have been mobilised and concentrated at the soil surface. Impacts occur in the Ellen Brook, Brockman and Wooroloo catchments to the east and north of the Region, In these areas salinity is found on privately owned land (mostly agricultural), and in reserves such as Julimar, waterways, seeps, wetlands and valley floors. The effects of salinity can be severe and widespread including large scale vegetation death and ecological destruction.

The impacts of climate change are potentially severe for biodiversity at a regional level. The Intergovernmental Panel on Climate Change expects Australia's water resources, terrestrial and aquatic ecosystems, agriculture and forests to be vulnerable. The latest climate change scenarios developed by CSIRO for Australia include increased risk of drought, increased soil erosion and dryland salinity, more hot days and greater bushfire risk. Long-term planning is essential to minimise the future impacts of climate change on natural resources.

Land Clearing

Land clearing in the Region results from and is mainly caused by urban development. Urban development largely comprises residential subdivisions, although high levels of development for commercial and industrial purposes are also taking place. This development tends to occur in areas of the Swan Coastal Plain that

contain remnant native vegetation. Clearing also occurs for the development of the infrastructure (eg roads and utilities) that is required to support this primary development.

The Australian Government formally identifies the threat from land clearing as a key threatening process under the *Environment Protection and Biodiversity Conservation Act (1999)*. Given this it is incumbent upon the State to respond appropriately to this threat to the Region's biodiversity.

In addition to the primary impact of vegetation loss, and clearing causes fragmentation of native flora and fauna populations, decline in habitats, shelter and food sources for native fauna.

Fragmentation

In general, larger natural areas have greater ecological viability than smaller areas and fragmentation of natural areas impacts significantly on this viability. Given that there are competing demands for land uses, particularly in the urban setting, the conservation of native vegetation, particularly in larger areas can be difficult to achieve. Fragmentation is also caused by many of the other priority threats discussed, if not a combination of them. For example, a particular area of bushland may be fragmented due to a combination of 'dieback' (*Phytophthora cinnamomi*) infestation, induced localised drought due to excessive water abstraction and arson.

Fragmentation and insufficient reserve sizes can lead to incremental loss of ecological viability. It may also result in 'edge effects' which means that weeds and other threatening processes affect the areas concerned. Furthermore, gene pools may be reduced, dispersal of plant seeds may be limited and fauna movements may be significantly reduced.

Weeds

Weeds may enter natural areas through a number of vectors including wind, water, animals, vehicles and footwear. This is exacerbated by physical disturbance, particularly clearing of naturally occurring vegetation and increased nutrient loading which provides a niche for the establishment of weeds. Once weeds are established a number of stresses, or flow on effects may occur. This includes alterations to soil chemistry, out-competing local native plants due to rapid increases in their gene pools, as well as space and biological resources required by native species being occupied. Additionally, there may be a resulting decline in habitats, shelter and food sources for native fauna.

An initiative under the National Weeds Strategy (1997) was the identification of an Inaugural List of Weeds of National Significance (comprised of the 20 weed species posing the greatest threats). There are occurrences of five of these weed species in the Swan Region as follows:

- Bridal creeper (*Asparagus asparagoides*);
- Bitou bush/Boneseed (*Chrysanthemoides monilifera*);
- Blackberry (*Rubus fruticosus* agg.);
- Salvinia (*Salvinia molesta*); and
- Gorse (*Ulex europaeus*).

Inappropriate Fire Regimes

The sources of fires include arson, unintentional ignitions, lightning strikes and prescribed fuel reduction burns. Fire regimes are a function of when and where burning occurs, and the fuel loads present during these events. Inappropriate, or altered fire regimes may be defined as variations to natural patterns of fire events within ecosystems in terms of frequency, intensity, duration and the seasons of occurrence. However, it is often unknown, difficult to determine and debatable, what a 'natural' fire regime originally would have been for given ecosystems.

Fire management must also consider the threat that wildfire poses to life, property and industry in the Region. By definition this means that to some extent achievement of these objectives will result in less than ideal fire regimes to meet the needs of biodiversity.

The flow on effects, or stresses, that result from too frequent fires include losses to fire sensitive native flora and fauna (frequent fires prevent many native plant species from reaching reproductive maturity); decline in habitats; shelter and food sources for native fauna; reduced viability of many local plant species; and higher levels of weeds.

On the other hand infrequent fire will also impact on biodiversity, as for example, the seeds of some native plant species rely on fire for their release. In relatively small urban reserves the preferred fire regime is one of fire exclusion – in an effort to reduce weed invasion. However, the careful use of prescribed burns can also assist in the control of some weed species. Often extended periods of fire exclusion are punctuated by large and damaging wildfires.

As indicated by Abbott and Burrows (2003), it is of utmost importance that research is continued and integrated into planning and implementation of land management in the Region in order to achieve appropriate fire regimes.

Pests and Diseases

Pests and feral animals include mammals (particularly cats, foxes and rabbits) invertebrates and birds introduced from other parts of Australia and various countries. Pest and feral species may be introduced in a variety of ways including animals kept as pets; species used in primary production; inadvertent transportation of these species with imported biological materials and goods in general.

When populations of particular native fauna species become very high or move (or are moved) into previously unoccupied areas they also may become pests in terms of out-competing the other native fauna present. For example, galahs, corellas, lorikeets from eastern Australia, kangaroos in small bushland areas.

The effect of pests and feral animals on many native fauna species can be, significant. This is particularly the case when they out-compete with native fauna. For example, rabbits and unnaturally high populations of kangaroos may overgraze areas, reducing food sources for other native fauna and impacting on the functionality of the ecosystems present. Another example is the high levels of introduced feral beehives, these occupy hollows in trees and in this way displace, birds and mammals from habitat niches. Populations may then build up rapidly and spread into other areas, particularly given that they do not have natural predators.

The *Commonwealth Environment Protection and Biodiversity Conservation Act (1999)* formally recognises feral cats, foxes, pigs and rabbits are key threatening processes. Accordingly, there are Commonwealth Threat Abatement Plans for each of these species, which should be referred to when planning control of the impacts caused by these species.

Plant diseases (pathogens) occur naturally in the Region. However, when weeds and feral animals are introduced, or reach high levels, the ecosystems present tend to lack in resilience to prevent the diseases escalating. Additionally, they may result in fragmentation of native flora and fauna populations, decline in habitats, shelter and food sources for native fauna and so on. There are presently significant knowledge gaps with regard to most of the diseases that may affect the Region's native flora.

Phytophthora cinnamomi, commonly referred to as 'dieback' has been well studied, and has affected many of the native plant species of the Region, and throughout the south west, for several decades. This work has demonstrated that the disease kills a large number of native plants and impacts on the structure and functionality of plant communities. However, as a whole the knowledge gained has only translated into suitable management actions over a relatively small portion of susceptible lands, and little is known about the overall effect of the disease on ecosystem functionality. Given that nearly all of the Region's native vegetation is susceptible to the disease (and there is a high probability of infestation in many areas), there is a need to expedite preventive and precautionary measures throughout these areas. Ideally, this will include a cross-regional approach to the disease

Phytophthora cinnamomi a water mould (pseudo fungus) disease affecting up to 25 per cent of Western Australian native plant species, is thought to have been introduced to Western Australia in the root material of introduced plants shortly after European settlement. It reproduces in moist soil and its microscopic spores can spread in groundwater flows, including surface expressions of groundwater in wetlands, constructed dams, drains and so on. Human activities including recreational use of bushland, earthworks, quarrying and agricultural stock movements can spread spores rapidly. Some management can be achieved by use of appropriate hygiene measures these include: restrictions to vehicle movement, or wash-down with a water solution of bleach or similar (Kilgour 2000).

There are flow-on impacts to fauna due to the impact of *Phytophthora cinnamomi* on native plant species and communities. Research to date provides evidence that forest animal communities in the Region are

affected by the presence of the disease, particularly in the case of native mammals and invertebrates, with further research required on its impacts on native birds, amphibians and reptiles. (Personal Communication, Garkaklis 2004).

The *Commonwealth Environment Protection and Biodiversity Conservation Act (1999)* formally recognises *Phytophthora cinnamomi* as a key threatening process. Accordingly, the relevant Commonwealth Threat Abatement Plan should be referred to when planning to reduce the impacts of the disease.

In the case of deaths and declines of *Eucalyptus rudis* (Flooded gum or Rudis), *Eucalyptus gomphocephala* (Tuart) and *Eucalyptus wandoo* (Wandoo) recent study appears to indicate that these problems are caused by a number of stress factors rather than a single disease (when plants and ecosystems are unduly stressed this predisposes plants to diseases). For example, research into Flooded Gum declines indicates that drought stress, high levels of psyllids on leaves (which reduces photosynthesis) – in part due to the reduced presence of bird predators to psyllids, and reduced understorey are all factors that appear to interact as the cause and underlying basis of this problem's continuation. Research is continuing into the causes of these problems including the State Government's establishment of response groups to investigate, and act on the Tuart and Wandoo declines.

Additionally, it is important that land managers and associated stakeholders continue to observe and monitor for potential, introduced or as yet unknown diseases. For example, the plant disease *Armillaria* occurs naturally in the Region and there is some potential for it to escalate to levels where it unduly impacts on the native flora present.

3.4.4 Current Response

Some areas within the Region, particularly in and around wetlands and water bodies, are visited by bird species that migrate between the northern and southern hemispheres each year. There are two international agreements in place supporting the conservation of these birds and their habitats. These agreements are between the Australian Government and the Governments of Japan and the People's Republic of China, the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA), respectively (Government of Western Australia. 2000a).

The Australian Government *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act) gives the federal Environment Minister the power to control actions that have, or may have, a significant impact on matters of National environmental significance. Matters of National environmental significance under the Act are as follows:

- World Heritage properties
- National Heritage places
- Ramsar wetlands of international significance
- Nationally listed threatened species and ecological communities
- Listed migratory species
- Australian Government (Commonwealth) marine areas
- Nuclear actions (including uranium mining)

The State of Western Australia has signed a Bilateral Agreement (August, 2002), relating to the Act's requirements to assess potential impacts on matters of National environmental significance.

The *Natural Heritage Trust Act (1997)* provides a framework to restore and conserve Australia's natural environment. In particular, it promotes biodiversity conservation, sustainable use of natural resources, as well as wider regional community capacity building and institutional change. The State of Western Australia signed a Bilateral Agreement relating to NHT Phase 2 in December 2002.

There are various formal Australian Government policies and strategies related to biodiversity that aim to assist the States, Local Governments and wider regional communities in the planning and implementation of best-practice biodiversity conservation. These policies and strategies include:

- National Strategy for Ecologically Sustainable Development
- National Strategy for the Conservation of Australia's Biodiversity
- Wetlands Policy of the Commonwealth Government of Australia
- National Objectives and Targets for Biodiversity Conservation 2001-2005

- National Weeds Strategy
- Register of the National Estate

There are also National frameworks and strategies prepared independently, and subsequently endorsed by, the Australian Government which include:

- National Framework for the Management and Monitoring of Australia's Native Vegetation (Australian and New Zealand Environment and Conservation Council)
- National Local Government Biodiversity Strategy (Australian Local Government Association and Biological Diversity Advisory Council 1999)

The National Action Plan (NAP) for Salinity and Water Quality builds on the work established under the Natural Heritage Trust, State/Territory strategies and the Commonwealth of Australian Governments Water Agreement. The Action Plan aims to encourage wider regional communities to prevent, stabilise and reverse trends in salinity and improve the quality of water and secure reliable water allocations. Biodiversity conservation and appropriate water allocations for the environment are key outcomes being sought from the implementation of NAP. A Bilateral Agreement for the Action Plan was signed between the State of Western Australia and the Australian Government in September 2003.

Western Australian legislation that provides a framework for biodiversity conservation is as follows:

- I. *Conservation and Land Management Act (1984)*
- II. *Wildlife Conservation Act (1950)*
- III. *Environmental Protection Act (1986)*
- IV. *Swan River Trust Act (1988)*
- V. *Town Planning and Development Act (1928)*

These *Acts* provide the legislative basis for the operations of CALM (i and ii); DoE (iii); the SRT (iv); and the DPI (v). CALM is the State agency with primary responsibility for biodiversity conservation in Western Australia. The *Town Planning and Development Act (1928)* provides the legislative basis for the town planning operations of Local Government.

Recent amendments to the *Environmental Protection Act (1986)* are being passed by State Parliament. The amended *Act* replaces the *Soil and Land Conservation Act (1945)*, with the clearing permit system assessing the impacts of clearing on biodiversity and all aspects of the natural environment. Some exemptions apply to the clearing permit system, such as limited clearing for fire access tracks, and where statutory planning approvals are in place.

Furthermore, the Government of Western Australian is at an advanced stage in the development of a draft '*Biodiversity Conservation Act for Western Australia*'. The proposed *Biodiversity Conservation Act* is expected to give legal recognition to threatened ecological communities. Coupled with this, consultation is continuing with key interest groups and relevant agencies. The *Act* will supersede the *Wildlife Conservation Act (1950)* and complement the *Conservation and Land Management Act (1984)*. This will assist both in on-ground implementation and institutional change for effective biodiversity conservation, and as such is in line with the key aims of this Strategy.

State policies and strategies related to biodiversity aim to assist Local Governments, wider regional communities and the Australian Government in planning and implementation of best-practice biodiversity conservation. These policies and strategies include:

- Bush Forever
- Environmental Protection (Swan and Canning Rivers) Policy
- Environmental Protection (Swan Coastal Plain Lakes) Policy
- Statement of Planning Policy No.2: Environment and Natural Resources Policy
- Wetlands Conservation Policy for Western Australia
- Waterways WA Program
- State Weed Strategy
- Environmental Weed Strategy
- State Sustainability Strategy
- State Salinity Strategy
- *Phytophthora* Dieback Management Framework

The draft Statement of Planning Policy (Perth Metropolitan Region Urban Bushland Policy) currently in preparation by the Western Australian Planning Commission will require Local Governments to prepare Local Bushland Strategies as part of a wider Local Biodiversity Strategy. The Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region (Perth Biodiversity Project 2004) have been developed to assist Local Governments prepare these wider Local Biodiversity Strategies.

The ongoing implementation of the Comprehensive, Adequate and Representative (CAR) conservation reserve system approach is essential to conserve and protect the biodiversity of the Region. CALM, on behalf of the Conservation Commission of Western Australia, is responsible for management of lands within the formal conservation reserve system. Currently 46,912 hectares (seven per cent of the total area, or 11 per cent of the remaining vegetated area, of the Region) is included in the formal conservation estate.

A further 198,858 hectares (30 per cent of the total area, or 46 per cent of the remaining vegetated area, of the Region) is included within State Forest, the majority of which is located in the Darling Range. In accordance with the Forest Management Plan 2004-2013 (FMP), these lands are managed for the sustainable use of the ecosystems present by CALM, on behalf of the Conservation Commission of Western Australia (Conservation Commission of Western Australia 2004).

The Department of Planning and Infrastructure has been given the lead agency role in implementing Bush Forever, which covers remnant native vegetation on the Swan Coastal Plain portion of metropolitan Perth. Over the next ten years the Western Australian Planning Commission will continue to acquire Bush Forever sites for addition to the CAR reserve system. However for most of the land included in Bush Forever, current tenure and ownership arrangements will remain (eg. Crown Land for purposes as a utility or residential zoned in private ownership) (Government of Western Australia 2000). Currently 50 per cent of the area identified in Bush Forever is already protected in the conservation reserve system.

Full implementation of Bush Forever will mean that for seven of the 26 vegetation complexes within the study area, the (Bush Forever) target of conserving and protecting greater than ten per cent of their original area will not be met. Coupled with this, up to 50 per cent of the vegetation conserved may be outside the formal reserve system, or not have conservation as the primary land use. A number of mechanisms are being used to conserve and protect Bush Forever sites including the use of conservation covenants, and financial assistance with management. It is imperative that programs and partnerships for 'off-reserve conservation' of biodiversity continues to be developed, promoted and consolidated (Government of Western Australia 2000).

An equivalent comprehensive plan to Bush Forever is ultimately required for bushland east of the escarpment of the Darling Range, which covers a significant part of the Region. This proposed comprehensive plan is referred to as 'Bush Forever Phase II'. As for the Swan Coastal Plain, this will result in additions to the CAR conservation reserve system and mechanisms to conserve and protect identified sites in private ownership. In the case of the Darling Range and escarpment, the Forest Management Plan (FMP) 2004-2013 identifies that approximately one quarter of this State Forest will become National Parks. Given this, it is likely that one of the major outcomes for 'Bush Forever Phase II' is endorsement of this FMP action.

Another measure that complements and is vital to biodiversity conservation in the Region is the Western Australian Local Government Association's Perth Biodiversity Project. This project assists Local Governments integrate biodiversity into the land use planning and development processes through the Local Government Biodiversity Planning Guidelines for natural area protection and management in the Perth metropolitan region. Local Governments are committed to biodiversity protection and annual expenditure in 2000-01 by Local Government on biodiversity related activities and associated human resources were \$5.14 million (Perth Biodiversity Project, 2002).

While the Australian Government *Environment Protection and Biodiversity Conservation Act (1999)* has provisions for the listing of both threatened species and ecological communities, the *State Wildlife Conservation Act (1950)* only has provision for the listing of threatened species. The *State Biodiversity Conservation Act* is expected to give legal protection to threatened ecological communities. Refer to Appendices 10-12 for the listings of these species and communities, which highlight that there are many species and communities listed under the State's identification processes that are not listed by the Australian Government. The categories used in these lists are set by an international classification system administered by the World Conservation Union (formerly known as the International Union for the Conservation of Nature and Natural Resources, and as such still commonly known by the acronym IUCN).

CALM's Threatened Species and Communities Unit coordinates the preparation and implementation of Recovery Plans and Interim Recovery Plans for threatened flora, fauna and ecological communities in the Region. The plans describe the actions required to improve the conservation status of threatened species and communities. Plans are often prepared and implemented by Recovery Teams, and consist of a group of key stakeholders who are partners in this recovery work. Recovery Teams can be formed for one, or a group of threatened species or communities and may comprise 'friends of' or other community based volunteers, non-Government organisation members (eg. World Wide Fund for Nature (WWF)), Zoological Parks Authority and Botanic Parks Authority officers, and university based experts.

Generally, the level of priority for the management approach adopted is based on the degree of threat to the survival and viability of the species and communities concerned. For example, if a flora species is listed as Critically endangered (CR) the aim of recovery work undertaken is for downlisting of the species to a less threatened status (Endangered (EN) or Vulnerable (VU)), or when there is a very high degree of recovery, removal from the list may be possible (Refer to Appendix 13).

A NHT Phase I funded project undertaken by CALM reviewed all threatened flora in the Region, by identifying all listed species and prioritising management actions to guide future recovery programs. The resulting published report is used to direct recovery action for these species.

Currently Recovery Plans, or Interim Recovery Plans are being implemented for a range of threatened fauna species within Swan NRM Region. This includes the Western Swamp Tortoise; several mammal species – for instance the Chuditch and Numbat, as well as Carnaby's Black Cockatoo. These recovery plans can involve significant input from community groups, for example Birds Australia are significant partners in the recovery of Carnaby's Black Cockatoo. There are a suite of other organisations responsible for recovery plan implementation at Local, regional or National levels and this is where community partnerships and partnerships with other organisations is encouraged.

The Threatened Species Network, which is a partnership between the Australian Government and WWF, operates a grants program which can be accessed by community groups. In this way a vehicle is provided to foster community involvement in biodiversity conservation, and this also forms a key part of the implementation of recovery plans.

An important program, run by CALM, for fauna biodiversity conservation is the *Western Shield* program, which commenced in 1996. *Western Shield* aims to restore vulnerable native fauna (predominantly mammal species, but also some bird and reptile species) to sustainable population levels, primarily by reducing the impacts of fox and cat predation. A recent review of the program has found it to be highly successful. In particular, it has achieved considerable improvement in the conservation status of the Woylie, Tamar Wallaby and Quenda. It has also achieved broad-scale improvement (not always quantified) in the abundance and distribution of a range of other mammals, reptiles and birds. (Possingham *et al* 2003).

The Dieback Working Group, which is comprised of representatives from State and Local Government agencies, as well as private enterprise and community volunteers, has developed both Managing Phytophthora Dieback in Bushland and Managing Phytophthora Dieback Guidelines for Local Government. The working group is currently in the process of tailoring the guidelines for Local Government to the specific needs of other stakeholders and natural resource managers. For example, the working group is currently producing Best Practice Guidelines for the Extractive Industry. The working group also undertakes presentations, workshops, training, demonstrations and other support activities tailored to the needs of specific groups and in order to promote best-practice in land management with regard to Phytophthora Dieback.

Urban Nature is a State Government initiative delivered by CALM. The program focuses on identifying, accrediting and promoting best practice bushland management for urban areas. It will provide and promote capacity building, training and education on bushland conservation and management to the wider regional community, Local Government and State agencies. This program will complement Ecoplan, which has been operating since 1991 and is CALM's community support program for groups and individuals who are caring for bushland reserves in the Perth area.

Additional advice is available from Land for Wildlife which is a simple voluntary non-binding program that is designed to recognise and support landowners who wish to manage some or all of their land for biodiversity conservation.

Externally supported school based education programs on biodiversity and the environment are being undertaken, however many of these programs have been developed without formal Education Department input. These have been funded by the NHT, Government Agencies, Local Government, non-Government organisations, community groups and corporations, programs like CALM's Eco Education, Bush Rangers, and Greening Australia WA's Grow Us A Home are examples.

Adult community education is delivered through many organisations, State departments and community groups. In partnership, the Swan Catchment Centre, Ecoplan (CALM) and Greening Australia WA deliver the Skills for Nature Conservation Training program. Other current programs include those delivered by APACE, Naragebup, Ribbons of Blue/Waterwatch WA, CALM's *Nearer to Nature* and the Eastern Metropolitan Regional Council's *Bush Skills for the Hills*.

Covenancing schemes are mechanisms that enable private landholders to protect biodiversity on private property through legal changes to land titles. There are three Covenancing schemes in Western Australia that can be accessed by property owners in the Region. These are:

- **Nature conservation covenant program** – CALM administrates Voluntary Nature Conservation Covenants that are a legally binding tool for permanently conserving natural bushland and wetlands on private land in Western Australia. The covenants are restrictive, and affect activities such as grazing and clearing. Some funding is available on a case by case basis as a contribution towards fencing and other land management costs. The covenant is negotiated with each landowner to be flexible to their needs, and ongoing management advice and assistance is provided through stewardship once the covenant is on title.
- **National Trust conservation covenant scheme** - started in April 1999, but the heritage-based organisation has been operating since 1964 under the *National Trust (WA) Act (1964)*. The scheme offers heritage advice and permanent covenants to run with the land title. Covenants can be tailored to meet the owner's needs and enables the landholder access to environmental management advice and bushland planning.
- **Voluntary conservation covenants scheme** - established in accordance with requirements available under the *Soil and Land Conservation Act (1945)*. This scheme has been established since 1990. Department of Agriculture has statutory powers to enter land into covenants for soil and conservation purposes. Otherwise, covenants are voluntary and can be binding in perpetuity or limited in time (usually for at least 30 years, but can be longer).

Bush Brokers is a brokering mechanism between sellers and buyers of bushland. It is a partnership between the World Wide Fund for Nature, Real Estate Industry of Western Australia and the Soil and Land Conservation Council. It aims to promote the purchase of bushland for conservation and sustainable use. It is complementary to the covenancing schemes used above, and is often used in conjunction with these schemes.

A "Biodiversity Incentives Package" has been developed by the State Government through collaboration between DoE and CALM.

A large percentage of individual and community group contribution to biodiversity conservation occurs through groups involved in protecting and managing areas of bushland, wetland and riverine environments. These groups, which include catchment groups, 'friends' groups and school groups, make a vital contribution to the protection of locally significant biodiversity. At the regional level community activities by many (but not all) groups are coordinated through the Swan Catchment Centre. There are also a number of other peak bodies and special interest groups making vital contributions. These include the Conservation Council, Urban Bushland Council, the Wildflower Society, several wildlife carer groups, Environmental Weeds Action Network and Australian Association of Bush Regenerators.

Many community organisations are assisted in their work with grants from the Swan Alcoa Landcare Program which is jointly funded by the SRT and Alcoa World Alumina Australia. In-kind support is provided by Local Governments and advisory services from Government agencies and the Swan Catchment Centre. Other funding sources include, but are not limited to, Lotterywest (Gordon Reid Foundation) and the State Minister for the Environment grants. Their contributions need to be formally recognised, particularly in the management of publicly held bushland. The community's leadership needs to be supported through a strengthening of partnerships between individual and community groups and State and Local Governments.

3.4.5 NRM Strategy Response

The Strategy responses outlined below form the basis for the biodiversity asset category targets detailed in Section 4.

Scientific research is required to build upon the current level of knowledge of biodiversity in the Region. Therefore a set of guiding ecological principles have been identified to be used when planning for biodiversity conservation and setting management priorities to ensure that ecological integrity of the Region is retained.

Maintaining ecological integrity is vital in achieving the Swan community's aspirational goals.

"A system with integrity has the capacity to support and maintain a balanced, integrated, adaptive community of organisms having a full range of components (genes, species, assemblages) and processes (mutations, demography, biotic interactions, energy dynamic) expected from natural habitats of the region." (Gutzwiller 2002)

Four broad rationales underpin the objective of conserving biodiversity (State of the Environment Advisory Committee 1996):

- **Ecosystem processes** - biodiversity underpins ecosystem processes that are necessary to maintain or regulate water resources, soil formation, the recycling of nutrients, atmospheric quality and climate.
- **Economic** - plants, animals and ecosystems are potential sources of food and medicines, are tourist attractions and provide resources for industry, agriculture and forestry.
- **Aesthetics and culture** - people can obtain amenity and recreational benefits from biodiversity, and it contributes to culture.
- **Ethics** - the belief that there is a moral duty to avoid the extinction of other species.

The prioritisation of future investment to progress biodiversity outcomes in the Region is underpinned by the following guiding principles and supports those outlined in section 1.3.1. The biodiversity targets were developed on these guiding principles.

Guiding Principles

- **Comprehensive, Adequate, and Representative**
"A comprehensive, adequate and representative system of ecologically viable protected and managed areas, integrated with the sympathetic management of other areas, including urban, agricultural, forestry and industrial." (Natural Resources and Environment 1997)
- **Conservation**
 - Protection of biodiversity in-situ is the highest priority
 - Conservation planning at multiple scales is preferable to planning at one scale. (site, neighbourhood, local, sub-regional, NRM region, natural region.)
 - All natural areas have intrinsic value
 - Larger areas of habitat are generally better than smaller areas
 - A compact shape is preferable to an irregular or an elongated shape
 - Diverse habitat will generally support more species than will uniform habitat (however areas of uniform habitat are important for biodiversity conservation, and may support unique biota)
 - Connected landscapes are more likely to maintain population processes than are fragmented landscapes
 - Wider and structurally diverse corridors are likely to facilitate movement of a wider array of species than narrower corridors
 - Management of threatening processes should occur at a scale and consistency which matches the scale and intensity of the threat
- **Restoration**
 - Protection and management of intact natural areas should occur prior to revegetation activities except where fragmentation and loss of vegetation structure is the most degrading threatening process

- Adaptive management using bush regeneration techniques should occur before revegetation is initiated
- Restoration of ecological linkages is of a higher priority than revegetation of cleared land
- Use of local provenance seed and suitable local species, reflecting all structural layers should be used in revegetation programs
- Collection of local native seed follows FloraBank guidelines (reference) and is directed by planned regional/local revegetation strategies

- **Knowledge**

Biodiversity conservation is enhanced by knowledge and understanding of species, populations, ecosystems and ecosystem functions. There is a need to continue to acquire and develop knowledge and understanding of the Region's biological diversity and ecological functions.

Decisions on which actions will be resourced over others will be guided by the previously outlined guiding principles, which focus on achieving protection of biodiversity through management of threatening processes and selection of priority areas (eg larger remnant habitat versus fragmented small remnant habitat).

It is well understood that the conservation and maintenance of biodiversity requires the protection and management of ecological communities and natural areas across private and public land. The Strategy considers the need to ensure that the Region's physical diversity (landforms and soils) and the range of organisms and ecological processes (the biological diversity or 'biodiversity') are conserved according to National and State requirements (BR1). This will rely on the adequate protection of regionally significant bushland and locally significant natural areas that exist outside of Bush Forever sites, CALM estate and proposed Regional Parks. These natural areas are areas of native vegetation, wetland, revegetated areas, open water (fresh, estuarine, and saline), rocky outcrops and sandy or rocky coasts.

The impacts of dryland salinity in the south west of Western Australia are well documented, and some parts of the Swan Region's Wooroloo and Ellen Brook catchments are currently being impacted by salinity (see also sections 3.2.2 and 3.2.3). In particular, the State Salinity Strategy outlines a coordinated response to address, to the extent possible, the impacts of salinity. Within Swan NRM Region catchment boundaries, the Upper Helena catchment has been identified by the State Salinity Strategy as a priority catchment for salinity action.

To achieve and maintain the long-term biodiversity conservation targets within the Region, a combination of approaches is proposed. These include comprehensive planning and the development and maintenance of strong partnerships between the wider regional community, industry and the Australian, State (particularly at agency level) and Local Governments. These Strategy responses are a reflection of the targets and the management actions and will be relevant across multiple natural resource asset categories.

Specifically these approaches will seek to retain and protect remaining bushland, wetlands and natural areas within a Comprehensive, Adequate and Representative (CAR) reserve system, both through additions to this system and the ongoing management of this estate by CALM. It is important that there is adequate resourcing for the ongoing management of the formal conservation reserve system (BR1).

A coordinated planning approach will be adopted, including statutory land use planning and regulation, across all land tenures, in order to retain native vegetation and habitat areas to the extent possible and effectively protect, manage and restore the biodiversity of these areas. It is considered that the establishment of an urban growth limit within the Region is a key part of this planning and regulation. Improved decision-making will result from knowledge gained, and disseminated, on the condition of biodiversity assets and successful management options and incentives (BR1 and BR2).

The management and recovery of threatened species and ecological communities, including management of underlying threatening processes, is a significant component of CALM's current operations. Local Governments, community groups, non-Government organisations, tertiary institutions and many other organisations and individuals also provide considerable contributions to threatened species and ecological community conservation. However, given the magnitude of threatening processes and the number of threatened species and communities, significant increases in, and focusing of current resources is required to prevent further declines of species and ecological communities. This can be most effectively implemented by a partnership approach involving key stakeholders and responses that deal with threatening processes on a whole of landscape scale (BR2 and BR3).

It is envisaged that the wider regional community will increasingly contribute to biodiversity conservation as a result of awareness-raising and effective engagement in line with this Strategy. In particular by greater participation in best practice biodiversity conservation and management on private land. Mechanisms and incentives private landowners may be able to use to achieve this include conservation or similar zonings under Local Government Town Planning Schemes, covenanting, rate and land tax relief, existing programs such as Land for Wildlife, Bush Brokers and Bush Bank (BM1.5 and BM2.5). Another important strategy to increase community support for biodiversity conservation is the provision of opportunities to experience natural areas (i.e. actually having places to go to see and interact with the environment). This is an important management activity of CALM (particularly in National Parks, marine parks and regional parks) as well as for other agencies and natural area managers.

Biodiversity conservation needs to be communicated to a wide audience. Whilst the most up to date technical knowledge needs to underpin biodiversity conservation and management, ideally information will also be presented in formats that can be understood by all stakeholders, with clear identification of how all stakeholders can participate.

A primary aim of this Strategy is to ensure that biodiversity, at all levels, is protected comprehensively and adequately. This will need to be coupled with effective and adequately resourced management of natural areas and native populations.

Achieving the primary aim will facilitate the protection and conservation of:

- Sustainable levels of retention of vegetation complexes on private property and within the reserve system
- Threatened Ecological Communities
- Habitats of threatened species and threatened species, and recovery of threatened species and communities
- Vegetation complexes with less than 10 per cent of the original extent remaining
- Linkages between areas of remnant native vegetation/habitats
- Linkages between viable populations of native taxa over their original geographical extent

In general, complete reconstruction of habitat will only be used for the purposes of strengthening identified regional ecological linkages (biodiversity corridors), and buffering vegetation complexes where less than 10 per cent of the original complex remains (BR2). There is a need for an increase in on-ground management of bushlands, wetlands and riverine vegetation to prevent further degradation from the impacts of weeds, dieback, feral animals, and altered fire regimes, clearing and altered hydrology (BR3). These actions need to be guided by threat abatement plans and a scientifically based biodiversity strategy for the Region (BM2.3).

A fundamental action required is the design, development and implementation of a monitoring and evaluation framework for the biodiversity of the Region. A current gap in the Region's knowledge is an understanding of what determines the health and condition of biodiversity, and what are suitable indicators and appropriate monitoring and analysis for it (BM1.1). Such a framework will coordinate relevant research and identification of baseline information and the development of baseline indicators, systems for information management as well as roles and responsibilities.

In addition to knowing what is required and at what scale to achieve long-term biodiversity conservation, is our capacity to implement strategic actions. Biological condition targets are therefore complemented by regional capacity targets (BM1.5, BM2.5 and BM3.4). Individual and community group involvement in NRM will continue to be supported through the regional and sub-regional coordinators and facilitators network. The overall broad outcome is a protected and managed network of viable biodiversity areas achieved through successful partnerships and the guided and coordinated actions of skilled, knowledgeable, motivated and adequately resourced networks of people, organisations, institutions, industry and Government.

3.4.6 Trade-offs

The principle trade-offs in protecting the remaining high value biodiversity assets in the Region will require negotiations between the Government – particularly at State level, and the wider regional community, to determine acceptable urban development (including the scale and levels of this development).

Economic factors are driving an ongoing high rate of residential and industrial development, and the resultant need to provide supporting infrastructure, within the Region. This necessitates a high rate of

clearing of the Region's natural areas (with some State Government agency support for the provision of these areas for development purposes). Indeed, the focus of these economic processes, including speculation, is on natural areas being zoned urban/industrial, and as such to be developed for these purposes.

Negotiations will need to be entered into between the wider regional community and the State Government to identify appropriate allocations for the intrinsic economic values of natural areas (including economic), as compared to the benefits that can be derived from urban development.

The issue of compensation for loss of productivity on private property, to protect biodiversity will need consideration. This can also be extended to other industries which trade on resources derived from natural resources and areas of biodiversity (ie. the timber industry, mining industry and wildflower/native seed industry). Trade-offs will need to be negotiated for loss of potential economic gain, with sustainable alternatives introduced and developed. New industries that sustain and support biodiversity conservation need to be devised, including the transitions to achieve these changes. The protection, from development pressure, of locally significant and regionally significant biodiversity assets on public land from development pressure will also need to be considered, in light of the minimum 30 per cent representation of vegetation complexes as outlined above.

The social, economic and environmental costs / benefits associated with decision-making will be considered during an assessment of trade-offs during the development of the Swan NRM Region investment plan.