Shire of Northam

LOCAL BIODIVERSITY STRATEGY

February 2015

DOCUMENT TRACKING

Item	Detail
Project Name	Shire of Northam Local Biodiversity Strategy
Project Number	
File location	
Prepared by	Renata Zelinova
Approved by	
Status	
Version	1
Last saved on	

Acknowledgements:

This report has been prepared through the Local Biodiversity Program, an initiative of the Western Australian Local Government Association (WALGA) in partnership with the Department of Planning (DoP) and the Department of Parks and Wildlife (DPaW), funded through the State Natural Resource Management (NRM) Program 2012-2014.

The Local Biodiversity Program wishes to acknowledge the following people for their involvement in the Shire of Northam Local Biodiversity Strategy.

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Abbreviations

AW – Avon Wheatbelt Bio-region

BVA – Beard Vegetation Association

CSIRO - Commonwealth Scientific and Industrial Research Organisation

DAFWA – Department of Agriculture and Food Western Australia

DEC – Department of Environment and Conservation

DPaW – Department of Parks and Wildlife (replaced DEC in 2013)

EPA – Environmental Protection Authority

EPBC Act – Environment Protection and Biodiversity Conservation Act 1999

EPT – Environmental Planning Tool

ESA – Environmental Sensitive Area

GIS – Geographic Information System

IBRA – Interim Biogeographic Regionalisation of Australia

JF – Jarrah Forest Bio-region

LBP– Local Biodiversity Program

LWF – Land for Wildlife

NAIA – Natural Area Initial Assessment

NRCGP – Northam Regional Centre Growth Plan

NRM – Natural Resource Management

PEC – Priority Ecological Community

SWAEI – Southwest Australia Ecoregion Initiatives

TEC – Threatened Ecological Community

UCL – Unallocated Crown Land

WALGA – Western Australian Local Government Association

WAPC – Western Australian Planning Commission

Executive Summary

VISION

Over the next 20 years, the diversity of indigenous species and ecosystems in the Shire of Northam is conserved, resilient to threats, restored and valued by the local community.

OBJECTIVES:

- To achieve a comprehensive, adequate and representative network of locally protected natural areas by improving the protection status, health and viability of each vegetation complex that is not currently adequately protected in the Shire
- To maintain and improve landscape function by implementing best practice environmental restoration and use of sustainable land use practices including appropriate land use planning and natural resource management.
- To achieve long term community engagement in local biodiversity management.

The Local Biodiversity Strategy:

- provides an overview of biodiversity assets retained in the Shire;
- summarises legislative and policy requirements for biodiversity conservation;
- reviews existing provisions in the local planning framework for biodiversity conservation;
- recommends a set of actions to improve the current status of biodiversity conservation in the Shire o Northam.

The strategy outlines key actions to be implemented over the next 5 years that will enable achievement of th vision for biodiversity conservation and contribute to the achievement of the Shire of Northam corporate visi

Methodology used to identify local conservation priorities follows the State government endorsed process fo local biodiversity conservation planning developed by the Western Australian Local Government Association Biodiversity Programs. Mapping and technical assistance was provided by the Local Biodiversity Program, informed with expert local knowledge through the representatives of the Stakeholder Reference Group set u by the Shire of Northam.

An assessment of the current status of biodiversity in the Shire shows the following:

- 23.7% of the pre-European extent of native vegetation remains in the Shire.
- Native vegetation retention is unevenly distributed, with 42% remaining within the western portion of Shire that overlaps with the Jarrah Forest bioregion and around 10% remaining in the eastern portion the Shire that overlaps with the Avon Wheatbelt bioregion.
- 4.7% of the pre-European extent of vegetation is protected (Department of Parks and Wildlife lands managed for conservation) or 5.3% when including Unallocated Crown lands reserved for Conservat of Flora and Fauna in the Shire's Local Planning Scheme.
- 76% of the remaining vegetation is classified as Local Natural Areas.

- Of nine Beard Vegetation Associations (BVAs) represented in the Shire, five have less than 1% protected, an additional one has less than 5% protected locally.
- All Beard Vegetation Associations are considered regionally significant, all have less than 17% of pre European extent protected in the Wheatbelt and Jarrah Forest bio-regions.
- Of eleven vegetation complexes represented in the Jarrah Forest portion of the Shire, nine are considered regionally significant, three having 0% and additional three less than 5% of their pre-European extent protected in the Shire.
- **99.5% of the remaining vegetation in the Shire is of regional conservation significance.**
- Over 1130 native species have been recorded within the Shire, including four endemics, 14 threaten and further 51species being of conservation priority.
- Decline in fauna is a primarily due to the loss of habitat, especially species specific hollow bearing tre and presence of feral predators such as foxes and cats.
- The chain of wetlands associated with local rivers such as the Avon River and the Mortlock River and their tributaries not only retain specialist habitat but the associated riparian and upland vegetation is critical to maintaining connectivity through the highly fragmented landscape.
- The overall health of waterways in the Shire varies and reflect land management within their catchments.
- Future on-ground activities need to build on the significant investment towards improving the Avon River health over the past twenty years.
- The health of the Avon River and its tributaries has direct impact on water quality of the Swan River.
- A regional connectivity study that aimed to develop guiding principles for corridor planning within the Avon River Basin identifies the western portion of the Shire as being within a 'high connectivity zone' and the eastern portion within a 'medium connectivity zone'.
- The biodiversity of the Shire continues to be threatened by a range of passive factors including passi clearing (through on-going grazing), inappropriate land-use, lack of protection and active manageme of weeds, pest animals, pathogens and impacts from industry such as agriculture.
- To remain viable into the future the biodiversity found within the Shire of Northam, especially rare an threatened species, endemics or species of interest require active management.

To assess the relative conservation priority, 20 criteria representing biodiversity attributes were intersected w 2013 native vegetation mapping. The prioritisation criteria consider:

- Representation of ecological communities in the Shire and biogeographical regions
- Presence of rare and threatened species and ecological communities
- Presence of wetlands, waterways, riparian vegetation
- Native vegetation patch size and connectivity among patches.

Most mapped native vegetation met numerous criteria, indicating high conservation values of the remaining vegetation.

Considering that the current retention and protection status of native vegetation is below the State and the national policy accepted thresholds of 10% and 30% of pre-clearing extent, any further clearing of vegetation should be avoided, including the removal of significant, mature paddock trees and stag-trees and excessive fenceline / roadside vegetation. Many paddock trees are being removed in the agricultural areas within the Shire to facilitate the use of GPS steer harvesting and seeding equipment. Increased awareness among landholders of ways to avoid removing these valuable trees should aim at eliminating this not essential practice. Remnant paddock trees are often hollow bearing, of significant age and are examples of what remnant vegetation would have looked like pre clearing. Large paddock trees provide food and habitat and a important in a local context for species of regional and national importance such as Carnaby's black cockato

The Shire's Local Planning Strategy and Scheme include numerous provisions for biodiversity. Findings of th Local Biodiversity Strategy will provide further guidance and reduce uncertainty in future decision making. Further recommendations for strengthening existing provisions for biodiversity conservation in the Shire's existing land use planning framework are made, including development and adoption of Local Planning Polic which will provide guidance to developers and land owners regarding necessary consideration of biodiversity development design options to minimise the impacts of future land uses and facilitate restoration of degraded areas to increase suitable habitat for local fauna and improve the health of local waterways.

Fifty-five 'Target Areas' have been identified to highlight areas with good opportunities to improve the representation of under protected native vegetation in the Shire. For each of these areas specific suggestion are made on opportunities to protect portions of the highest conservation value. The change or extensions o reserve purposes to include conservation are recommended as a priority where opportunities exist. Howeve with over 80% of native vegetation mapped on Rural zoned lands in the Avon Wheatbelt portion of the Shire and 42% on Rural zoned lands in the Jarrah Forest portions of the Shire, future vegetation retention and its management to maintain biodiversity values will depend on conservation on private land. Any future rezonin for development should avoid clearing and provide formal protection to the retained natural areas.

The 'Target Areas' highlight portions of remaining vegetation where protection of portion of the vegetation w contribute to the national target of 17% of bioregions protected, adopted by the Australian Government (201 Local contributions to the national target were calculated considering the proportion of pre-clearing extent of native vegetation associations and vegetation complexes in the Shire of Northam and the remaining extent using the 2013 native vegetation mapping. Due to high levels of clearing in portions of the Shire, fragmented nature of remaining native vegetation, for eight out of fourteen vegetation complexes and vegetation associations represented in the Shire, it will not be possible to achieve the desired level of formal protection. Protecting all remaining vegetation in good or better condition representative of these over-cleared vegetatio types should be a priority.

In the context of this Local Biodiversity Strategy, natural areas are considered protected if they are on Crown land vested for conservation, zoned or reserved in a local planning scheme for conservation and/or manage on private land with conservation covenant on land title.

Many of the existing biodiversity threatening processes are expected to be further exacerbated with changin temperatures and rainfall due to climate change. Building resilience of the natural areas and facilitating expected shifts in species distributions by improving landscape connectivity are considered important ways

improving biodiversity conservation. The Local Biodiversity Program developed three connectivity metrics to assist with identifying the most cost effective ways of improving connectivity between protected natural areas

Connectivity analysis of native vegetation in the Shire identified gaps between existing protected areas and identify parts of landscape where buffering of small protected areas and strategic re-vegetation between the areas will contribute to a more effective network of natural areas. The results of the connectivity analysis should be used to inform future priorities for vegetation restoration to build the resilience of local ecosystems against anticipated impacts of climate change.

All mapping layers developed for the Local Biodiversity Strategy are available through the special login on-li mapping viewer, the Environmental Planning Tool. A brief guide how to use this mapping viewer is provide the Appendices.

The Local Biodiversity Strategy contains information that can be used by the Shire of Northam and other relevant stakeholders to:

- Inform land use planning to facilitate sustainable development and protect environmental assets
- Identify priority areas for restoration, utilising offset requirements or external grant opportunities
- Engage all relevant stakeholders.

The main document provides an overview of biodiversity status, legislative and policy requirements for biodiversity conservation, review of existing land use provisions for biodiversity conservation in the Shire, describes the methodology adopted to prioritise natural area in the shire and recommends a set of actions, focusing on functions and responsibilities of the Shire. Appendices include more detailed information and descriptions of methodologies used in the Local Biodiversity Strategy, results of native vegetation status statistical analysis which supports the prioritisation and site specific recommendations for the fifty-five 'Targe Areas'.

Priority Actions:

Action	Priority
Integration into the land use planning framework	
Confirm the conservation values of the selected *Land Administration Act 1997 r*eserves proposed for change of purpose, or change of classification of reserve to Conservation of Flora and Fauna in the planning scheme (Appendix D, Table 5).	High (2015-2016)
Scheme Amendment to change the classification of selected high conservation reserves to Conservation of Flora and Fauna (vested in the Shire)	High
Scheme Amendment to change the classification of selected high conservation reserves (vested in State agencies)	Medium
Introduction of a new Rural Conservation zone, or strenghten Rural, Rural Residential and Rural Smallholding zone provisions	High
Amend Conservation designations on Local Planning Strategy maps to include adopted Target Areas and local conservation reserves	Medium
Develop a number of Local Planning Policy/Policies (see section 4.1)	High
Local Government Natural Area Management	
Develop a strategic 5 year management plan for all conservation reserves using the information collected via NAIA Templates	High

Action	Priority
Develop and implement best-practice procedures for all Shire staff and contractors working and accessing natural areas and managing infrastructure assets	Medium-High
Investigate the feasibility of forming a *Biosecurity Group* in partnership with adjoining Local Governments	Medium
Implement a strategic reserve management plan	Medium
Increase riparian vegetation cover and condition on lands managed by the Shire (focusing on upper reaches and northern shores of priority waterways)	Medium
Private landholder support	
Facilitate private landholder consultation to identify the most desirable incentives for biodiversity conservation on private land	High
Prepare and implement a private landholder incentives strategy to support biodiversity conservation on private lands.	Medium
Facilitate riparian vegetation restoration on private lands	
Communication	
Integrate all Local Biodiversity Strategy mapping into the Shire's information system	High (2014-2015)
Develop and promote sustainable landscaping strategy for residential areas and street-scaping	Medium
Facilitate discussions with local Aboriginal leaders to investigate opportunities for their involvement in promoting the cultural values of natural areas in the Shire	High
Facilitate discussions with the Wheatbelt NRM, adjoining Local Governments, DPaW and other relevant stakeholders on identification of regional ecological linkages.	Medium
Develop a monitoring and reporting schedule	High
Undertake a review of the feasibility and effectiveness of the proposed implementation actions every 5-7 years.	Medium
Local Government capacity building	
Contract or employ Environmental Officer services to include natural area management, submission of grant applications to obtain external funding for reserve management and facilitate partnerships with other relevant stakeholders and the community in reserve management, restoration and support to private landholders.	High
Form partnerships with not-for-profit groups active in the Shire to facilitate reserve management and private landholder support for biodiversity management	High
Establish a Natural Resource Management (NRM) Reference Group to facilitate partnerships in implementing the Local Biodiversity Strategy objectives and other NRM priorities (e.g. Avon River and other priority waterways recovery)	High

1 Context

1.1 Benefits of biodiversity conservation

Biodiversity, or biological diversity, is a variety of all life forms. There are three levels of biodiversity:

- Genetic diversity or the variety of genetic information contained in individual plants, animals and micro-organisms;
- Species diversity of the variety of species;
- Ecosystem diversity or the variety of habitats, ecological communities and ecological processes.

Natural Resource Management Council 2010

Conservation of biodiversity is critical to sustainable living which depends on maintenance of ecological services provided by the variety of ecosystems. Ecosystem services can be divided into four main groups (TEEB 2011, Millenium Ecosystem Assessment, 2005):

- Provisioning services such as food, raw materials, fresh water, medicinal resources;
- Regulating services including microclimate, carbon sequestration and storage, moderation of extreme events, waste-water treatment, erosion prevention, pollination, biological control;
- Habitat or Supporting Services such as habitat for species, maintenance of genetic diversity;
- Cultural services such as recreation, mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design, spiritual experience and sense of place.

Other benefits of keeping green spaces in urban and peri-urban areas include positive effects on property values. It has been estimated that property values increase about 10% in streets with large trees. Other recorded benefits include increased profits in tree-lined retail areas, greater acceptance of higher density residential developments near good quality green spaces, up to 25% reduction in energy consumption in buildings shaded by trees, reduced impacts on storm water management, reduced pollution and improved human health (reduction in heat-related illnesses), sense of place and identity, encourage outdoor activity, reduced infrastructure damage due to UV radiation exposure (Brown *at al* 2013, Pandit 2013, Matusik Property Insight 2006).

A study undertaken in rural Victoria, Australia concluded that with a shift in rural land ownership from agriculture-focused farmers to amenity focused 'lifestyle' owners, remnant vegetation adds value to lifestyle properties. It was found that an optimal proportion of tree cover on property was about 40% of land area leading to a 12% increase in average property price (Polyakov et al. 2012). Another study examined the levels of benefit provided by native vegetation on rural

properties across a range of property types and sizes (Polyakov *at al* 2014). It was found that private landowners on small and medium sized properties benefit most from presence of native vegetation on these properties. However, to maximize the biodiversity value of native vegetation on small and medium rural lands, effective management will need to be established to minimize fragmentation and impacts of weeds, feral animals or diseases on native vegetation.

1.2 Definition of Conservation, Protection and Retention

The Local Biodiversity Strategy aims to conserve the diversity of natural areas and associated ecosystems in the Shire of Northam. In the context of this Strategy, conservation, protection and retention of natural areas are defined as follows:

Conservation: In relation to biodiversity, conservation is the protection, maintenance, management, sustainable use, restoration and improvement of the natural environment (Australian Government 2010).

Protection: Protected areas are those natural areas that are secured for conservation either as

- public lands vested for a biodiversity conservation purpose (e.g. nature conservation)
- Indigenous Protected Areas
- private lands where the biodiversity values are secure for conservation under zoning, or covenanting
- Shared management reserves (Australian Government 2010).

Retention: is all the process ensuring a natural area is retained but not necessarily afforded protection to ensure its continued existence and viability (Del Marco *et al* 2004).

A Local Biodiversity Strategy:

Provides an overview of biodiversity assets retained in a local government area and identifies conservation priorities;

Summarises legislative and policy requirements for biodiversity conservation;

Reviews existing provisions in the local planning framework for biodiversity conservation;

Recommends a set of actions to improve the current status of biodiversity conservation;

Facilitates engagement of relevant stakeholders.

1.3 Legislative and Policy Framework

Biodiversity conservation requires a multi-level approach including Commonwealth, State, Local Government, industry and non-government groups, private individual and the community, all contributing to biodiversity conservation at appropriate levels. Development and implementation of a local biodiversity strategy provides an effective mechanism for meeting legislative requirements and strategic objectives at the local government level.

Australia's Biodiversity Conservation Strategy 2010-2030 (NRMMC 2010) provides the overarching guiding national framework, identifying three national priorities for action and ten national targets for all governments to work towards during the first 5 years of implementation. Priority actions include:

1 Engaging all Australians in biodiversity conservation through:
   - 1.1 Mainstreaming biodiversity
   - 1.2 Increasing indigenous engagement
   - 1.3 Enhancing strategic investments and partnerships.

2 Building ecosystem resilience in a changing climate by:
   - 2.1 Protecting diversity
   - 2.2 Maintaining and re-establishing ecosystem functions
   - 2.3 Reducing threats to biodiversity.

3 Getting measurable results through:
   - 3.1 Improving and sharing knowledge
   - 3.2 Delivering conservation initiatives efficiently
   - 3.3 Implementing robust national monitoring, reporting and evaluation.

Implementation of a Local Biodiversity Strategy contributes to the delivery of majority of the Australian Government priority actions.

Australia, as the signatory to the international Convention on Biological Diversity, adopted a target of 17% of each of its bio-regions[1] being protected in the National Reserve System (http://www.environment.gov.au/land/nrs/about-nrs/requirements). Priority actions towards meeting this target are identified in the *Australia's National Reserve System Strategy 2009-2030* (Australian Government 2010) which was prepared in collaboration will all States. The Strategy identifies priority actions for a coordinated national approach towards achieving the following national targets for a National Reserve System:

- Examples of at least 80% of all regional ecosystems in each bioregion by 2015
- Examples of at least 80% of all regional ecosystems in each subregion by 2025
- Core areas established for the long-term survival of threatened ecosystems and threatened species habitats in each of Australia's bioregions by 2030

The National Reserve System is the network of formally recognised parks, reserves, and other protected areas primarily dedicated to the long-term protection of Australia's Biodiversity. Only those areas that meet the International Union for the Conservation of Nature (IUCN) definition of protected area are considered part of the National Reserve System. According to the IUCN, a protected area is: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Australian Government 2010

[1] Bio-regions are regions defined by a combination of biological, social and geographical criteria, seeking to describe the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation. They are determined by the Interim Biogeographic Regionalisation for Australia (IBRA) (http://www.environment.gov.au/land/nrs/science/ibra).

- Critical areas for climate change resilience, such as refugia, to act as core lands of broader whole of landscape scale approaches to biodiversity conservation by 2030.

The Shire of Northam overlaps with two bio-regions and protection levels within both are under the 17% target (Australian Government 2014).

Biodiversity conservation is supported by a range of Commonwealth and State legislation, statutory and non-statutory policies. The principal national and state legislation includes:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Wildlife Conservation Act1950*
- *Environmental Protection Act 1986* and the related *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*

The key State Government environmental and planning policies relevant to biodiversity conservation are:

***EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia* (EPA, 2000)** provides an overview of the Environmental Protection Authority's (EPA) position on the clearing of native vegetation in the State. Particular reference is made to clearing in agricultural areas, stating that clearing in agricultural areas of the South West of Western Australia should not continue, except for relatively small areas and where alternative mechanisms for biodiversity protection are addressed. The Position Statement lists several key criteria when assessing impacts of potential clearing, including the recognition of 30% of pre-clearing extent of a vegetation type as a threshold level below which species loss appears to accelerate exponentially and a level of 10% of pre-clearing extent as being a level representing 'endangered'.

***Environmental Protection Bulletin No 20: Protection of naturally vegetated areas through planning and development* (EPA, 2013)** EPA's expectations for consideration of naturally vegetated areas in the design of urban and peri-urban development at all stages of land use planning are outlined in this Bulletin, including design guidelines for planning and development proposals. It outlines the matters related to the protection of natural areas that are most appropriately addressed at the different land use planning stages, ranging from regional planning strategies and frameworks to local planning strategies, schemes and subdivision or development plans.

EPA's broad principles for maintaining biodiversity and protecting native vegetation and flora:

- Avoid clearing
- Maintain biodiversity at sustainable levels
- Conserve biodiversity in-situ
- Prevent loss of biodiversity
- Prepare and implement regional strategies for biodiversity protection
- Protect ecological linkages
- Anticipate threats to biodiversity and
- Reintroduce native vegetation.

EPA, 2008

The Bulletin No. 20 complements the ***EPA Guidance Statement No. 33: Environmental Guidance for Planning and Development*** (EPA, 2008) which outlines the EPA's broad principles for maintaining and protecting native terrestrial vegetation and flora, the EPA's objectives for biodiversity conservation, flora and fauna, and lists the natural areas that the EPA

considers are of high conservation significance, including critical environmental assets and high value environmental value assets.

Statement of Planning Policy No. 2: Environment and Natural Resources Policy (SPP2) (WAPC 2003) was prepared under statutory procedures set out in the *Planning and Development Act 2005.* The WAPC and local governments must have 'due regard' to the provisions of state planning policies when preparing or amending local planning schemes and when making decisions on planning matters.

The objectives of SPP *No. 2* are to: integrate environment and natural resource management with broader land use planning and decision-making; protect, conserve and enhance the natural environment; and promote and assist in the wise and sustainable use and management of natural resources.

General policy measures relevant to the Shire include:

'*(iv) Protect significant natural, indigenous and cultural features, including sites and features significant as habitats and for their floral, cultural, built, archaeological, ethnographic, geological, geomorphological, visual or wilderness values.*

(vi) Recognise that certain natural resources, including biological resources, are restricted to particular areas and that these geographical areas or land types may need to be identified accordingly and appropriate provision made to protect the areas for the use of those resources.

(x) Support conservation, protection and management of native remnant vegetation where possible, to enhance soil and land quality, water quality, biodiversity, fauna habitat, landscape, amenity values and ecosystem function.

(xi) Consider alternatives to land acquisition for conservation and landscape protection where limited or no public access is required.'

Other policy measures relevant to local biodiversity conservation planning include those in clause 5.5 Biodiversity, which states that planning strategies, schemes and decision-making should:

'*(i) Consider mechanisms to protect areas of high biodiversity and/or conservation value.*

(ii) Seek to avoid or minimise any adverse impacts, directly or indirectly, on areas of high biodiversity or conservation value as a result of changes in land use or development.

(iii) Assist in establishing a comprehensive, adequate and representative conservation reserve system throughout the State for flora, fauna habitat, landscapes, waterways, estuaries and wetlands.

(iv) Safeguard and enhance linkages between terrestrial and aquatic habitats which have become isolated, including the re-establishment of habitat corridors.

(v) Assist the return of areas of high biodiversity conservation value to the public estate or otherwise ensure the protection of high biodiversity conservation values through mechanisms including planning controls or conservation covenants.

(vi) Support the use of management plans to protect areas of high biodiversity conservation value in the long term.'

1.4 Regional Natural Resource Management Strategies

Two regional natural resource management groups (NRM) operate in the Shire of Northam; the Wheatbelt NRM and the Perth Region NRM. These regional groups play an important part in facilitating partnerships, sourcing funds and coordinating delivery of the regional NRM strategies.

The Wheatbelt NRM Strategic Plan 2012-2015 outlines strategic objectives and priorities towards achieving its vision "to bring exemplary natural resource management to the Wheatbelt to create healthy environments and livelihoods" (Wheatbelt NRM 2014). Implementation of the Shire of Northam's local biodiversity strategy will contribute towards many of the regional objectives, providing good opportunities for close cooperation.

Wheatbelt NRM 5-year strategic objectives include:

- Develop Strategic Adaptive Management approach and embed resilience/systems thinking into NRM
- Strengthen partnerships in the understanding and management of our social-ecological systems
- Adapt to a changing climate
- Increase perennial vegetation cover
- Support agricultural industry innovation targeting efficiency in chemical use and improved soil health
- Promote 'fit for purpose' land use
- Coordinate fire and invasive species management in both conservation and agricultural systems
- Encourage community action for environmentally sustainable lifestyles.

The Shire of Northam is within the Avon Arc sub-region of the Wheatbelt NRM region. NRM priorities for the Avon Arc subregion include: Enhance, protect and manage fragmented, at-risk biodiversity, improve fertiliser efficiency of agricultural landscapes, major tributary riparian management, and manage peri-urban changes.

Perth Region NRM which overlaps with the western portion of the Shire of Northam is currently reviewing its Strategic plan. The local biodiversity strategy provides a good opportunity to inform the regional strategic planning process and identify new opportunities for partnerships. More information about the Perth Region NRM Strategy review can be found on the following link http://www.perthregionnrm.com/community/swan-region-strategy/swan-region-strategy-review.aspx.

1.5 Local Strategic and Planning Context

In 2010, the Shire adopted a corporate plan, *Strategic Community Plan 2012-2022* (Shire of Northam 2013b), which sets out the broad objectives and initiatives for future development and growth within the Shire. Delivery of these initiatives should be consistent with the Shire's Mission Statement and be based on a number of goals and strategies, including:

"*To deliver responsive, sustainable services in a manner that preserves and enhances our environment and lifestyle whilst respecting our heritage and facilitating economic growth."*

Shire of Northam Corporate Mission:

"To deliver responsive, sustainable services in a manner that preserves and enhances our environment and lifestyle."

Strategic Community Plan 2012-2022

Shire of Northam Local Planning Strategy (Shire of Northam 2013b)

The Shire's adopted mission to preserve and enhance the environment is directly reflected in its Local Planning Strategy which was adopted in 2013:

Vision/Objectives

- Protect, conserve and enhance the environmental values and natural resources of the Shire for the benefit of current and future generations while providing appropriate development opportunities to promote the local economy.
- Protect privately owned land recognised as Conservation on Strategy maps to provide for possible future inclusion into State Nature Reserves.

Numerous strategies and actions were identified in the Local Planning Strategy to achieve this vision, including preparation of a local biodiversity strategy. For the full list of strategies and actions relevant to biodiversity conservation see Appendix A.

The Shire's Local Planning Strategy identifies new areas for development to facilitate the predicted population increase by 27% to 12,300 persons in 2031. While the largest increase is anticipated within the Northam townsite, localities such as Wundowie, Bakers Hill and Clackline are also expected to be affected.

Shire of Northam Local Planning Scheme No. 6 (Department of Planning 2013)

Similar strategic planning objectives are outlined in the aims of the local planning scheme:

"(i) protect, conserve and enhance the environmental values and natural resources of the Scheme area including the protection of remnant vegetation and the rehabilitation and revegetation of degraded land."

The objectives for Rural zoned land in the Shire provide further rationale for this Strategy:

"*To protect land from land degradation and further loss of biodiversity by:*

(i) Minimising the clearing of remnant vegetation and encouraging the protection of existing remnant vegetation;
(ii) Encouraging the development of and the protection of corridors of native vegetation;
(iii) Encouraging the development of environmentally acceptable surface and sub-surface drainage works; and
(iv) Encouraging rehabilitation of salt affected land."

In 2012, the Shire in partnership with the Wheatbelt Development Commission and state agencies developed a growth plan for the Northam townsite which was identified as one of nine towns in Western Australia with the potential for significant growth. The region's natural environment, relative housing affordability, proximity to the Perth Metropolitan Region and lifestyle options, are factors that are forecasted to encourage continued population growth.

The Northam Regional Centre Growth Plan's (Shire of Northam 2012) objective for the environment is:

> "*The protection and enhancement of natural environmental and cultural assets, biodiversity, air and water quality, and building resilience against the long term effects of climate change."*

The Growth Plan identifies a number of strategic goals and actions towards meeting the environmental objective, including:

- "By 2013 existing vegetation corridors along waterways shall be protected and revegetation along waterways where clearing has taken place will be occurring.
- Remnant vegetation shall be protected from clearing and damage where possible.
- By 2013 landscapes with high natural resource values will have been identified and protected. Restoration of degraded landscapes will be encouraged and roads that have landscapes requiring protection will be identified.
- By 2013 the capacity of landscapes to absorb development shall be well understood. Careful planning, siting and design of new development in a way which is sensitive to local landscape character will be the norm.
- By 2013 sustainable use of the Shire's natural resources will occur through sound planning, protection, and management practices.
- By 2013 the long term protection of areas of local and regional conservation significance in Crown ownership throughout the Shire shall be facilitated.
- By 2021 the long-term health and aesthetic value of the Avon River will be protected through sound environmental management practices and when planning for drainage and environmental works.
- By 2017 the quality of stormwater runoff from urban areas will be improved by incorporating the best management practices of water sensitive urban design.
- By 2013 best practice measures will be in place in regards to the protection of river system health.
- By 2021 the river systems will be improved when and where possible."

Additional strategic goals were adopted to address waste disposal, climate change adaptation, protection of sensitive land uses from all types of emissions and risk management strategies and measures to protect from natural disasters and environmental impacts.

This Local Biodiversity Strategy provides information on local conservation priorities and identifies land where revegetation and habitat restoration will enhance landscape connectivity, highlighting land in the Shire where the local strategic environmental objectives can be achieved.

2. Biodiversity Assets

2.1 Regional context

The Shire of Northam is within an internationally recognised hotspot for biodiversity conservation, the South West of Western Australia. Hotspots identify regions with high levels of biological diversity and endemism[2] that are under threat (Myers *et al* 2000, Conservation International 2011). In the South West of Western Australia approximately half of the flora are endemic (Hopper and Gioia 2004) and the latest estimates show over 8000 species of flora in this region with approximately 15-20% not yet named (Keighery and Keighery, 2011).

Figure 1: SWAEI Priority Index (Purple identifies selected 100%in the modelling, to green polygons selected less than 10%)

Hotspots for biodiversity conservation are areas of 'exceptional concentratio species (at least 1500 species of vascular or higher plants) and experiencin habitat' (at least 70% of original habitat lost) (Myers *et al* 2000). Around the qualified as hotspots and the Southwest of Western Australia was the only area in Australia. In 2004, additional nine areas were included (Conservation International 2011).

The conservation significance of vegetation within the Shire is supported through the outcomes of a systematic conservation planning process undertaken by the Southwest Australia Ecoregion Initiative (SWAEI) (SWAEI 2012). The SWAEI identified "Zones for Conservation Action", defined as 'a cluster of highly desirable planning units[3] that contribute to achieving the targets set for 1,391 biodiversity conservation features in the most efficient manner' (SWAEI 2012). The priority indexation in Figure 1 demonstrates that many areas within the Shire are identified as critical to achieving the conservation targets in the Ecoregion (purple).

Figure 2 shows that within many planning units with high biodiversity values (greens and browns) there are good opportunities to retain these

Figure 2: SWAEI Biodiversity Importance/Cost of threat

Find the above layers in the EPT: Priorities for Further Investigations/ Southwest Australia Ecoregion Initiative http://lbp.asn.au/index_public.html or go to http://swaecoregion.org/webmap/SWAEI_Map_tidy.html

[2] Endemic refers to a species having a natural distribution confined to a particular geographic region.
[3] Planning units used in the SWAEI modelling consisted of hexagons with a 2km diameter.

assets as few are considered threatened by urbanisation, *Phytophthora* dieback and salinity.

Two biogeographical regions occur within the Shire of Northam; the Jarrah Forest and Wheatbelt Interim Biogeographic Regions of Australia (IBRA). Significant sections of the Wheatbelt IBRA are over-cleared, with remaining vegetation showing high levels of flora endemism.

The western half of the Shire is within the Jarrah Forest IBRA. While large areas of vegetation are protected at the bioregion level, there are numerous vegetation types in the Jarrah Forest without adequate formal protection and management for conservation (Local Biodiversity Program, 2013).

2.2 Geology, Landforms and Soils

The Shire of Northam is underlain by the Yilgarn Block granite craton, the massive, ancient, igneous geological unit located east of the north-south trending Darling Fault. As well as granite, the craton contains dolerite dykes and metamorphic rocks such as gneiss.

Although there are occasional outcrops of the granitic bedrock, especially in valleys, it is largely overlain by a layer of much younger lateritic rock and associated gravels, clay and sand, and weathered bedrock, to a depth of up to 20 m. The hard cap layer of laterite is generally 2 m in depth. It forms low breakaways where the plateau surface has been eroded by water courses.

The diversity of landforms found in the Shire is influenced by the drainage systems and rainfall which vary across the Shire from east to west. The Shire contains two broad physiographic zones: the Darling Range in the west; and to its east, the Rejuvenated Drainage Zone, which includes the Rejuvenated and the Mature Drainage Zones (Pen 1999).

In the western portion of the Shire, closer to the Darling Fault, the highest elevations are around 300 m AHD. Drainage lines occupy steep, well-defined V-shaped valleys and channels in which the valleys may be 60 m to 200 m deep (Pen 1999). The average annual rainfall here is around 600-700 mm.

The central and eastern portion of the Shire is within the Mature Drainage Zone which occurs in areas with average annual rainfall of 450-650 mm. In this zone valleys are broad, as much as 5 km across, but the landscape is undulating with noticeable drainage lines, broad flattish but generally continuous river valleys, with some salt lakes and pools. Streamlines are considered rejuvenated, often having a braided, densely vegetated form. The rejuvenation was caused by the uplifting of the Darling Plateau about 50 million years ago triggering the incision of the rivers more deeply into the landscape.

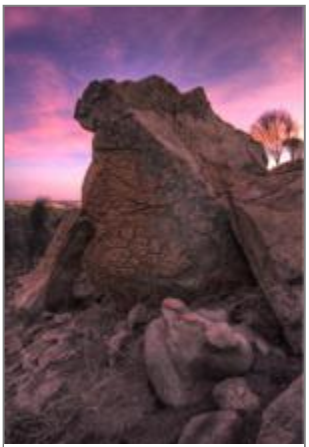

Figure 3: Mt Ommaney, Northam (Google Images)

Changes in landform, soils and rainfall are reflected in the diversity of vegetation occurring in the Shire of Northam. Within the westerly portion of the Shire, in the Darling Range and Plateau, the gently undulating

uplands are dominated by jarrah (*Eucalyptus marginata*) forest, mixed with marri (*Corymbia calophylla)*, bull banksia (*Banksia grandis)* and common sheoak (*Allocasuarina fraseriana)*. The sides of the major valleys support jarrah, marri and sometimes wandoo (*E. wandoo*), with yarri (*E. patens)* on the lower slopes and flooded gum and freshwater paperbark (*Melaleuca rhaphiophylla*) on the valley floor. The slopes of minor valleys of tributary streams are dominated by jarrah, marri and yarri. Their swampy floors support scrubs of brook peppermint (*Taxandria linearifolia*) and other shrubs, and woodlands of modong (*Melaleuca preissiana*) and swamp banksia (*Banksia littoralis*).

In the Shire's central and eastern portions, where rainfall is lower, forest communities are replaced by woodland communities. The typical jarrah/marri forests of the Darling Plateau are replaced by wandoo woodlands and on the eastern slopes of the Darling Range, York gum (*E. loxophleba* subsp. *loxophleba*) begins. Flooded gum (*E. rudis*) grows along the drainage lines. East of Northam, red morel (*E. longicornis*), gimlet (*E. salubris*) and salmon gum (*E. salmonophloia*) begin to dominate, with wandoo still present.

Patches of Brown Mallet (*E.astringens*) also occur in the Shire and are considered some of the Northern most outlier occurrences of this species (Julia Murphy, personal comment).

A suite of Eucalypt mallee species including but not limited to *E. pluricaulis, E. decurva, E. drummondii, E. horistes, E. tenera, E. phenax, E. albida* are also found within the Shire. These species grow on a variety of soil types and again some are considered outlying occurrences of their known extent (Julia Murphy, personal comment).

The lighter yellow and grey/white sand plains in the eastern portion of the Shire also support regionally important occurrences of *Banksia prionotes* (Acorn Banksia) and *B.attenuata* (Slender Banksia) that often grow in association with Proteaceous species. These communities are very important for nectivorous species, especially over the warmer and drier months (Julia Murphy, personal comment). An occurrence of *Acacia tetragonophylla* (Kurara) in the Shire is another example of a species that is generally known from further North and East and is typically to the pastoral areas of Western Australia. This occurrence is significant in that it is approximately 180 km South from the next nearest population and considered 'atypical' to the area and the local landforms and soil types (Julia Murphy, personal comment).

The isolated granite outcrops support rich and diverse ecosystems that contribute to high biodiversity, endemism and rarity of species in the south-west of Western Australia. Due to the high degree of heterogeneity recorded between outcrop assemblages of fauna (invertebrates) and flora, a large proportion of granite outcrops in the Wheatbelt need to be protected (Pinder *et al* 2000, Yates *et al* 2003).

A number of hills (Sugarloaf Hill, Mount Dick, Centenary Hill etc), some of which are small but are highly elevated, are also important geologically and for endemic flora found in these niches. The same is true for the breakaways that are associated with some of the hills found in the Shire (Julia Murphy, personal comment).

2.3 Vegetation

For this Strategy, native vegetation mapping is used as a surrogate to describe the variety of ecosystems in the study area. Biodiversity conservation priorities at the regional or biogeographic region scale and local scale are based on the degree of retention and protection of native vegetation. One of the key principles of biodiversity conservation is to prevent loss of species and ecosystems failure by retaining at least 30% of the pre-European settlement extent of each ecological community (EPA 2000, Del Marco *et al* 2004).

About 24% of the Shire is covered by remnant vegetation which is unevenly distributed. Remnant vegetation is mostly concentrated within the western half of the Shire, within the Jarrah Forest bioregion, where 42% of the pre-European extent remains. There is significantly more remnant vegetation in the Jarrah Forest than in the eastern half of the Shire, the Wheatbelt bioregion, where only about 10% of the pre-European extent of vegetation remains.

Over 76% of the Shire's remnant vegetation is classified as Local Natural Areas, or natural areas outside the lands managed by the Department for Parks and Wildlife (DPaW), including freehold land and land reserved in Local Government and other State Government agencies. Local Natural Areas are the focus of this Local Biodiversity Strategy.

Table 1:Overview of 2013 extent of remnant vegetation in the Shire of Northam (Local Biodiversity Program, 2014 & DPaW, 2013)

	Area	% of pre-European extent	% of current extent
Pre-European vegetation extent	143,125ha	100%	
2013 remnant vegetation extent	33,908ha	23.69%	100%
Portion of current extent on DPAW managed lands	8,077ha		23.81%
Portion of current extent in Local Natural Areas	25,831ha		76.19%
Portion protected on DPAW lands	6,688ha	4.67%	19.72%
Total protected locally*	**7,644ha**	**5.34%**	**22.54%**

*Locally protected natural areas include lands reserved for conservation on DPAW managed lands, other reserves with conservation purpose and land reserved in the Local Planning Scheme

The Roadside Conservation Committee has undertaken assessments of roadside vegetation conservation values of major roadsides across the State, including the Shire of Northam. These surveys have ranked the conservation value of roadsides by local government area, recording main vegetation types, vegetation structure and species, weeds, other threats and habitat features such as hollow logs and wildlife corridors.

In highly cleared landscapes such as the eastern side of the Shire, vegetation is often retained only within roadsides and might contain threatened or priority flora (see Figure 4 and in Appendix D Figure 4.2). Therefore the roadside vegetation mapping data should be used to support the prioritisation of conservation works within the Shire as well as to inform any planed road maintenance work to avoid damage to high conservation value vegetation. The Roadside Conservation Committee provides a range of publications on how to minimise impacts of

roadworks on native vegetation (http://www.dpaw.wa.gov.au/management/off-reserve-conservation/roadside-conservation).

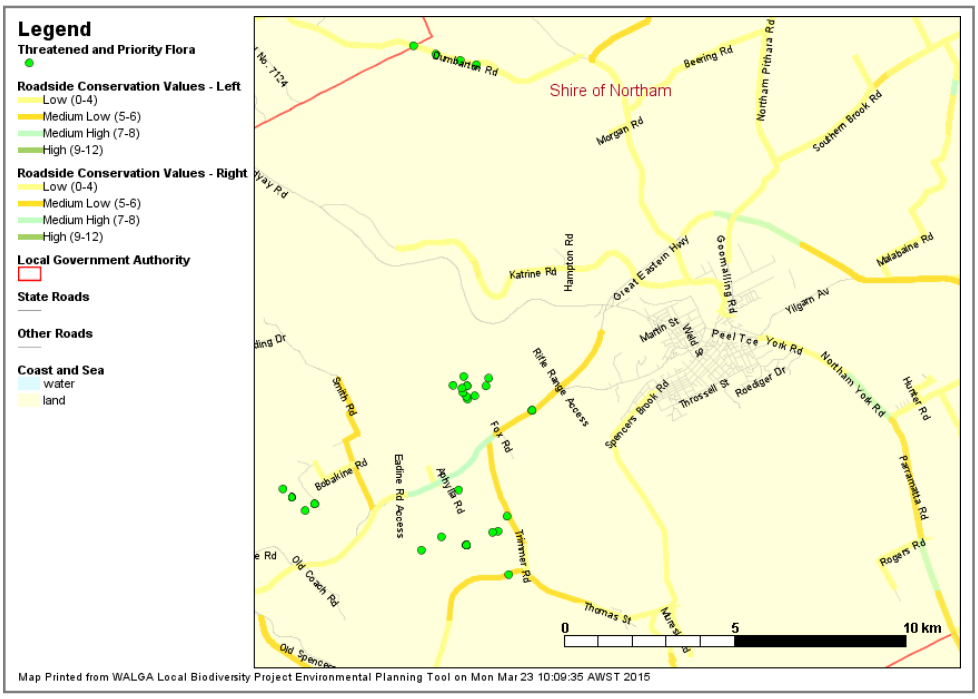

Figure 4: Roadside vegetation conservation value in the portion of the Shire of Northam (1988-1996) and records of Threatened and Priority flora (DPAW 2014).

2.3.1 Diversity of vegetation

There are two regional scale vegetation mapping datasets that cover the Shire:

- The Beard vegetation mapping (Shepherd *et al* 2001) describes vegetation at 1:250,000 in the south-west of Western Australia and is based primarily on vegetation structure. Vegetation associations have been described to the minimal standard of Level 3 Broad Floristic Formations for the National Vegetation Inventory System (See Appendix B).
- Vegetation mapping of the south-west forest regions of Western Australia by Havel and Mattiske (2000) converted geomorphologic maps into maps of vege
  using climatic data and outputs of localised quantitative studies, pro
  the scale of 1:250,000. This dataset covers only the Darling Range
  (Jarrah Forest bioregion).

Figure 5: Pre-European vegetation mapping (Mattiske & Havel 2000). Compare with Figure 6.

The State wide mapping by JS Beard (Shepherd *et al* 2001) shows broad f
and describes nine Beard vegetation associations (BVAs) within the Shire

Three vegetation associations; BVA4 (Medium woodland; marri & wandoo)
woodland; jarrah, wandoo & powderbark) and BVA3003 (Medium forest; ja
laterite with wandoo in valleys, sandy swamps with teatree and banksia) ar
Jarrah Forest bioregion for which more detailed vegetation mapping is available. The extent of these three vegetation associations closely aligns with the boundary between the two biogeographic regions and therefore the more detailed mapping is used in this Strategy to

describe the vegetation within the Jarrah Forest portion of the Shire. Figures 6 and 7 compare the two mapping datasets for the same portion of the Shire.

Figure 6: Remnant vegetation by Beard vegetation associations in the southern portion of the Shire of Northam

In the Wheatbelt bioregion portion of the Shire, BVA352 (Medium woodland; York gum) was mapped as the most common vegetation association. Currently it still remains the most common vegetation association but less than 10% remains in the Shire and less than 30% remain in the bioregion.

The most threatened vegetation associations in the Shire are BVA694 (Shrublands; scrub-heath on yellow sandplain Banksia-Xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions) and BVA1049 (Medium woodland; wandoo, York gum, salmon gum, morrel & gimlet). Less than 10% of the pre-European extent is retained in the Wheatbelt bioregion and within the Shire.

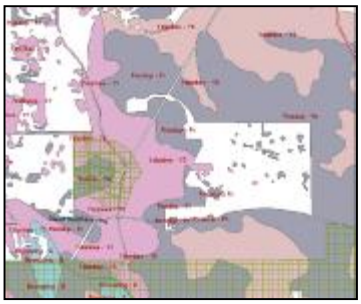

Figure 7: Remnant vegetation by vegetation complexes (Havel & Mattiske, 2000) in the southern portion of the Shire of Northam

Two mapped vegetation associations have a limited extent and therefore can be considered locally rare. They are BVA511 (Medium woodland; salmon gum & morrel) with 531ha and BVA946 (Medium woodland; wandoo) with only 16ha mapped in the Shire. These amounts represent less than 1% of the total pre-clearing extent mapped in the Wheatbelt bioregion so the portions in the Shire of Northam could be considered negligible in the bioregion context. However, these vegetation associations were over-cleared and less than 30% of the pre-European extent remains in the bioregion. In the Shire, their limited coverage was also reduced to less than 30% of BVA946 with only 4ha remaining, and to less than 10% of BVA511 with only 67ha remaining in the Shire.

At a local level, the best retained vegetation association in the Wheatbelt portion of the Shire is BVA1048 (Mosaic: Shrublands; melaleuca patchy scrub / Succulent steppe; samphire) with 48% of its pre-European extent still remaining in the Shire. However, at the regional level, its extent has reduced to less than 30%.

While all vegetation associations of the Wheatbelt portion of the Shire of Northam also occur outside the Shire, with portions of the regional extent within the Shire ranging from less than 1% to about 9%, these vegetation associations are cleared across the region to below the 30% or 10% threshold levels. Therefore all vegetation associations represented in the Shire of Northam are of high conservation priority.

In the Jarrah Forest portion of the Shire, there are three Beard vegetation associations and eleven vegetation complexes. The vegetation complex mapping indicates the appropriate biodiversity conservation priorities in the Jarrah Forest portion of the Shire.

Three vegetation complexes have less than 500ha in the Shire and can be considered locally rare. They are Cooke (470ha), Goonaping (258ha) and Swamp (29ha).

The most common vegetation complexes are Yallanbee 6, Pindalup and Yallanbee 5, which together originally covered about 60% of the Jarrah Forest portion of the Shire. The Shire proportion of the regional extent of these vegetation complexes ranges from less than 1% to 13%, so none of these are geographically limited to the Shire boundaries.

The representative vegetation complexes and vegetation associations can be divided into two conservation significance categories reflecting their retention and protection status at the regional and local scale (Table 2).

Table 2: Categories of vegetation in the Shire of Northam

		Vegetation complexes (See Appendix C for descriptions)	**Beard vegetation associations**	**Total vegetation remaining in each category or % of remaining vegetation**
Regionally significant				
Less than 10% retained in the region			BVA694 BVA1049	1266ha or 3.7%
Less than 30% retained in the region and/or less than 17% protected in the region	And less than 30% retained in the Shire	Bindoon Coolakin Michibin Murray 2 Williams	BVA352 BVA511 BVA946	7611.93ha (AW) 6884.31ha (JF) (Total not shown due to the overlap of vegetation mapping datasets)* 36.98%
	And more than 30% retained in the Shire	Cooke Pindalup Yallanbee 5 Yallanbee 6	BVA1048 (BVA4, BVA1006 and BVA3003**)	371.56ha (AW) 19559.88ha (JF) 19,931.44ha(AW+JF) or 58.78%
Locally significant				
Locally rare and unprotected		Swamp		12.84ha or 0.04%
Other vegetation complexes		Goonaping		201.87ha or 0.5%
Total*				100%

*Summary of area totals in each category in Table 2 is larger than the area of vegetation remaining in the Shire (33908ha). This is due to the overlap between the two vegetation mapping datasets, in particular between BVA352, BVA511, BVA946 and the vegetation complexes in the corresponding conservation significance category.
**These three BVAs are not included in the total area of 19,559.88ha (JF)

Table 2 demonstrates that nearly all vegetation remaining in the Shire is of regional conservation significance. Comparing the distribution of vegetation complexes and Beard vegetation associations with the conservation significance categories demonstrates the benefits of undertaking detailed mapping of vegetation complexes. While Beard vegetation associations representative of vegetation in the Jarrah Forest bioregion (BVAs 4, 1006 and 3003) are considered regionally significant due to poor representation in the State's conservation estate, they are all retained above the 30% threshold level locally. Vegetation complex mapping which illustrates patterns of vegetation in the Jarrah Forest bioregion identifies vegetation complexes that are of higher conservation priority as little of this vegetation is retained locally. Within an area containing Beard vegetation associations of equal conservation significance, areas of higher conservation priority can be identified by mapping at a more detailed level (i.e. vegetation complexes.)

The retention and protection status of vegetation complexes is based on the 2013 vegetation extent mapping available through DAFWA and calculations by the Local Biodiversity Program. The retention

and protection status of the Beard vegetation associations are based on figures published by the Department of Parks and Wildlife (Government of Western Australia 2013). See Appendix D for the detailed statistical data.

2.3.2 Protection status of vegetation

In the context of this Local Biodiversity Strategy the following land categories are considered formally protected:

- Lands managed by DPaW for conservation (National Parks, Nature Reserves, Conservation Parks and *Conservation and Land Management Act* S5(g) Reserves)
- Land Administration Act 1997 reserves for the purposes of Protection of Vegetation, Flora, Fauna or Foreshores (vested in and managed by an agency other than DPaW)
- Land classified as local reserves for *Conservation of Flora and Fauna* under the Shire of Northam Local Planning Scheme No 6 (2013)
- Private lands with conservation covenants[4] on land title.

There are many landholders (broad-acre farming or lifestyle) that manage their remnant vegetation for the purposes of conservation or amenity, with one property managed under a conservation covenant (Wheatbelt NRM) and 28 landholders participating in the voluntary program *'Land for Wildlife"* (DPAW, 2014) in the Shire. However, a review of covenanting programs in Australia (Fitzsimons and Carr, 2013) found that lack of time to undertake active management of protected values by the covenantors was one of the biggest impediments to achieving biodiversity conservation outcomes. Other barriers included lack of financial resources, human resources and consistent monitoring methodologies to access the effectiveness of adopted management strategies. Therefore, effective stewardship programs to assist land owners with the management of remnant vegetation for conservation purposes are critical. See section 4.2.2. of this document for recommended strategies to develop an effective private landholders incentives scheme.

In the regional context, which only considers the representation of vegetation within the DPaW conservation lands, two vegetation complexes represented in the Shire have more than 17% of their pre-European regional extent protected; Goonaping and Swamp. All Beard vegetation associations (including those within the Jarrah Forest bioregion) and all other vegetation complexes have less than 17% protected in the Wheatbelt and Jarrah Forest bioregions.

Large portion of the Shire of Northam falls within one of the Australia Government's under-represented bioregions (regions that have less than10% of original remnant vegetation protected) and in these regions the conservation and maintenance of existing biodiversity values is considered the highest priority (Australian Government, 2014).

There are several vegetation complexes and vegetation associations that have no local protection and thus not contributing to their regional protection status. The Local Biodiversity

[4] Conservation covenants are binding agreements between a landowner and an authorised body to help the land owner to protect and manage the environment on their property, registered on the land title. In Western Australia there are two main agencies providing biodiversity conservation covenanting programs: the Department of Parks and Wildlife and the National Trust.

Program estimates the area of each vegetation association or complex that should be contributed from the Shire of Northam to assist in reaching regional goals for protection. These estimates are based on the proportion of the pre-European regional extent of vegetation in the Shire (see Tables 1 and 2 in Appendix D). Cooke and Pindalup vegetation complexes are not adequately protected at the regional level but there is an acceptable level of representation in the Shire[5].

Table 3 lists all vegetation associations and vegetation complexes with inadequate protection in the region (less than 17% of the pre-European extent in the bioregion) and their local protection status.

Table 3: Protection status of regionally under-represented vegetation within the Shire of Northam and further area of vegetation requiring protection in the Shire to contribute to the improved protection status in the bioregion.

Vegetation mapping		% of pre-European extent in the Shire of Northam protected*	Minimum area required in the Shire to improve protection status of vegetation at the regional level
Wheatbelt bioregion (0.49% of pre-European extent protected in the Shire)			
Beard vegetation associations	352	0.48%	All remaining in good condition#
	511	0.00%	All remaining in good condition#
	694	0.23%	All remaining in good condition#
	946	0.00%	All remaining in good condition#
	1048	2.9%**	107ha
	1049	0.00%	All remaining in good condition#
Jarrah Forest bioregion (5% of the pre-European extent protected in the Shire)			
Vegetation complexes	Bindoon-Bi	0.00%	810ha
	Cooke-Ce	46%	0
	Coolakin-Ck	3.80%	1129ha
	Michibin-Mi	5.26%	1067ha
	Murray 2-My2	1.70%	215ha
	Pindalup-Pn	19.09%	0
	Williams-Wi	0.00%	191ha
	Yallanbee-Y5	15.96%	108ha
	Yallanbee-Y6	15.26%	286ha

*Protected within DPaW managed lands for conservation, in local reserves with conservation purpose or reserved Conservation of Flora and Fauna in the Local Planning Scheme No 6(2013).

**All protected outside DPaW managed lands.

#Remaining area of native vegetation representative of this BVA is below or at the minimum area that is required from the Shire to achieve proportionate contribution to the regional protection target of 17%. Due to the unavailability of information on vegetation condition of native vegetation in the Shire, it is not feasible to calculate the minimum area.

The same pattern of uneven vegetation distribution observed in the distribution of remaining vegetation is reflected in the differences in protection levels between the two bioregions in the Shire. While just over 5% of the pre-European extent of vegetation is protected in the Shire, the majority of the protected areas are in the Jarrah Forest portion of the Shire, with only 443ha or 0.49% of the pre-European extent of the Wheatbelt bioregion portion of the Shire protected.

[5] This should not be interpreted that no further areas with vegetation representative of Cooke and Pindalup vegetation complexes should be formally protected. Vegetation representation is only one of many criteria being considered when selecting areas for conservation.

BVA511, BVA946, BVA1049, Bindoon and Williams vegetation complexes are not represented in any conservation reserve or protected via other mechanisms within the Shire.

Table 3 shows the minimum area of regionally under-protected vegetation associations and vegetation complexes that should be protected within the Shire to contribute the Shire's proportion of the regional protection target[6]. In most instances the minimal area required to contribute to the national target for vegetation associations in the Wheatbelt bioregion is no longer achievable due to the limited extent remaining.

2.4 Threatened species and ecological communities

A search of the NatureMap database (DPaW, 19/03/2015) identifies 1126 different native species of flora and fauna within the Shire of Northam, including nine species of fauna, one spider and five species of flora that are rare or likely to become extinct. A further eleven fauna species are protected under international agreements or other specially protected fauna. Thirty eight priority species are listed (Table 4). Two native arachnid species are listed as endemic to the Shire area: *Antichtopauropus brevitarus and Stylopauropoides lapicidarius.*

In 2011, a discovery of a new species, *Euoplos sp (Albino trap door spider)* on a private property in the Shire was the focus of international media for new biological discoveries and recognised by the National Geographic's list for the top ten weirdest life forms of 2011 (http://news.nationalgeographic.com.au/news/2011/11/111108-new-spider-albino-australia-trapdoor-burrows-animals/).

Dr Mark Harvey (WA Museum senior curator) has stated "this is only one of three known species in the world — all from Western Australia — with a white head and normal-coloured body."

Table 4: List of Threatened and Priority flora and fauna for the Shire of Northam (DPWA 2015)

Specially protected fauna (Recovery Plans have been endorsed for the highlighted species)	Conservation co
Actitis hypoleucos (Common sandpiper)	IA
Apus pacificus (Fork-tailed swift)	IA
Ardea modesta (Eastern Great Egret)	IA
Aspidites ramsayi (Woma)	S
Bettongia penicillata subsp. ogilbii (Woylie, Brush-tailed Bettong)	T
Calidris ruficollis (Red-necked Stint)	IA
Calyptorhynchus banksii subsp. *naso* (Forest Red-tailed Black Cockatoo)	T
*Calyptorhynchus baudinii (*Baudin's Cockatoo)	T
Calyptorhynchus latirostris (Carnaby's Black Cockatoo)	T
Dasyurus geoffroii (Chuditch, Western Quoll)	T
Falco peregrinus (Peregrine Falcon)	S

[6] The minimal proportion is calculated as the percentage of the Shire proportion of the 17% of pre-European extent in the bioregion. For example, the pre-European extent of Bindoon-Bi of 4763ha represents 13.2% of the regional pre-European extent of this vegetation complex. To achieve at least 17% protection regionally, at least 6129ha needs to be protected in the Jarrah Forest bioregion. An amount the Shire should contribute to achieve the national target (17%) can be determined as 13.2%

Falco peregrinus subsp. *macropus* (Australian Peregrine Falcon)	S
Hydromys chrysogaster (Water-rat)	P4
Idiosoma nigrum (Shield-backed Trapdoor Spider)	T
Isoodon obelus subsp. *fusciventer* (Quenda, Southern Brown Bandicoot)	P5
Ixobrychus flavicollis subsp. australis (Australian Black Bittern)	P1
Leipoa ocellata (Malleefowl)	T
Macropus irma (Western Brush Wallaby)	P4
Macrotis lagotis (Bilby, Dalgyte)	T
Merops ornatus (Rainbow Bee-eater)	IA
Morelia spilota subsp. imbricata (Carpet Python)	S
Oxyura australis (Blue-billed duck)	P4
Phascogale tapoatafa subsp. tapoatafa (*Southern Brush-tailed Phascogale*)	T
Tringa glareola (Wood Sandpiper)	IA
Tringa nebularia (Common Greenshank)	IA
Tyto novaehollandiae subsp. novaehollandiae (Masked owl)	P3
Westralunio carteri (Carter's Freshwater Mussel)	T
Threatened and Priority Flora	**Conservation code**
Acacia aphylla (Leafless Rock Wattle)	T
Acacia camphylophylla	P3
Acacia lirellata subsp. lirrellata	P3
Amperea micrantha	P2
Anigozanthos bicolor subsp. exstans	P3
Anigozanthos humilis subsp. chrysanthus (Golden Catspaw)	P4
Asterolasia grandiflora	P4
Caladenia integra (Mantis Orchid, Smooth-lipped Spider Orchid)	P4
Calytrix oncophylla	P2
Chordilex chaunocoleus	P4
Cyanicula ixioides subsp. candida	P2
Cyanicula ixioides subsp.ixioides	P4
Dicrastylis reticulata	P3
Eremaea blackwelliana	P4
Eucalyptus loxophleba x wandoo	P4
Frankenia conferta (Silky Frankenia)	T
Frankenia glomerata (Cluster Head Frankenia)	P3
Gastrolobium hamulosum (Hookpoint Poison)	T
Gastrolobium rotundifolium (Gilbemine Poison)	P3
Grevillea candolleana	P2
Grevillea pimeleoides	P4
Hibbertia montana	P4
Lasiopetalum sp. Northam (F. Hort 1196)	P2
Lechenaultia laricina (Scarlet Leschenaultia)	T
Stylidium asteroideum (Star Triggerplant)	P3
Stylidium exappendiculatum	P3
Stylidium periscelianthum (Pantaloon Triggerplant)	P3
Stylidium striatum (Fan-leaved Triggerplant)	P4
Synaphea diabolica	P3
Synaphea sp. Darkin (F.Hort et al. 586)	P3
Tetratheca pilifera	P3
Tetratheca similis	P3
Thomasia glabripelata	T
Thysanotus cymosus	P3
Thysanotus tenuis	P3
Trichocline sp. Treeton (B.J.Keighery & N. Gibson 564)	P2
Verticordia serrata var. linearis	P3

***Conservation Codes (See Appendix E for definitions)**

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
P1 - Priority 1
P2 - Priority 2
P3 - Priority 3

P4 - Priority 4
P5 - Priority 5

Two of the bird species listed in Table 4 have been recorded breeding in the Shire: Blue-billed duck (P4) and Rainbow bee-eater (IA) (Birds Australia, 2009). Rainbow bee-eaters migrate from north to the south west of Australia to breed, often utilising the existing breeding sites. They form nests in the ground and are therefore vulnerable to predation by foxes. Fencing off known breeding sites will significantly increase the chance of successful breeding.

Of the listed threatened fauna, it can be assumed that the Woylie became locally extinct. The current Recov for this species (Yeatman & Groom, 2012) identifies only four remaining indigenous populations in the south Western Australia, all outside the Shire. Bilby and malleefowl can also be assumed locally extinct (http://www.environment.gov.au/biodiversity/threatened/).

However, the Shire's natural areas still provide habitat and support populations of other six threatened fauna species. All vegetation in the Jarrah Forest portion of the Shire is mapped as priority for investigation as feed habitat for the Endangered Carnaby's black cockatoo, with large sections within a buffer of a known breedin one possible breeding site and two confirmed roosting sites (DEC, 2011). Wheatbelt is the traditional breedi region for the Carnaby's black cockatoos, however due to significant habitat loss they have been expanding westwards as a breeding bird into the Darling Range and on to the Swan Coastal Plain (Johnston *et al,* 201

Distribution of the Carnaby's black cockatoo in the Jarrah Forest bio-region overlaps with the distribution of t two threatened black cockatoos, Baudin's and Forest red-tailed cockatoos (Australian Government, 2012a). three species of black cockatoos are endemic to the south west of Western Australia.

Clearing of forests and woodland habitat resulted in the loss of food and hollow-bearing trees and are the m reason for the decline of all three species in the south west of Western Australia (Johnston *et al,* 2010). All t species use tree hollows for breeding. Formation of such hollows is a very slow process and recent studies s that hollows suitable for black cockatoos start appearing in eucalypts that are at least 230 years old. Some o nest used by the three black cockatoos are estimated to be between 300-500 years old (http://museum.wa.gov.au/explore/online-exhibitions/cockatoo-care/veteran-and-stag-trees). Protection of m trees, even in otherwise cleared landscapes is critical to the conservation of these endemic species.

In addition to the loss of habitat due clearing and altered fire regimes, major threats to conservation of black cockatoos are (Johnston *et al,* 2010):

- Competition for breeding hollows by other birds (Gallahs, corellas, some ducks) and possums;
- Feral European honey bees taking over nest hollows;
- Shooting by orchardists;
- Poaching of eggs and chicks for the aviary trade;
- Impacts of climate change such as extreme temperatures;
- Vehicle strikes.

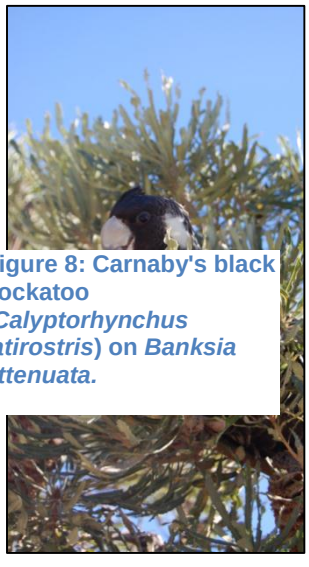

Figure 8: Carnaby's black cockatoo (*Calyptorhynchus latirostris*) on *Banksia attenuata.*

Protection and improvement of critical habitat, including adequate hollow-bearing trees in the landscape are key to ensuring the conservation of the chuditch and the Southern Brush-tailed Phascogale and to allow for genetic variation between populations in the south west of Western Australia (Department of Environment and Conservation, 2012, http://www.environment.gov.au/node/14789). Control of foxes and feral cats across all lands are also listed are priority recovery actions but more research is required into feral cat control techniques to minimise risk on chuditch (Department of Environment and Conservation, 2012).

Fauna surveys of four nature reserves managed by DPAW in the Shire demonstrated the diversity of fauna present and highlighted the importance of smaller reserves to the diversity of birds in the region. Many bird species not recorded elsewhere in the Shire and its surrounds were found in the Meenaar Nature Reserve which was found to be particularly rich in bird species. Although the reserve is less than 100 hectares and divided by a major highway, at least 17 bird species were recoded to nest in the Reserve (Department of Conservation and Land Management, 1987). This highlights the importance of protecting the smaller patches of vegetation retained in the highly fragmented landscape.

Westralunio carteri (Carter's Freshwater Mussel) is endemic to the south west of Western Australia and occurred in fresh waters from Moore River to King George Sound (Albany) and to the Avon River. It is estimated that its range reduced by about 50% due to salinization of the eastern extent of its range. The species was nominated in 2014 for listing as vulnerable under the EPBC Act. Further information has been required before the species can be listed under the EPBC Act that might be considered in 2015 (Commonwealth of Australia, 2015). To increase the chances for this species to expand to its original range, the mean water salinity should be less than 1.6 ppt and overhanging riparian vegetation, submerged tree roots and woody debris should be maintained along stream banks (Klunzinger & Walker, 2014)

Possible threatened ecological communities that do not meet survey criteria are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3.
.
Priority 1: Poorly known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally 5 or less occurrences or a total area of less than 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Source: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/tecs/tec-definitions-dec2010.pdf

See Appendix E for the full list of flora and fauna species recorded in the Shire of Northam, including naturalised species.

While there are no threatened or priority ecological communities recorded within the Shire, the Department of Parks and Wildlife lists the 'Pools of the Avon and Dale Rivers' as Priority 1 ecological communities on its list of Threatened and Priority ecological communities published in May 2014 (http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/tecs/Priority_ecological_community_list_20_May2014.pdf).

2.5 Waterways and Wetlands

Waterways in the Shire of Northam flow in three catchments; Avon-Mortlock catchment that captures water from the eastern parts of the Shire, Main Avon catchment that covers the central parts of the Shire and Lower Swan catchment which captures water from the most of the Darling Range portion of the Shire.

Avon (Wheatbelt) wetland mapping (DEC 2008) identifies several channel wetlands, including Avon River and its tributaries, many of them forming wetland suits[7] being part and several wetlands associated with granite outcrops (Figure 9).

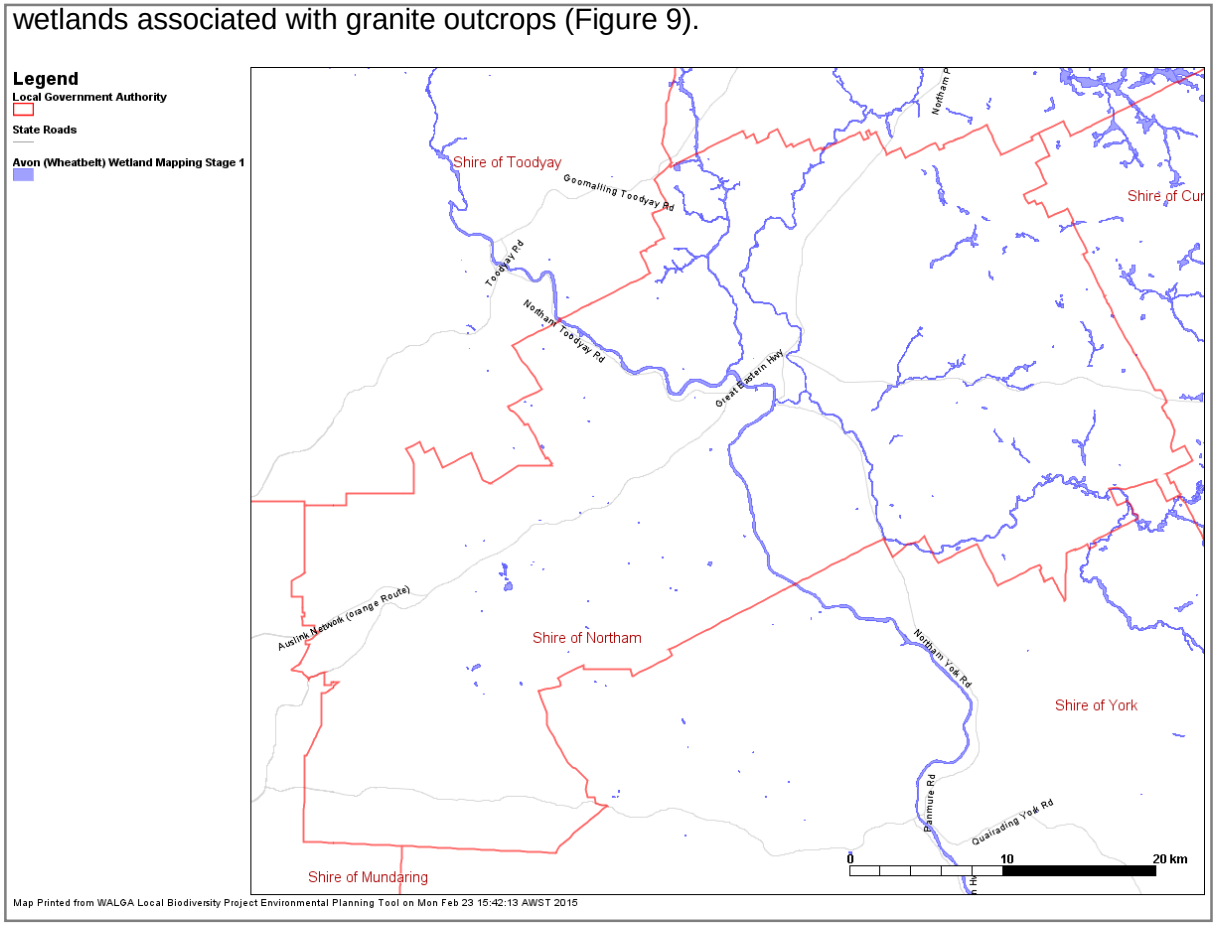

Figure 9 : Avon (Wheatbelt) Wetland Mapping (Phase 1) (Department of Environment and Conservation, 2008)

In its natural state, the portion of Avon River within the Shire had a highly braided form with a broad floodplain, numerous large and small pools. Following a major flood in 1955, the Avon River was modified or trained to reduce risk of future flooding. River training between 1957 and 1972, overgrazing, vegetation clearing and salinization within the Avon Rover basin significantly affected the condition of the river (Government of Western Australia, 2007; Pen, 1999). As a result, the once diverse wildlife which occupied the river and other wetlands became simplified and less abundant,

[7] The term 'suite' refers to a group of wetlands in the same group, linked hydrologically but not necessarily geographically (DEC 2008).

with increasing number of introduced plants and feral animals. One of the obvious changes is the replacement of *Eucalyptus rudis* by more salt-tolerant *Casuarina obesa* (Water and Rivers Commission, 1999a).

While none of the mapped wetlands are classified as an important wetland by the Department of Parks and Wildlife (Department of Environment and Conservation, 2008), the Avon River, its tributaries and other wetlands are critical to maintaining biodiversity by providing specific habitat. In the Shire of Northam the waterways are critical to connecting natural areas across the landscape.

Avon River pools that form during the dry and hot months are considered the most valuable habitats of the river system (Government of Western Australia, 2007). In addition to their environmental values, they also have high aesthetic, recreational and cultural values (Shire of Northam 2012).

In 2007 the Department of Water compiled information on ecological, social and economic values of 21 sections of the Avon River and identified 16 pools as a high priority for rehabilitation. Three of these priority pools occur in the Shire of Northam: Glen Avon Pool, Katrine Pool and Burlong Pool. While not listed as a priority for rehabilitation in the Department of Water study (Government of Western Australia, 2007), Northam Town Pool also has ecological, social and economic values that should be maintained. Key management priorities include sediment management, water quality and aesthetics.

The section of the Avon River between the Northam Town Pool and Burlong Pool contains the only section of the river not affected by the river training scheme which operated from 1957 to 1972. It was designed to reduce the duration of flooding events. This section, known as the 'West Northam Forest', retains a relatively natural character, with braided channels and a dense vegetated floodway (Government of Western Australia, 2007).

There have been several major initiatives and groups over the last two decades in particular that have initiated works, research or administered funding and regional activity towards improving the condition of waterways in the Avon Basin (Revell *et al,* 2006).

In 1999, the Avon River Management Authority adopted a vision for the Avon River for the year 2020 (Water and Rivers Commission, 1999b). It is summarised as follows:

- '*The Avon River and its tributaries have significantly improved as naturally functioning ecosystems according to measurable indicators.*
- *Sustainable agricultural systems are now firmly in place in 50% of the Avon River basin.*
- *All point sources of pollution of the Avon River have been identified and either eliminated or their impact minimised.*
- *Town Planning Schemes and Rural Strategies are in place and being implemented, which ensure top priority to maintaining the quality and the recovery of the Avon River ecosystem.*
- *Recreation use of the river is managed so as to provide fun, as well as appreciation of the river, with minimal environmental impact.*
- *The river wildlife has also recovered according to measurable indicators, and feral animals have been largely eliminated from the riverine bushland.*
- *Rural and urban communities have learned to respect the river, and to share responsibility for its recovery and conservation.*

- *Integrated, purposeful management of the river and the catchment are accepted as the responsibility of government agencies and community groups, and these parties share a common vision and goals, and enjoy working together to achieve them'*.

Some significant on-ground outcomes towards restoring the waterways in the Shire of Northam have been achieved and significant data collected to inform future strategic management within the catchment. Table 5 summarises the major outcomes of river and foreshore condition assessments undertaken in the Shire (Water and Rivers Commission, 1999b; Water and Rivers Commission, 2002; Water and Rivers Commission, 2003). The foreshore and channel assessments recorded bank stability, waterways features, foreshore condition, vegetation health and coverage, fencing status, overall stream environmental rating, habitats and their diversity, evidence of management, management issues, vegetation type and water quality (pH and electrical conductivity). Recommendations for future management were also listed. These datasets and other localised surveys provide good baseline data, and following an update on progress over the past 10 years, can be used to inform further planning for management and restoration priorities.

Table 5: Overview of key findings of foreshore condition assessments for waterways in the Shire of Northam (Water and Rivers Commission, 1999b; Water and Rivers Commission, 2002; Water and Rivers Commission, 2003)

(% of surveyed sections)	**Avon River – Section 6 Northam (WRC, 1999)***	**Mortlock River North (WRC, 2003)**	**Spencers Brook (WRC, 2002)**
Foreshore condition			
A (A1 Pristine, A2 Near pristine, A3 Slightly degraded)	0	0	0
B (B1 Degraded – weed infested, B2 Degraded – heavily weed infested, B3 Degraded – weed dominant)	53%	8%	7%
C (C1 Erosion prone, C2 Soil exposed, C3 Eroded)	38%	91%	89%
D (D1 Ditch – eroding, D2 Ditch – freely Eroding, D3 Drain – weed dominant)	9%	1%	4%
Health Factors			
Floodway and bank vegetation			
Excellent	N/A	0	0
Good		0	0
Moderate		47%	26%
Poor		53%	70%
Very Poor		0	4%
Verge vegetation			
Excellent	N/A	0	0
Good		0	0
Moderate		30%	26%
Poor		66%	74%
Very Poor		4%	0
Stream cover			
Excellent	N/A	0	0
Good		1%	11%

(% of surveyed sections)	**Avon River – Section 6 Northam (WRC, 1999)***	**Mortlock River North (WRC, 2003)**	**Spencers Brook (WRC, 2002)**
Moderate		58%	78%
Poor		30%	7%
Very Poor		11%	4%
Bank stability and erosion			
Excellent	N/A	0	0
Good		2%	0
Moderate		54%	22%
Poor		43%	74%
Very Poor		1%	4%
Sections with artificial bank stabilisation interventions		8%	22%
Habitat diversity			
Excellent	N/A	0	0
Good		1%	0
Moderate		97%	81%
Poor		2%	15%
Very Poor		0	4
Overall stream health rating			
Excellent	N/A	0	0
Good		0	0
Moderate		20%	26%
Poor		74%	70%
Very Poor		6%	4%
Observed vegetation regeneration	16%	73%	48%
Fencing status			
Both sides	52%	41%	7%
Left bank	32%	16%	26%
Right bank		12%	26%
No fencing	16%	31%	41%

*Avon River recovery plan used different methodology to assess the overall health of the river section.

The Wheatbelt NRM uses a threshold of more than 30% of waterway being degraded as an indicator of potential fundamental system change in river functions (Wheatbelt NRM, 2014). As identified in Table 5, all assessed waterways in the Shire of Northam are below this threshold. Waterway and riparian vegetation management, including fencing and revegetation are recommended as priority actions to improve the health of the waterways ((Wheatbelt NRM, 2014, Water and Rivers Commission, 1999b; Water and Rivers Commission, 2002; Water and Rivers Commission, 2003). While most of the Avon River is fenced, the Mortlock River, Spencers Brook and tributaries in the Shire of Northam will benefit from further fencing.

Extensive records of water quality monitoring are available for the Avon River and its main tributaries in the Shire of Northam, including information on pH, total nitrogen, total phosphorus or water salinity. All of these measures vary from one location to another. For example the natural pH of a waterway depends on the soil and rock over which the water moves. On the Mortlock River North, the average pH value recorded between 1975 and 2002 was 7.87 (7 equals neutral), with a

maximum of pH 8.74 (slightly alkaline) and a minimum of pH 6.70 (slightly acidic). Monitoring of pH is important as change in pH more than 0.5 units from the natural seasonal minimum and maximum may be detrimental to flora and fauna living within the waterway (Water and Rivers Commission, 2003). On the Avon River, most readings of pH collected during a snapshot assessment in 2006 were classified as neutral and slightly alkaline, in the Shire of Northam they ranged from 7.5 to 9.1 (Government of Western Australia, 2006). In the western portion of the Shire, the pH values ranged from 6.7-7.2 (classified as neutral) with one site recording pH 6.3, slightly acidic.

Except for the one locality with pH 6.3, all assessed waterways show pH above the threshold of below pH 6.5, adopted by the Wheatbelt NRM (2014). In areas with pH below the threshold level, retrofitting of local dam disposal of saline discharge is recommended (Wheatbelt NRM, 2014).

The salinity levels in waterways in the Shire ranged from moderately saline (2000-5000mg/L TDS[8]) to highly saline (10000-35000mg/L TDS) levels (Government of Western Australia, 2006). Higher salinity was recorded in the Mortlock River North, where the average salinity level for data collected between 1976 and 1997 was 13,400mg/L TDS (Water and Rivers Commission, 2003). Waterway salinity values declined towards the western boundary of the Shire (Government of Western Australia, 2006). Increased water salinity affects the quality and diversity of foreshore vegetation with indigenous vegetation such as *Eucalyptus rudis* being replaced by salt-tolerant species such as *Casuarina obesa.* Increased salinity of waterways can affect riparian vegetation restoration efforts (Government of Western Australia, 2006).

Water quality monitoring data collected within the Avon basin, with numerous collection sites occurring in the Shire, can be accessed via the Department of Water's *Water Information Reporting* platform available on http://wir.water.wa.gov.au/SitePages/SiteExplorer.aspx. Between 1999 and 2008, the Department of Water undertook water quality monitoring of 255 sites from 23 basins in Western Australia. One of the monitoring sites is within the Northam townsite and 3 additional sites are either within or in close proximity of the Shire boundaries. Data collected during these statewide assessments is available through the Department's interactive webpage available via http://www.water.wa.gov.au/idelve/srwqa/ .

2.6 Ecological linkages

Habitat loss and fragmentation due to land clearing, salinization of the landscape and the introduction of feral animals are recognised as the biggest threats to biodiversity in the Wheatbelt region. Improving landscape connectivity by securing and managing remaining vegetation and undertaking revegetation are an effective management response to fragmentation (Australian Government, 2012b; EPA, 2008; Wilkins *et al,* 2006; Molloy *et al,* 2009).

See the Wheatbelt connectivity zones mapping in the Environmental Planning Tool: Northam Local Biodiversity Strategy/Wheatbelt NRM Corridor Plan Connectivity Zones

[8] TDS – Total Dissolved Salts.

Wheatbelt NRM, an independent, community-based organisation for natural resource management in the Avon Wheatbelt bioregion, has developed a regional scale corridor plan (Richardson *et al,* 2013), based on the following broad principles for corridor planning and implementation:

1. "The planning process must be robust but any analyses able to be readily re-run in-house to exploit future opportunities.
2. Existing vegetation needs to be used as a skeleton on which to build corridors.
3. For existing vegetation patches the bigger the better.
4. For existing vegetation patches the closer the better.
5. Threats need to be considered early in the planning process.
6. Clearly defined and measurable objectives need to be determined during the planning process."

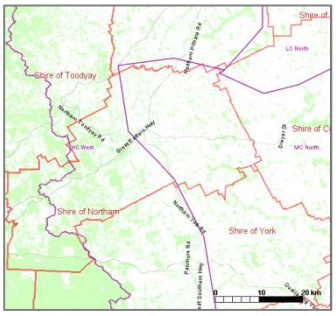

Figure 10: Wheatbelt NRM Connectivity zones (purple boundaries) and 2014 native vegetation extent.

The study identifies high, medium and low 'connectivity zones' which take into account the number of patches of 'functional vegetation"[9], their area and configuration. The Shire of Northam falls within two connectivity zones: the portion west of the Northam townsite, within a high connectivity zone (HC West); and the portion east of the townsite, within a medium connectivity zone (MC North).

High connectivity zones include patches that are considered already well-connected. Maintenance and improvement of connectivity at local scales should be a priority in these areas. Medium connectivity zones identify areas where achievement of landscape connectivity will require significant investment.

Improved connectivity within the Wheatbelt's medium connectivity zone will connect the rangelands, the extensive land use region east of the Wheatbelt, with the jarrah forest to its west, facilitating climate change response by connectivity along the climatic gradient from the drier central areas to the more mesic coastal areas (Richardson *et al,* 2013).

Connectivity zones address connectivity at the broad landscape scale. To assist with implementation, assessment of opportunities and constraints to establishing an ecological corridor at local level is recommended. Considerations include: the remnant patch size and distance between patches; land tenure; ecological values; and potential constraints to securing long term functionality of a corridor (Richardson *et al,* 2013).

The local natural area prioritisation presented in Section 3 of this document can be used to identify priority natural areas to form the stepping stones in corridors to be improved within the high and medium conservation zones.

[9] Richardson *et al* (2013) defines "functional vegetation" as remnant patches outside the high risk salinity zone, are greater than 30ha and within a nominal distance (500m or 1km) of another patch or are greater than 200ha.

2.7 Threats to biodiversity

The extent and integrity of naturally occurring ecosystems in a landscape are affected by numerous threatening processes. As a result, many species of flora and fauna, and entire ecosystems, have been lost in the region, including within the Shire of Northam. The 2005 Avon Natural Resource Management Strategy (Avon Catchment Council 2005) recorded the following biodiversity losses within the Avon Basin Region:

- Five extinct flora species
- 71 endangered species and over 450 species of vascular plants being at risk from rising water tables
- Two extinct mammal species
- 121 Declared Rare Flora and 234 Priority Flora
- At least three endangered bird species and many of those remaining having a greatly contracted range.

The key contributors to biodiversity decline in the region are:

- Vegetation fragmentation, loss of habitat due to clearing and lack of management
- Altered hydrology, changing rainfall-runoff patters, sedimentation of river pools, altered water quality, loss of riparian vegetation
- Altered fire regimes
- Feral animals, introduced plants and diseases such as Phytophthora dieback and marri canker
- Rubbish dumping, trampling and uncontrolled river crossings, stock access to waterways
- Lack of community understanding of the environmental values and the thereateninig processes.

Vegetation loss in semi-rural environments is often hidden as it occurs incrementally. Subdivisions into small lots of between 1-4 hectares, in rural residential or rural subdivisions, that provide for rural style living lead to clearing of vegetation along property boundaries, building envelopes and for access tracks. Any remaining vegetation will degrade over time due to unsustainable land use and increased exposure to threatening process such as increased risk of weed invasion, spread of pathogens and fire hazard reduction activities (Gardner, 2007). Grazing of the understorey by stock is another significant threat to the long-term viability of native vegetation and its habitat value to local fauna.

Table 6: A list of weeds and feral animals identified as major threats to biodiversity in nature reserves in the Shire of Northam*.

Significant Weeds
WONS - Weed of National Significance (http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html) **DP** – Declared Pests include plants that are prevented entry into the State or have control or keeping requirements within the State.

• Spiny or Sharp Rush (*Juncus acutus*) • Skeleton Weed (*Chondrilla juncea*) **DP** • Bridal Creeper (*Asparagus asparagoides)* (WONS) • African Lovegrass (*Eragrostis curvula*) • Balloon Cotton Bush (*Gomphocarpus physocarpus*) • Euphorbia terracina (*Geraldton Carnation Weed*) • Cape Tulip (*Morea flaccida & Morea miniata*) **DP** • Patterson's Curse (*Echium plantagineum*) **DP**	• Ryegrass (*Lolium loliaceum*) • Stinkwort (*Dittrichia graveolens*) • Watsonia (*Watsonia meriana var. bulbillifera*) • African Boxthorn (*Lycium ferocissimum)* (WONS) • Early Black Wattle (*Acacia decurrens*) • Flinders Range Wattle (*Acacia iteaphylla*)

• **Feral animals**
  • Feral Cats
  • Wild Dogs
  • Foxes
  • Native parrots
  • Pigs
  • Rabbits	

*Source: Summary of Assets from Asset Collation prepared by the Avon Catchment Council in 2004. Copy provided by Greening Australia (WA).

Table 6 lists priority weeds in the Shire but does not include all weeds that occur within the Shire. The Shire's proximity and connectivity (via the Great Eastern Highway) to the wetter Hills area provides a conduit for emerging weeds that are becoming established. Roadsides provide ideal conditions for both established and emerging weeds as they are more mobile in these environments, are water gaining areas (through drains and culverts) and are disturbed via grading and maintenance.

The Shire of Northam already adopted a Local Law to address the control of Watsonia (*Watsonia meriana var bulbillifera and Watsonia meriana var meriana*) which required land owners to control this species and gives powers to the Shire to recover cost associated with control of the weed by the Shire if the landowner fails to do so (Pest Plant Local Law 2011, Government Gazette No 138, 22 July 2011). The provisions of this Local Law could be extended to other priority weed species. The Shire should also investigate opportunities for forming a *Recognised Biosecurity Group* under the provisions of the *Biosecurity and Agriculture Management Act 2007* (https://www.agric.wa.gov.au/bam/recognised-biosecurity-groups-rbgs). The Department of Agriculture and Food provides support to forming Recognised Biosecurity Groups.

Some ecosystems are more susceptible to specific threats. For example, Shedley (2007) identifies several high priority vegetation communities and species in the Avon Basin that require sensitive fire management, including:

- granite rock and ironstone outcrops
- heath communities
- salmon gum woodlands
- fresh and brackish wetlands
- malleefowl habitat
- fauna dependent on tree hollows.

Many threats will be exacerbated by the impacts of changing climate, particularly increased temperatures and increasing aridity (Wheatbelt NRM, 2014). The Wheatbelt NRM's Strategy (2014) recommends that the goals for the management of native vegetation should be to build resilience

and to limit the impact of existing and emerging stressors on the natural ecosystems and landscapes.

According to Davies (2010), a 10% increase in riparian revegetation is required for a 1ºC decrease in water temperature in the waterways of south-western Australia. Due to increased drying and warming, it is recommended that restoration of rivers and streams includes targeted replanting of riparian vegetation, focusing on north banks of east-west upland streams to moderate water temperatures to levels below thermal limits of sensitive fauna (Davies 2010).

Management responses to improve biodiversity conservation in fragmented landscapes and to increase the capacity of natural areas to adapt to climate change should include the following (Molloy *et al* 2009, Commonwealth of Australia 2010):

- Provision of access to a greater number and diversity of resources
- Conservation of larger and more viable populations
- Enabling species dispersal and migration
- Provision of a more representative mosaic of habitat types and structures
- Facilitation of greater genetic variation within species
- Increase the capacity of species and communities to persist through removal of threats and adapting to disturbances.

Many of the above requirements can be facilitated are being addressed in this document.

3 Prioritisation of Local Natural Areas for Biodiversity Conservation

3.1 Methodology

The local biodiversity conservation planning approach adopted in this study follows the State government-endorsed methodology that was developed through the Perth Biodiversity Project and published in the *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region* (Del Marco *et al,* 2004). It is used by numerous Local Governments in the South West of Western Australia. Local biodiversity conservation planning incorporates assessment of ecological values of local natural areas, consideration of opportunities and constraints to their protection and identification of conservation priorities and feasible implementation actions.

A set of biodiversity conservation principles guides the local biodiversity conservation planning process. Identification of local conservation objectives and identification of effective implementation mechanisms are based on the need to meet legislative, environmental and planning policy requirements and best practice in biodiversity conservation.

BIODIVERSITY CONSERVATION PRINCIPLES

1. Prevent exponential loss of species and ecosystem failure by retaining at least 30% of the pre-European extent of each ecological community
2. Protect regionally significant and locally significant natural areas
3. Biodiversity is best conserved in-situ - protect what you have before revegetating
4. Regeneration is a higher priority than revegetation
5. Prioritise protection and management of natural areas which have the highest biodiversity value
6. Involve the community in helping conserve biodiversity
7. Biodiversity values must be made transparent in decision-making processes
8. Site-specific field survey is essential to understanding biodiversity value
9. Natural area conservation is a legitimate land use

Native vegetation mapping is used to describe the various ecosystems represented in the Shire. Combining native vegetation mapping with other spatial data that describes biodiversity assets, such as significant flora and fauna records, forms the basis for the identification of priority natural areas for conservation.

This Strategy focuses on *local natural areas* that have been defined as natural areas[10] which lie outside lands managed by the Department of Parks and Wildlife, Regional Parks (and Bush Forever in the Perth Metropolitan Region) (Del Marco *et al* 2004). In the Shire of Northam, over 25,700 hectares, or 76% of the remaining vegetation, is classified as 'Local Natural Areas'.

The objective of ensuring that a *comprehensive, adequate* and *representative* network of ecosystems is protected in the Shire assumes that by meeting this objective, the Shire will have made its necessary contribution to regional and national objectives for biodiversity conservation. *'Comprehensiveness'* refers to the degree to which a full range of ecological communities are protected. *'Adequacy'* refers to the ability of a reserve system to maintain the ecological viability and integrity of populations, species and communities. Complementary management of the adjacent lands can play a significant role in ensuring long term viability of conservation reserves. *'Representativeness'* refers to the extent to which protected areas are capable of reflecting the known biological diversity and ecological patterns and processes.

3.1.1. Criteria for determining conservation significance

Criteria for rating the conservation significance of local natural areas are based on *Local Government Biodiversity Planning Guidelines* (Del Marco *et al,* 2004) and reflect EPA criteria for identification of regionally significant natural areas (EPA, 2008). The criteria can be divided into four categories:

1. **Representation** – considers the regional and local level of retention and protection of all ecosystems represented within a Local Government, and compares this against accepted thresholds, such as the goal of retaining at least 30% of pre-European vegetation extent and protecting 17%.
2. **Rarity** – considers the presence of rare vegetation, flora and fauna.
3. **Maintenance of ecological functions** – reflects the level to which local natural areas contribute to the maintenance of healthy ecosystems in the landscape. Due to limited spatial data available to assess this at all ecosystem levels, vegetation connectivity and remnant patch size are used as a surrogate measure
4. **Protection of wetlands, riparian, estuarine and coastal ecosystems** – recognises the important role that these ecosystems play in maintaining biodiversity.

The EPA considers a range of additional criteria such as novel combination of species, diversity of species and vegetation, large populations, extreme ranges of species and scientific significance (EPA, 2008). However, this Strategy focuses on attributes that are mapped at Local Government and regional levels. It is not intended to undertake an all-

[10] Natural area is used to describe an area that contains native species or communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open water bodies, waterways, springs, rock outcrops, bare ground, caves, coastal dunes or cliffs. Note that natural areas exclude parkland cleared areas, isolated trees in cleared settings, ovals and turfed areas (Del Marco *et al* 2004)

inclusive assessment but rather to identify priority areas where further field assessments are required to confirm the inferred and other values.

Twenty criteria represented by various spatial layers were applied to the 2013 native vegetation extent mapping (DAFWA 2013)[11]. See Appendix F for the details. The final prioritisation layer shows the number of criteria met by each patch of remnant vegetation. The higher the number of criteria met, the higher the conservation priority of a given patch of remaining vegetation (See Figure 11, Appendix F or turn on the *Prioritisation Criteria* layer under the Northam Local Biodiversity Strategy heading in the EPT).

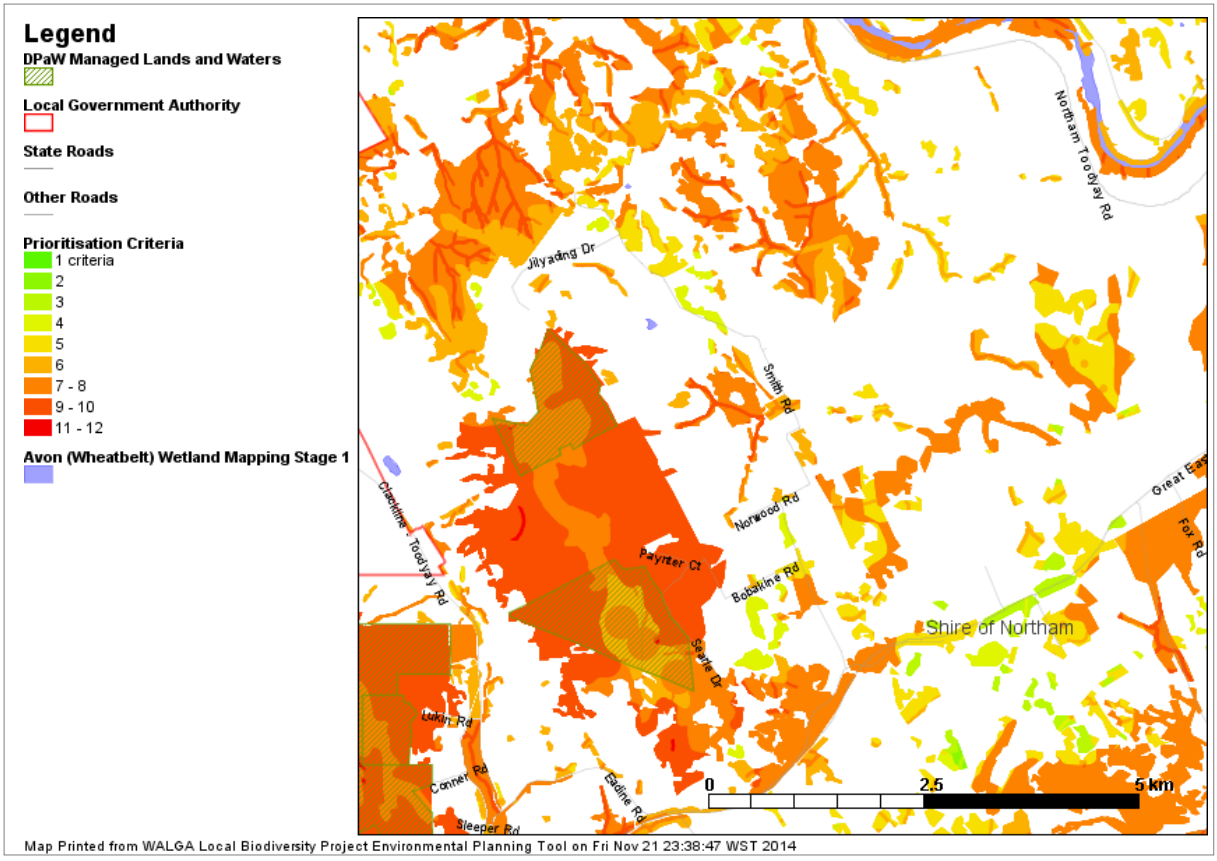

Figure 11: Number of prioritisation criteria met by native vegetation in the portion of the Shire of Northam (as displayed in the Environmental Planning Tool).

To interpret the information, it is important to understand which criteria are being triggered. An absence of threatened flora, fauna or ecological community's records does not necessarily mean those features are not present within a patch of native vegetation, as the lack of records can be due to the lack of adequate surveys. See Appendix H for further information on how to use data layers in the EPT to assist with decision making that is specific to a particular locality.

[11] The 2013 native vegetation extent mapping does not include all vegetation identifiable using aerial photography interpretation. For example, no native vegetation is mapped within the Meenar Nature Reserve. As the objective of this study is to consider 'local natural areas', for the purposes of prioritization, vegetation within the Meenar Nature Reserve, a natural area managed by DPAW for conservation, the missing vegetation was not substituted.

3.1.2. Connectivity and patch size analysis

The landscape connectivity zones identified for the Wheatbelt NRM Region (Richardson *et al,* 2013) provide a regional context for considering the role that individual patches of remaining native vegetation play at the local scale. However, further spatial analysis is needed, to better understand the impacts of changes in the current pattern of remnant vegetation and identify priority areas for restoration to improve connectivity at the local level.

Three connectivity descriptors or measures were developed through the Perth Biodiversity Project (Oh, 2012) to assess the level of connectivity between patches of remnant vegetation. A 'patch' was defined as a discrete polygon of vegetation or mapped wetland separated from another patch by at least 10 metres of non-vegetated land. Remnant patches were based on the 2013 native vegetation extent mapping (DAFWA, 2013) and the Avon (Wheatbelt) wetland mapping (DEC, 2008). Comparison of the native vegetation extent mapping with aerial photography identified gaps in the dataset, where native vegetation was missing. Vegetation within the Meenar Nature Reserve was added to the analysis.

The three connectivity descriptors, or measures, used to describe the various aspects of connectivity are:

- **'Fragmentation'** is a scaleless and dimensionless measure which describes the shape and local arrangement of defined patches in the study area. It measures the degree to which any remnant patch diverts from the 'ideal circle' shape. A high vegetation fragmentation index applies to large, compact or locally well-connected patches (least fragmented); a low index applies to small, isolated or poorly shaped patches (most fragmented).
- **'Regional Connectivity'** measures how well a patch contributes to a network of patches in the wider landscape. A high regional connectivity index applies to large patches or patches that are part of a large, dense regional network; and a low index applies to small, fragmented or isolated patches.
- **'Connectivity Reach'** refers to the size of the connective network that a patch belongs to but does not consider how sparse (fragmented) or dense that network is.

These connectivity descriptors, or measures, do not consider the inner patch diversity of habitats or the dispersal needs of individual species of fauna. However, they provide a good opportunity to objectively assess the role of individual patches, and the impacts that changes in vegetation distribution patterns have on connectivity (Perth Biodiversity Project, 2012; Local Biodiversity Program, 2013). A more detailed description of the connectivity modelling algorithm used is available in Appendix G.

A patch size analysis was undertaken to assist with quick identification of those areas of native vegetation that could potentially support a range of fauna or where specific land use provisions could be applied. In this analysis, a patch is defined as a discrete polygon of native vegetation separated from another polygon by 10m, where only native vegetation

extent mapping was used for the analysis (DAFWA, 2013) and wetland mapping was not included.

It is important to note that the patch size analysis does not consider the diversity or habitat characteristics within a patch. Although the patch size might indicate sufficient habitat size for a certain species of fauna, the quality of the habitat within this patch might not be adequate. Therefore this data layer should not be used in isolation.

Table 7 shows the patch size categories used and potential correlations with fauna habitat needs or other considerations.

Table 7: Patch size categories

Remnant vegetation patch size category	**Consideration** (Remnant size requirements for fauna are based on Wildlife Notes No 11, Hussey and Mawson 2004)
<2ha	2ha is the minimum to support one Brush-tailed Possum
2.1-5ha	5ha is the threshold to which the 2013 amendments to the clearing regulations limits apply 5ha is the minimum needed to support a Quenda population
5.1-10ha	Used in prioritisation criteria, 5-10 ha are common lot sizes for rural subdivisions. 10 ha has been adopted by the Wheatbelt NRM as a threshold for fragmentation (Wheatbelt NRM, 2014)
10.1-25ha	25ha of suitable vegetation is needed to support Pygmy Possums and Honey Possums
25.1-40ha	40ha Rural subdivision threshold
40.1-100ha	50-100ha needed to support Brush Wallaby population
100.1-200ha	Potential to support Woylie population
200.1-1000ha	Potential to support Echidna and Wambenger populations
>1000ha	Potential to support Chuditch population

The distribution of vegetation patches within the Shire correlates with the levels of native vegetation retention. Significantly larger patches, over 40 hectares, occur in the western portion of the Shire within the Jarrah Forest bioregion.

Despite the high level of clearing in the Wheatbelt portion of the Shire, the remaining vegetation is retained in several large and medium patches. These should be the highest priority for formal protection and form the key stepping stones in the local ecological network of natural areas. Results of the patch size mapping are available via the on-line Environmental Planning Tool and in Figure 12.

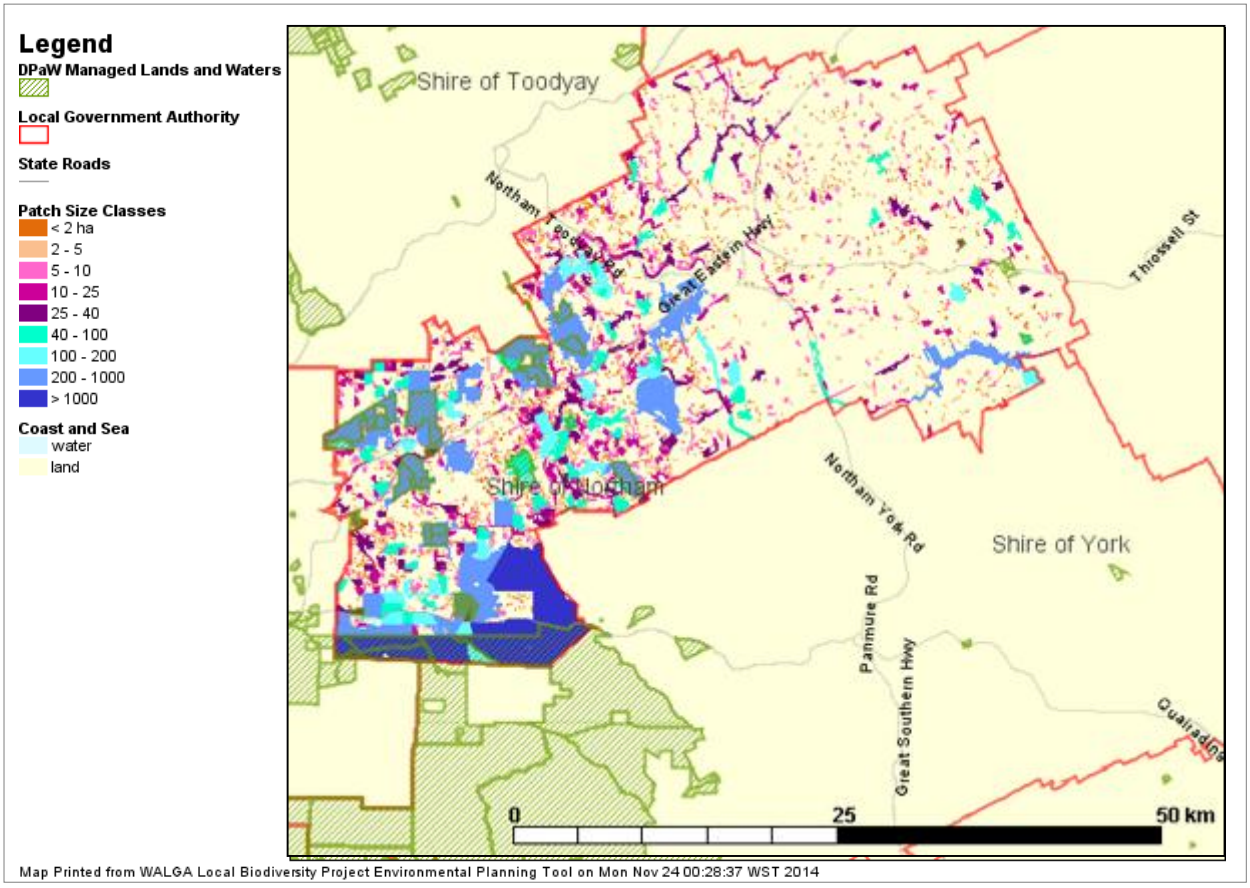

Figure 12: The patch size of native vegetation in the Shire(Local Biodiversity Program 2014).

3.1.3 Opportunities and constraints to local natural area protection

In the context of the local biodiversity conservation planning approach (Del Marco *et al,* 2004), protected natural areas are those that are secured for conservation either as public lands vested for biodiversity conservation purpose or private lands where the biodiversity values are secured under zoning or covenanting.

Of the 33,908 hectares of native vegetation remaining in the Shire, 6,486.8 hectares is protected in conservation reserves managed by the Department of Parks and Wildlife (DPaW). This represents 19% of the remaining vegetation and 4.5% of the pre-European extent (DPaW, 2013). A further 1,590 hectares is managed by the DPaW and these are areas that are considered to provide good opportunities for natural area retention and protection. However, site specific recommendations for DPaW managed lands are outside the scope of this Strategy[12].

An additional 934 hectares are protected in public reserves not managed by DPaW and vested for conservation and via the provisions of the 'Conservation of Flora and Fauna'

[12] Local biodiversity strategies focus on 'local natural areas', defined as natural areas outside DPaW managed lands.

reservation in the Shire's Local Planning Scheme No.6 (2013). These lands are defined as 'Locally Protected Reserves' in this Strategy and shown in Figure 13 (LP1 – LP11).

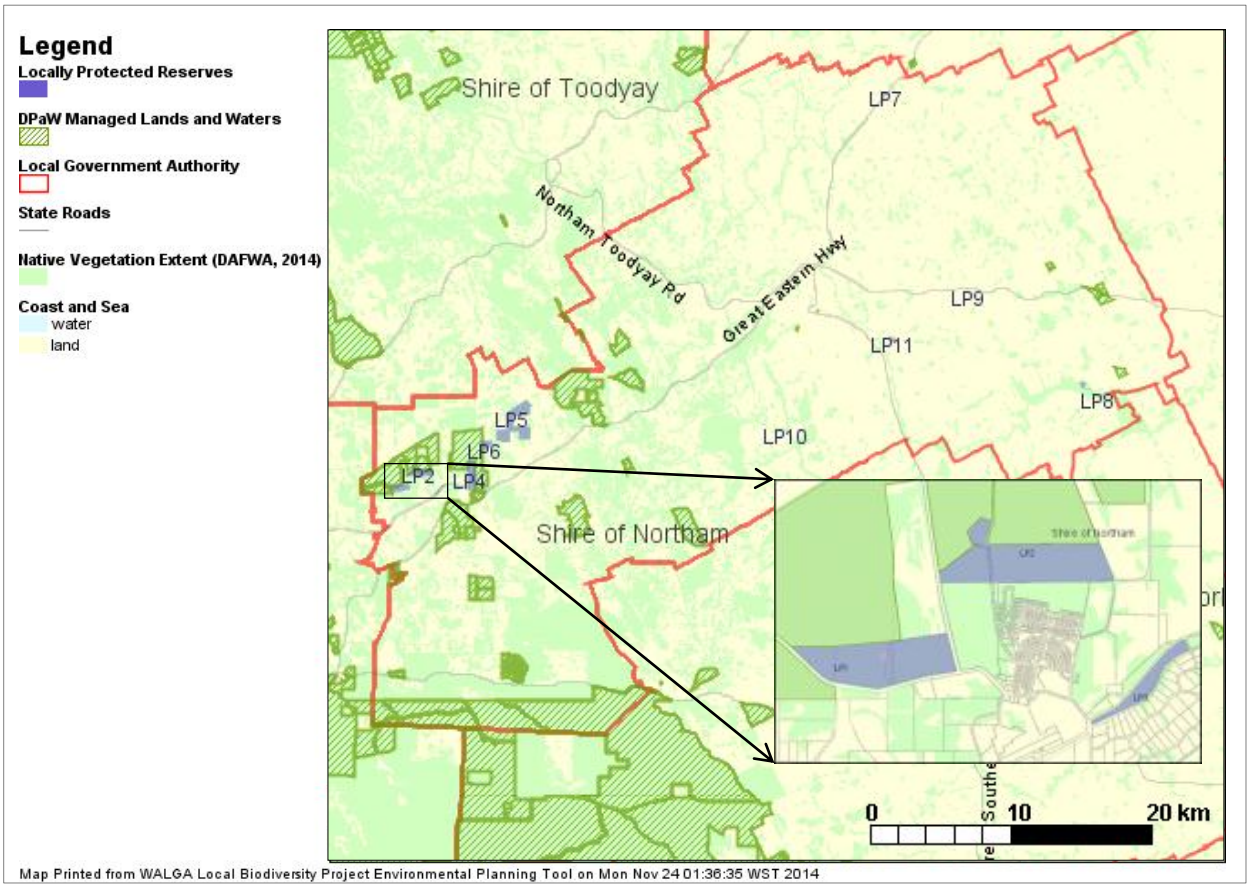

Figure 13: 2014 native vegetation extent, DPaW managed lands and lands protected through the Shire of Northam Local Planning Scheme No 6 (Local Biodiversity Program, 2014).

The 'Locally Protected Reserves indicated in Figure 11 comprise Unallocated Crown Land (UCL) and six reserves with conservation or landscape protection purposes (four vested in the Shire of Northam and two in the State). Table 5 lists these conservation purpose reserves. In the Shire's Local Planning Scheme No. 6 (2014) most of the 'Local Protected Areas' are classified as 'Conservation of Flora and Fauna', a land use category that also overlaps DPaW managed conservation purpose reserves. There are three 'Locally Protected Reserves' which are classified for other land uses in the Local Planning Scheme No 6 (2014):

- LP6 and LP10 are reserves classified for Parks and Recreation in the Scheme
- LP7 is a reserve classified for Public Purposes (about 0.4ha) and the remainder are zoned Rural in the Scheme.

It is recommended to amend the Local Planning Scheme and reclassify LP6, LP7 and LP10 as 'Conservation of Flora and Fauna" to reflect the vested purpose of these reserves (established under the *Land Administration Act 1997*).

Table 8: 2013 native vegetation extent in conservation reserves not managed by the Department of Parks and Wildlife (Local Biodiversity Program, 2014)

	Vegetation types represented in the reserves				Total	Management responsibility	Notes*#
Reserves managed by the Shire of Northam	**Yalanbee - Y6**	**BVA 352**	**BVA 1048**	**BVA 1049**			
R 48721 (Conservation)	34.44ha				34.44ha	Shire of Northam	In LP6; #14 Bakers Hill
R 1549 (Landscape Protection)		0.98ha	22.7ha		23.7ha	Shire of Northam	In LP8; #1 Grass Valley
R 6102 (Preservation of Natural Vegetation)		0.89ha			0.89ha	Shire of Northam	In LP9; #5 Grass Valley
R 42084 (Protection of Historical Site and Natural Vegetation)		9.70ha			9.70ha	Shire of Northam	In LP11, #1 Seabrook
R 41145 (Foreshore Protection)		0.33ha				Department of Planning	In LP10
R 50656 (Protection of Natural Landscapes)				3.34ha		Department of Regional Development	In LP7
Total:	**34.44ha**	**11.89ha**	**22.7ha**	**3.34ha**	**68.68ha**		

*Identification symbol in the mapping layer 'Locally protected reserves', e.g. LP7.

#Corresponding reference number in the Shire of Northam Land Rationalisation Strategy (2013a)

When identifying land with good opportunities to increase the protection status of remaining vegetation, reserved lands and Crown land are examined as a priority. In the Shire of Northam, 544 hectares of native vegetation is in public reserves vested in the Shire for various purposes. Nearly 69 hectares is in reserves with conservation purpose (Table 8) and 275 hectares is in reserves providing good opportunities for vegetation retention and potentially increased protection (see Appendix D, Table 8). Recommendations in the Shire's Land Rationalisation Strategy for the Northam Townsite (Shire of Northam, 2013a) were considered when compiling the list of reserves where the proposal is to extend or change the current purpose to include conservation.

Over 1,000 hectares of native vegetation is within Unallocated Crown Land (UCL). A significant portion of this vegetation is protected via the Shire's Local Planning Scheme No.6 provisions through reservation as 'Conservation of Flora and Fauna' (LP1-LP5 on Figure 13). Numerous UCLs are located along the Avon River and the Avon Mortlock Rivers Special Control Area (Local Planning Scheme No 6, 2014). Establishing management responsibilities and support for management of biodiversity values within these UCLs should be the highest priority for all relevant stakeholders.

Many private landholders have a good understanding and appreciation of the benefits that retaining native vegetation brings to their properties. In the Shire of Northam, nearly 860 hectares of native vegetation is within 29 properties registered with the DPaW's *Land for Wildlife Program* (personal communication DPaW *Land for Wildlife* Program Manager, 2014), a voluntary program through which participating landowners have access to technical advice on how to maintain habitat values of native vegetation on their land. Continued support to these landholders, promotion of this program to others and promotion of benefits of entering into conservation covenants could lead to wider participation and result in more formal protection of some vegetation on private land.

In addition to provisions for natural area protection, various land use categories in the Local Planning Scheme and vesting purposes of reserved lands can be divided into a further three categories according to the opportunities they provide for natural area retention or protection. Table 9 provides an overview, categorizing the Shire of Northam land uses.

Table 9: Opportunities for natural area retention and protection through land use planning (Local Biodiversity Program, 2014).

Opportunities category	Local Planning Scheme No 6 land uses and reserve purposes.	% of remaining vegetation within land use categories*
Protected	Crown reserves with conservation purpose (outside DPaW lands) and UCLs reserved in the Local Planning Scheme for Conservation of Flora and Fauna.	3.6% in AW 17.5% in JF
Good opportunities	Properties with DPaW's *Land for Wildlife* status. Parks and Recreation, Rural zoned lands and Crown reserves vested for Recreation (LU1) & Catchment (outside DPaW managed)	86% in AW 44.4% in JF[13]
Varied opportunities	State Forest, Special Use, Public Purposes, Rural Smallholdings (>10ha lot size) and Crown reserves vested for all other purposes to those listed above.	7.2% in AW 37.5% in JF[14]
Limited opportunities	Tourist, Commercial, Residential, Rural Residential, Development, Light & Service Industrial, Mixed Use and General Industry zoned land and Railway Reserve, Roads, Major or Regional Road Reserves	3.2% in AW 0.7% in JF[15]

*AW – Avon Wheatbelt IBRA region and JF – Jarrah Forest IBRA region portions of the Shire

More detailed information on the distribution of native vegetation within all land uses is available in Appendix D.

[13] Includes 15 ha of vegetation within properties registered with the *Land for Wildlife* Program and zoned Rural Smallholdings and Rural Residential in the Local Planning Scheme No 6.
[14] Excludes 6.6ha of vegetation within properties registered with the *Land for Wildlife* Program and zoned Rural Smallholdings in the Local Planning Scheme No 6.
[15] Excludes 8.4ha of vegetation within properties registered with the *Land for Wildlife* Program and zoned Rural Residential in the Local Planning Scheme No 6.

Most remaining vegetation is located on land where the zoning provides good or varied opportunities for retention and protection of representative vegetation in the Shire. The largest portion of the remaining vegetation is on land zoned Rural in the Local Planning Scheme No.6 (2014).

There is a difference between the two bioregions in the Shire. While 86% of the remaining vegetation in the Avon Wheatbelt portion of the Shire is located on land where zoning provides good opportunities for vegetation retention or protection, in the Jarrah Forest bioregion portion only 44% of remaining vegetation is in this category. Nearly the same amount is within land uses providing varied opportunities, such as State Forest.

A relatively small amount of vegetation is located on land where the zoning provides limited opportunities for vegetation retention, with a higher portion recorded in the already over-cleared eastern half of the Shire, where over 100 hectares of vegetation is mapped within road and railway reserves. While a relatively small amount of the remaining vegetation is located in transport corridors, it is often retained in highly cleared parts of the landscape, providing the only opportunity for fauna movement. Vegetation in road or railway reserves can provide habitat for threatened or Priority flora. Therefore road upgrades and maintenance activities should be undertaken in a way that avoids or minimizes impacts on vegetation.

The Northam Regional Centre Growth Plan (NRCGP) (Shire of Northam, 2012) area includes 136 hectares of native vegetation and the Avon and the Mortlock Rivers (See Figure 12). The results of natural area prioritisation show that most of the remaining vegetation in the NRCGP area meets numerous prioritisation criteria, suggesting high conservation value. There are two Beard vegetation associations represented in the NRCGP area; regionally significant vegetation BVA 4 and BVA 352. The NRCGP area west of the Avon River is within the transition zone between the two bioregions meeting in the Shire. Table 10 shows the distribution of vegetation within the NRCGP.

Table 10: 2013 vegetation extent by Beard vegetation associations within the Northam Regional Centre Growth Plan area (Local Biodiversity Program, 2014).

	Avon Wheatbelt IBRA		Jarrah Forest IBRA		Total
Growth Plan land uses	**BVA4**	**BVA352**	**BVA4**	**BVA352**	
Equine Precinct		8.96ha			8.96ha
Industrial Development	3.45ha	16.73ha	50.02ha		70.21ha
Urban Expansion	2.07ha	50.59ha	3.78ha	0.69ha	57.14ha
Total	**5.53ha**	**76.28ha**	**53.81ha**	**0.69ha**	**136.31ha**

The remaining vegetation and the rivers provide a good opportunity to establish a green network through the growing town. This will provide recreational opportunities, reduce the heat effect of built up areas, increase amenity, and encourage walking and cycling as preferred means of transport.

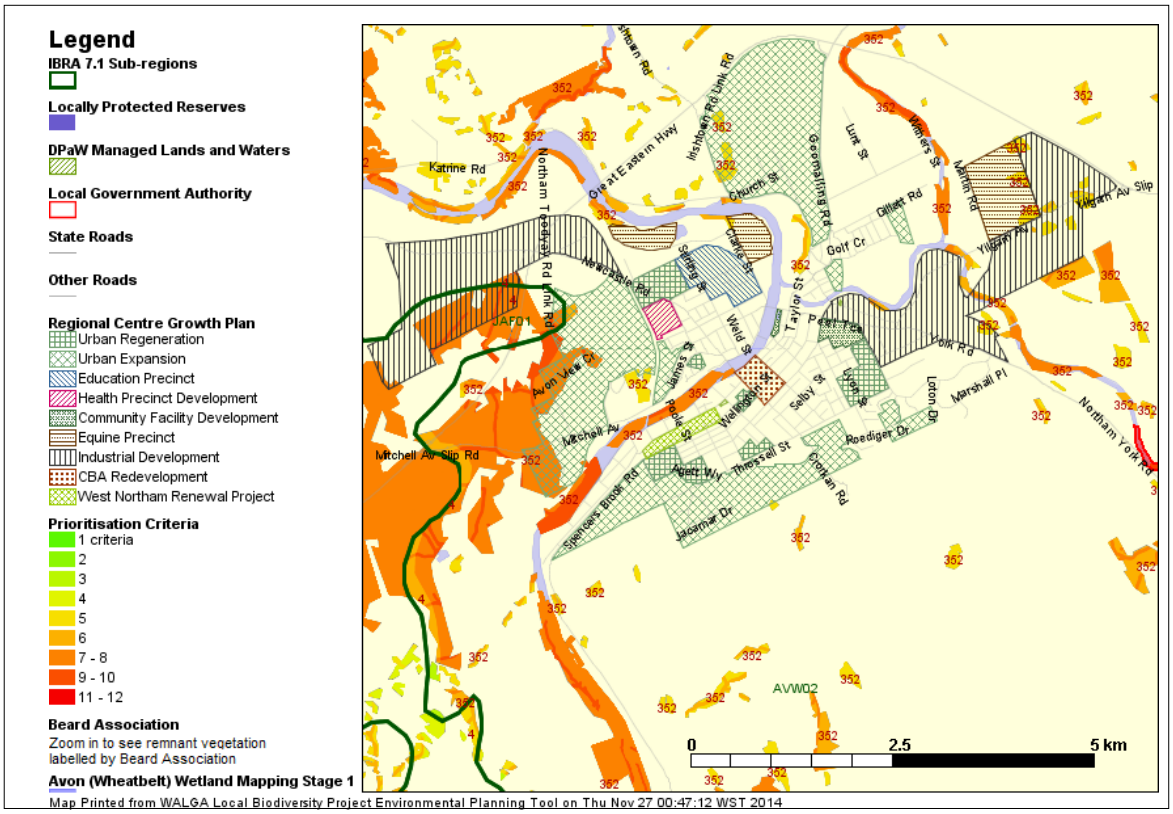

Figure 12: Number of prioritisation criteria met by native vegetation, and the Northam Regional Centre Growth Plan.

The Shire's Local Planning Scheme No 6 (2013) and Local Planning Strategy (2013) include numerous provisions and development controls supporting biodiversity protection and restoration of degraded lands (see Appendix A).

3.1.4 Identification of representation targets and the Target Areas

Representation of ecological communities is one of the criteria considered when identifying conservation priorities. The retention and protection levels of vegetation are relatively easy to measure and provide a good opportunity for setting quantifiable conservation targets.

When determining local conservation targets, an assumption is made that each local area within a Local Government administrative boundary should contribute to the regional conservation target. The area contributed should be at least equal to the proportion of the original vegetation extent within the local area. This is a general principle and might not be achievable in all local areas due to historic clearing or the varied degrees of opportunities existing across the region. In addition, representation is only one criteria and other biodiversity values are equally important when building the regional network of protected natural areas.

The calculation of local representation targets is explained using the example of the Bindoon vegetation complex. There were 4,763 hectares of Bindoon vegetation complex mapped as pre-European extent in the Shire of Northam, representing 13.2% of the total area of Bindoon vegetation complex mapped in the Jarrah Forest bioregion. To achieve at least 17%

protection of the Bindoon vegetation complex in the region (Jarrah Forest bioregion), at least 6,129 hectares should be protected within several locations of its pre-European extent. This means that from the Shire of Northam at least 810 hectares or 13.2% of the 6,129 hectares should be contributed. In 2013, there was no Bindoon vegetation complex protected in the Shire and, at the regional level, less than 30% remains and less than 17% is protected.

Therefore the conservation target for Bindoon vegetation complex in the Shire of Northam should be 810 hectares of the 1,005 hectares remaining. Further analysis of opportunities to formally protect this vegetation complex in the Shire needs to be undertaken to assess the feasibility of this proposed representational target.

When identifying potential mechanisms for formal protection[16], and assessing the feasibility of the proposed representational targets, the key factors to consider are land tenure, land use and the size of the patches of remnant vegetation that represent the vegetation complexes/Beard vegetation associations. Tables 1 and 2 in Appendix D show the calculations for determining the representation protection targets for each vegetation type and Table 9 in Appendix D provides an overview of opportunities to improve the protection status for vegetation complexes and Beard vegetation associations in the Shire of Northam.

These opportunities are further mapped by the identification of “Target Areas”, highlighting areas where good opportunities exist to improve the protection status of under-represented vegetation complexes in the Shire. They include significant patches of remnant vegetation representative of vegetation complexes/BVAs that have been identified as not being adequately represented in the regional conservation estate (considering reserve and off-reserve protection mechanisms).

Additional Target Areas are identified to highlight priority wetlands associated with watercourses in the Wheatbelt portion of the Shire. Vegetation restoration along these watercourses will improve landscape connectivity, improve water quality and reduce sedimentation in the Avon River pools.

It should be noted that it is not intended that all vegetation mapped within these Target Areas will be formally protected or all lands considered for restoration.

The Target Areas may include freehold land, land reserved for various purposes other than conservation, and Unallocated Crown Land. Priority was given to areas where there are good opportunities to protect vegetation considering the existing land use provisions, land tenure (Unallocated Crown Land) or the presence of initiatives that support land conservation (participation in the *Land for Wildlife* p*rogram*).

Other considerations when selecting the Target Areas were whether increased protection in the proposed location is likely to contribute to: protecting other biodiversity values such as threatened and Priority species or communities, fauna habitat, wetlands; maintaining connectivity between already protected natural areas; or extending or buffering already

[16] Natural areas are protected when reserved and managed for conservation (DPaW conservation lands or local reserves), and through measures such as a conservation zone or a conservation covenant.

protected areas; and the size of individual priority vegetation complexes within remnant patches (mosaic).

Appendix H provides details of areas within each vegetation complex that occur in Target Areas, and notes on mechanisms to protect the most significant portions of this vegetation. Appendix H demonstrates that despite more than 1,000 hectares of Bindoon vegetation complex remaining in the Shire, it is unlikely that the Shire's target of protecting 810 hectares of this complex can be reached. This is due to several factors (see Figures 13 and 14):

- the high levels of fragmentation of patches of the Bindoon vegetation complex
- none of the remaining vegetation is within UCLs or other Crown reserves
- None of the private properties with Bindoon complex are registered with the *Land for Wildlife* program (DPaW, 2014)
- 88% of the remaining extent is on Rural zoned land, 11% is reserved for Public Purposes and Special Use in the Local Planning Scheme and 1% is within Road reserves.

However, as demonstrated in Figure 14, most of the Bindoon complex is within 12m of a confirmed breeding site for the Endangered Carnaby's black cockatoo, a species that is protected under the EPBC Act. Opportunities to protect some of these areas by purchasing them to offset development of cockatoo sites elsewhere should be investigated. Protection and restoration of the habitat of this endangered species is a high priority.

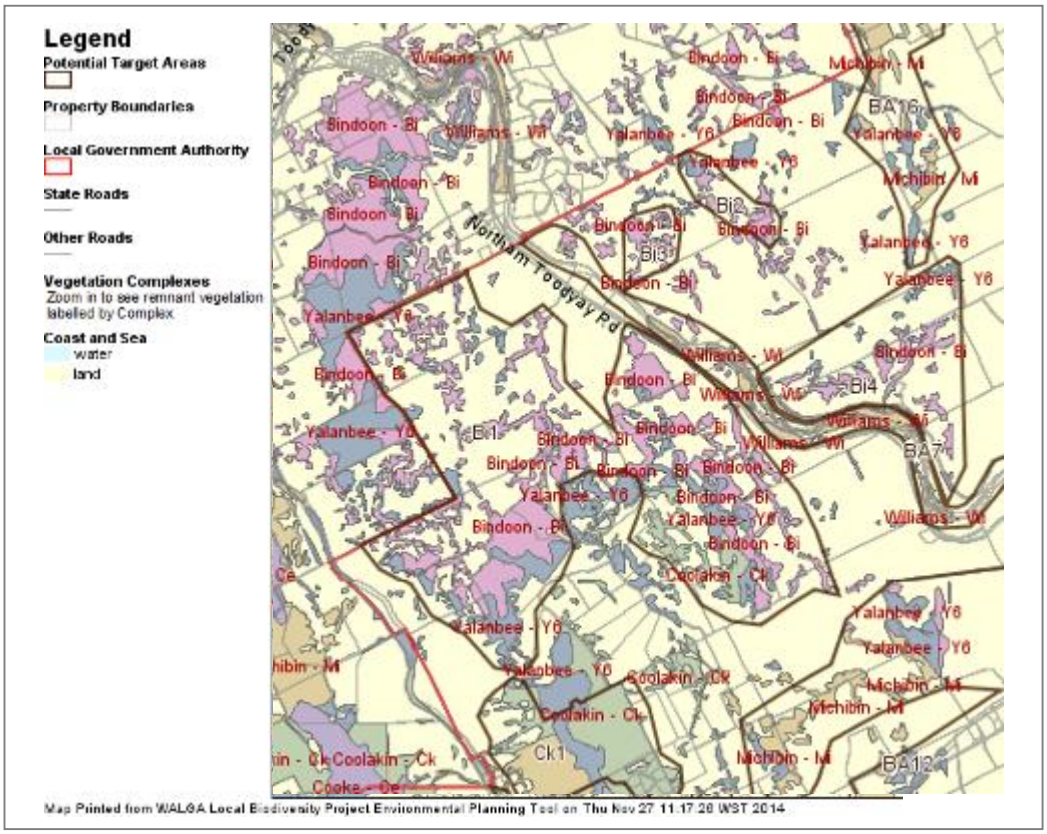

Figure 13: 2013 extent of Bindoon vegetation complex in the Shire of Northam. Potential Target Areas Bi1-Bi4. For more information see Appendix H.

It is important to note that Target Area boundaries are designed to be indicative only and include already cleared areas or even portions of areas where development has been approved. Target Areas are not to be interpreted as areas where development is prohibited. They should be used to identify areas where any remaining vegetation and other natural areas are of conservation significance and their retention and protection should be a priority when deciding on future land use planning.

Further, it is critical that ALL native vegetation in the Shire has conservation value: natural areas not included in a Target Area should NOT be deemed as not having conservation value. Target Ares highlight those areas where analysis, based on current knowledge, shows that conservation efforts should be directed. Considering the extent of clearing, the primary objective should be to use every opportunity to retain vegetation and restore habitat within strategic locations (see section 3.2.2).

Further opportunities to increase the protection status of vegetation in the Shire are provided by extending or changing the current vesting purpose of selected existing Crown reserves to include conservation. Some of these selected reserves are within the Target Areas such as R25785 is included in the Target Area Ck4, and many are outside the Target Areas such as R11619. So when identifying areas where opportunities are identified to improve the protection status of vegetation complexes/Beard vegetation association, two mapping layers need to be explored; the Target Areas and the 'Proposed Protection via Change of Reserve Purpose' (see Appendix I).

There are 27 Crown reserves vested in the Shire of Northam and 11 reserves vested in various State agencies, including 4,857 hectares of native vegetation, proposed for increased protection. Of the total amount of vegetation in these selected reserves, 81% is within one reserve managed by the Water Corporation. Only 456 hectares of native vegetation is located within reserves managed by the Shire. Improving the protection of natural areas in the Shire depends on all relevant stakeholders and the support of the Shire. The selection of Crown reserves vested in the Shire was partly based on recommendations in the Shire's Land Rationalisation Strategy (2013). Appendix D comprises a full list of reserves proposed to be formally protected or have their purpose altered to include natural area conservation.

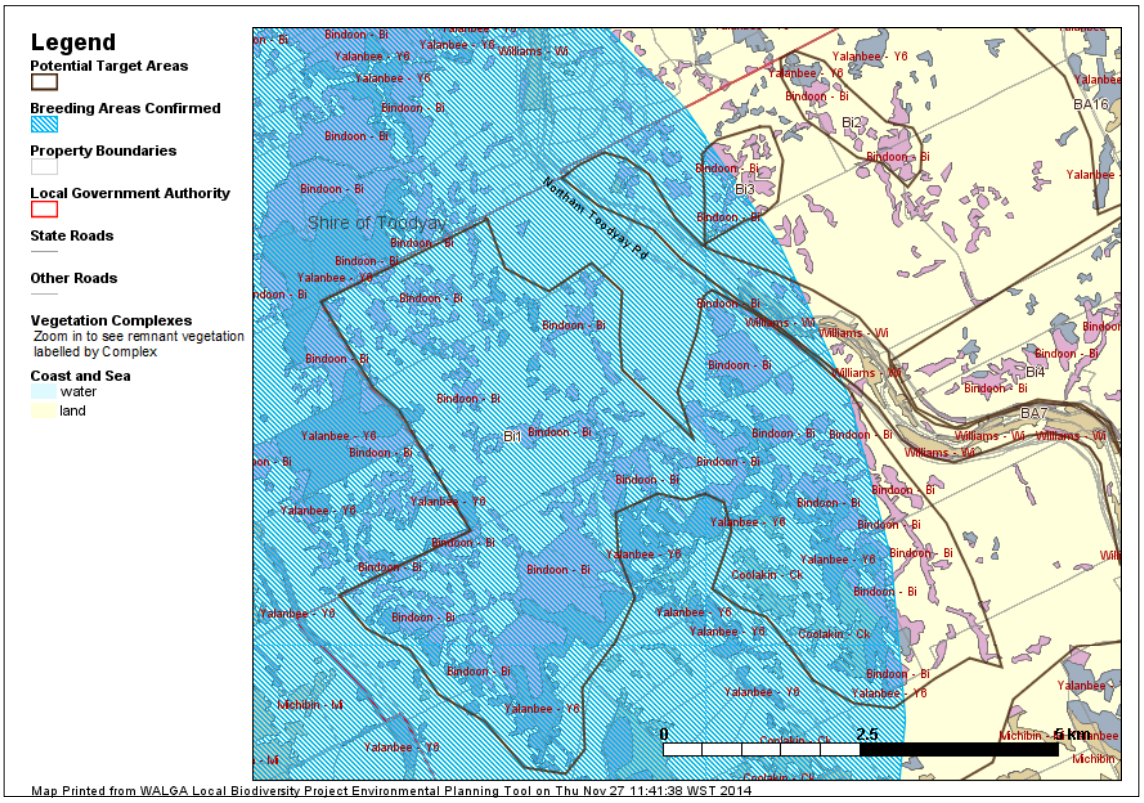

Figure 14: Confirmed breeding area buffer for the Carnaby's black cockatoos over portion of the Shire of Northam over 2013 vegetation extent by vegetation complex mapping.

3.2 Conservation Priorities

Considering the extensive clearing of native vegetation in the Shire, all remaining native vegetation plays an important role in maintaining biodiversity in the Shire. However, based on current knowledge, some areas of remaining vegetation are of higher relative conservation significance due to known records of threatened or priority flora, fauna or ecological communities or because they are associated with special habitats and are important for maintenance of specific ecosystem functions.

The relative conservation significance of each portion of native vegetation is mapped as the number of prioritisation criteria met by any portion of native vegetation (see Appendix F for the list of criteria). The more criteria met, the greater the relative significance. However, it is important to consider whether any of the criteria met, even in portions to which only a few criteria apply, include biodiversity values protected by the State or the Federal legislation. Figure 15 demonstrates the importance of understanding which criteria contribute to the relative importance of a patch of vegetation.

The results of the prioritisation mapping should be used in any future land use decisions which may affect native vegetation and other natural areas in the Shire. Native vegetation to which only a few criteria apply still need to be checked for the type of criteria met by the

patch itself as well as nearby areas. Adequate field surveys need to be undertaken to confirm the presence or suitability of habitat for protected species.

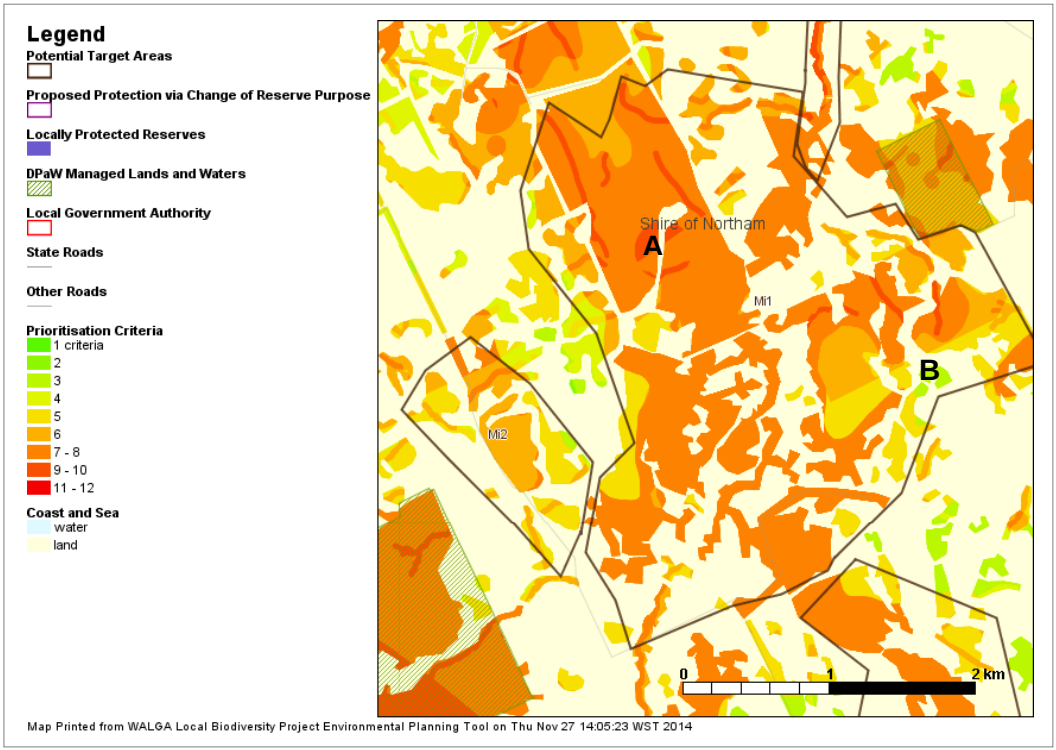

Figure 15: 2014 native vegetation mapping according to the number of prioritisation criteria met. Patch A meets 9 criteria. Patch B meets only 3 criteria but these include potential feeding habitat for Carnaby's black cockatoos. Patch A is of higher priority for protection but the importance of Patch B and its surrounds will need to be assessed under the relevant legislation.

3.2.1 Target Areas and Selected Reserves

Target Areas and selected reserves where inclusion or changes to conservation purposes are proposed should be identified for a specific objective, such as the need to achieve an adequate representation of the diverse vegetation communities in the conservation network in the Shire. By improving the protection status of native vegetation in the Shire, its protection at the regional level will also improve.

To further highlight the importance of the Avon River and the Mortlock River, six additional Target Areas were identified. While native vegetation retention within the buffers of these watercourses will contribute the retention/protection levels of the representative vegetation complexes, protection of riparian vegetation and improvement of the river ecosystem are the main objective for these Target Areas (Figure 16, AV1, AV2, MR1, MR2, MR3, W1).

Each Target Area focuses on a specific vegetation complex or Beard vegetation association. However, other biodiversity values may also be important. Therefore, when assessing which portions of native vegetation within any Target Area should be formally protected, the results

of the natural area prioritisation (Appendix F, Figure 16), connectivity analysis and confirmation of the indicative values in the field should be referred to.

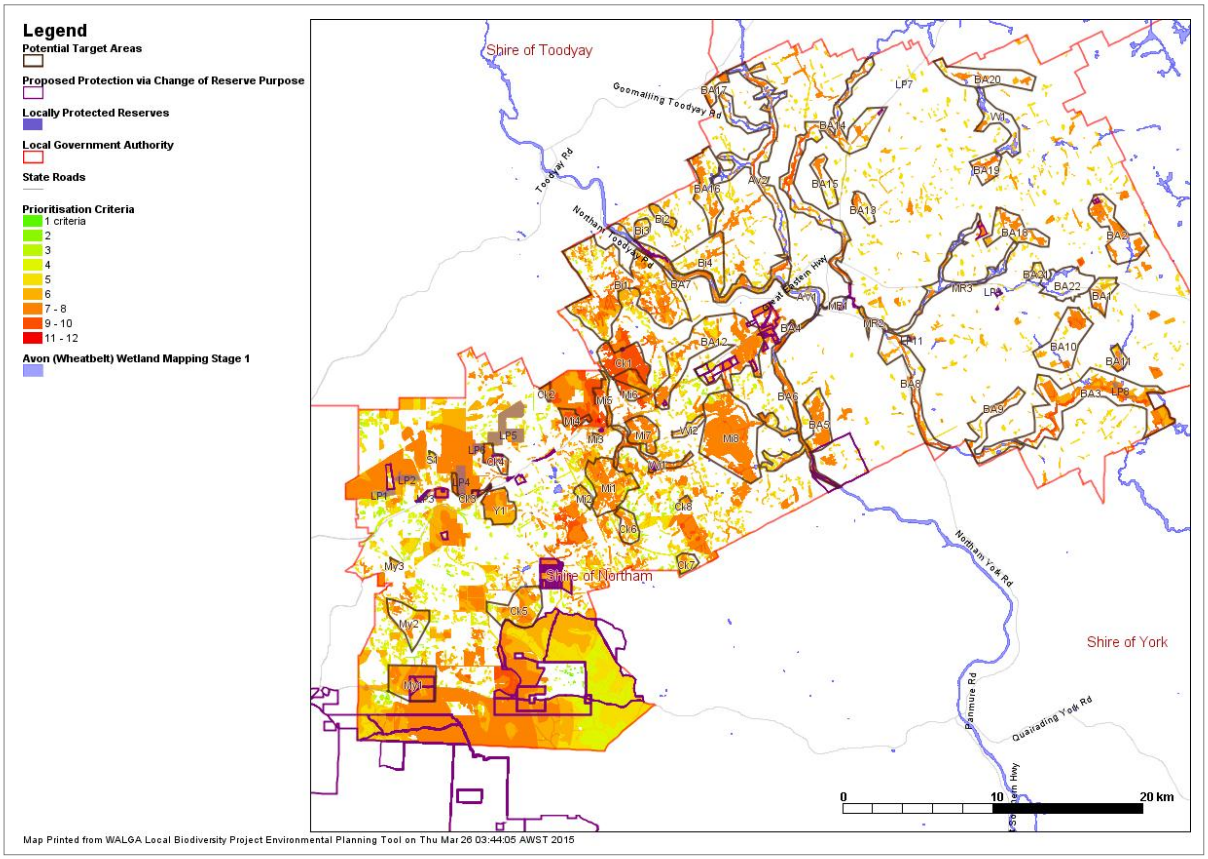

Figure 16: 2013 Native vegetation with the number of prioritisation criteria met, Potential Target Areas and Selected Reserves.

When identifying Target Areas, lands with least limitations to native vegetation retention were sought, referring to the existing land use provisions of the Local Planning Scheme No 6 (2013). However, some vegetation types are limited to lands that have been identified for more intensive development in the Shire's Local Planning Strategy (2013).

Target Areas within lands zoned *Future Rural Living (1-40ha)* in the Local Planning Strategy include: Mi3, Mi5, My3, portion of Ck1 and Ck3.

Target Areas within lands mapped as *Priority Resource and Extraction Area* in the Local Planning Strategy include Mi4, portion of Ck1, Ck2 and Bi1.

While there is more vegetation representative of Michibin – Mi vegetation complex within all Target Areas than the identified target for protection (Table 3 and Appendix H), in all other vegetation complexes within Target Areas identified for potential future development, the amount of vegetation within all Target Areas is smaller than the proposed target.

To achieve the proposed representation targets for native vegetation in the Shire of Northam, additional provisions for vegetation retention and protection are recommended for inclusion in the Shire's Local Planning Strategy and the Scheme (see Table 11).

3.2.2. Connectivity

The connectivity measures provide a visual indication of the role that a remnant patch plays in connecting remnant vegetation across the landscape and how vulnerable each connection is. Results of the spatial modelling covering the Shire and a 12 km buffer can be viewed on the Environmental Planning Tool.

Results of the connectivity modelling were used to select the Target Areas, identifying natural areas that are larger, compact, in close proximity to other natural areas and part of larger networks of natural areas. This was to ensure that areas proposed to be protected will remain viable in the long-term. Due to the highly fragmented character of the landscape, numerous smaller, isolated natural areas were also included in the Target Areas. To improve connectivity of natural areas in the Shire, ecological linkages should be identified.

In the local biodiversity conservation planning context, ecological linkages are defined as a series of continuous and non-continuous patches of native vegetation which, by virtue of their proximity to each other, act as stepping stones of habitat which facilitate the maintenance of ecological processes and the movement of organisms within, and across, a landscape (Molloy *et al* 2009).

While ecological linkages have not been identified for the Shire of Northam as part of this local biodiversity strategy, guidance is provided on how to utilise the results of the connectivity modelling to:

- identify gaps between protected natural areas (greater than 1000 metres)
- identify vegetation patches with high Connectivity Reach values and high Fragmentation values and poor levels of Regional Connectivity.

These areas should be priorities for future restoration works. Further scenario modelling can be undertaken to assess the effectiveness of a proposed network of ecological linkages or test the impact of vegetation loss on connectivity of protected areas in the landscape.

Comparison of remnant vegetation connectivity in the Shire of Northam with that of the adjoining Perth Metropolitan and Peel Regions provides an insight into how to interpret these connectivity measurements. For example, in the Perth and Peel Regions the highest values for Connectivity Reach (see description in the section 3.1.2 of this document) are over 77 within sections of the Jarrah Forest where native vegetation is retained in very large, nearly contiguous patches. In the Shire of Northam the highest value achieved is between 64 and 68 (recorded for the Water Corporation managed reserve R6203), indicating that even the largest patches of vegetation are part of smaller networks than those recorded in other parts of the Jarrah Forest where vegetation forms very large networks (see Figure 17). Yet all protected areas, including those in the eastern sections of the Shire, recorded Connectivity

Reach values above 30 (middle of the value range), indicating that these areas are generally part of an existing relatively large network of protected and unprotected natural areas.

However, Connectivity Reach only measures the size of the network that any native vegetation patch belongs to. It does not describe the quality of the connection *within* that network. Regional Connectivity and Fragmentation measures provide further insight. All three connectivity measures can be used to design an effective network of ecological linkages throughout the Shire and to identify priority areas for restoration. An example is provided in Figures 18 and 19.

The example in Figures 18 and 19 demonstrates the use of connectivity measures to identify priority areas for conservation action, focusing on strengthening or re-establishing connectivity between high conservation value natural areas. Several conservation reserves stretch southwest to northeast, from the western boundary of the Shire to the Wheatbelt portion and are linked to recognised regional ecological linkages in the adjoining Perth Metropolitan Region (Del Marco *et al* 2004). These reserves and other remaining patches of native vegetation are some of the largest retained in the Shire. However, there are significant gaps between some of them, including native vegetation that may be subject to future development applications, and cleared areas with some small patches of vegetation that are 500-1,000m apart, a distance that is greater than recommended for effective connectivity.

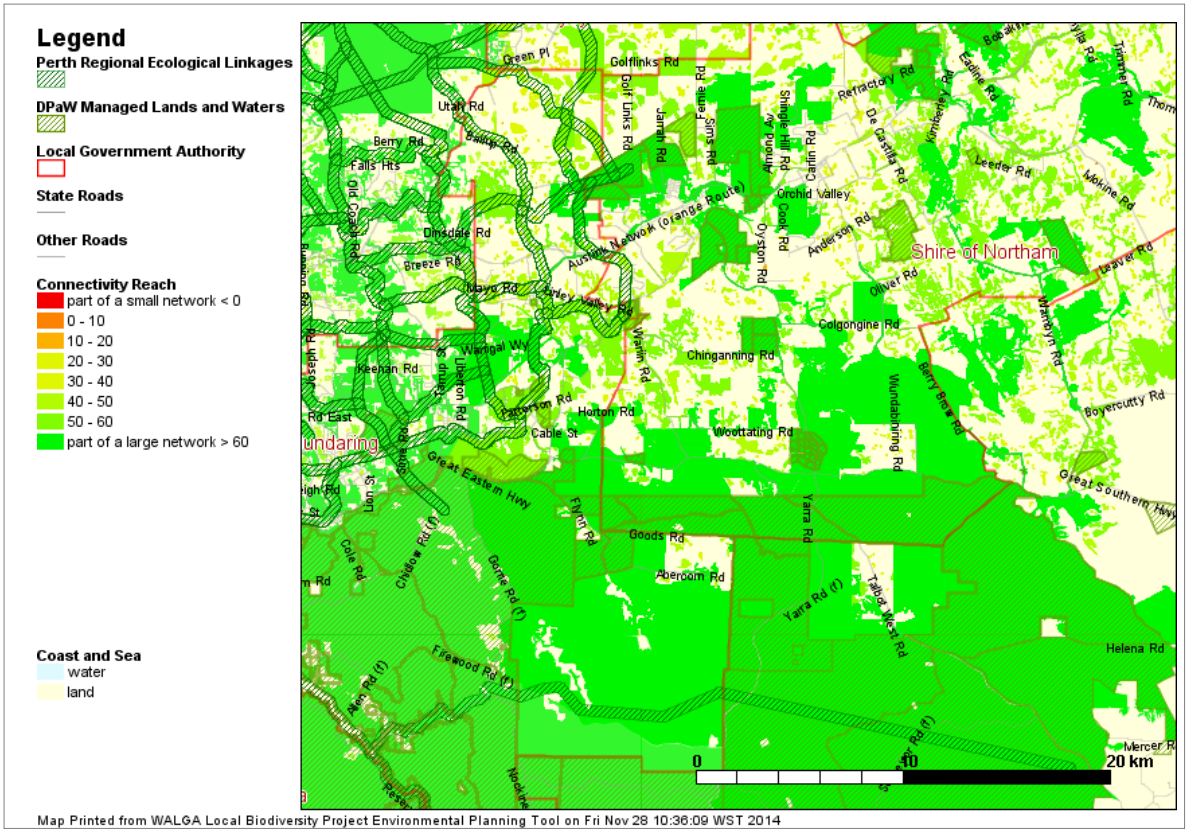

Figure 17: Connectivity Reach in Jarrah Forest portion of the Shire of Northam and adjoining portions of the Perth Metropolitan Region

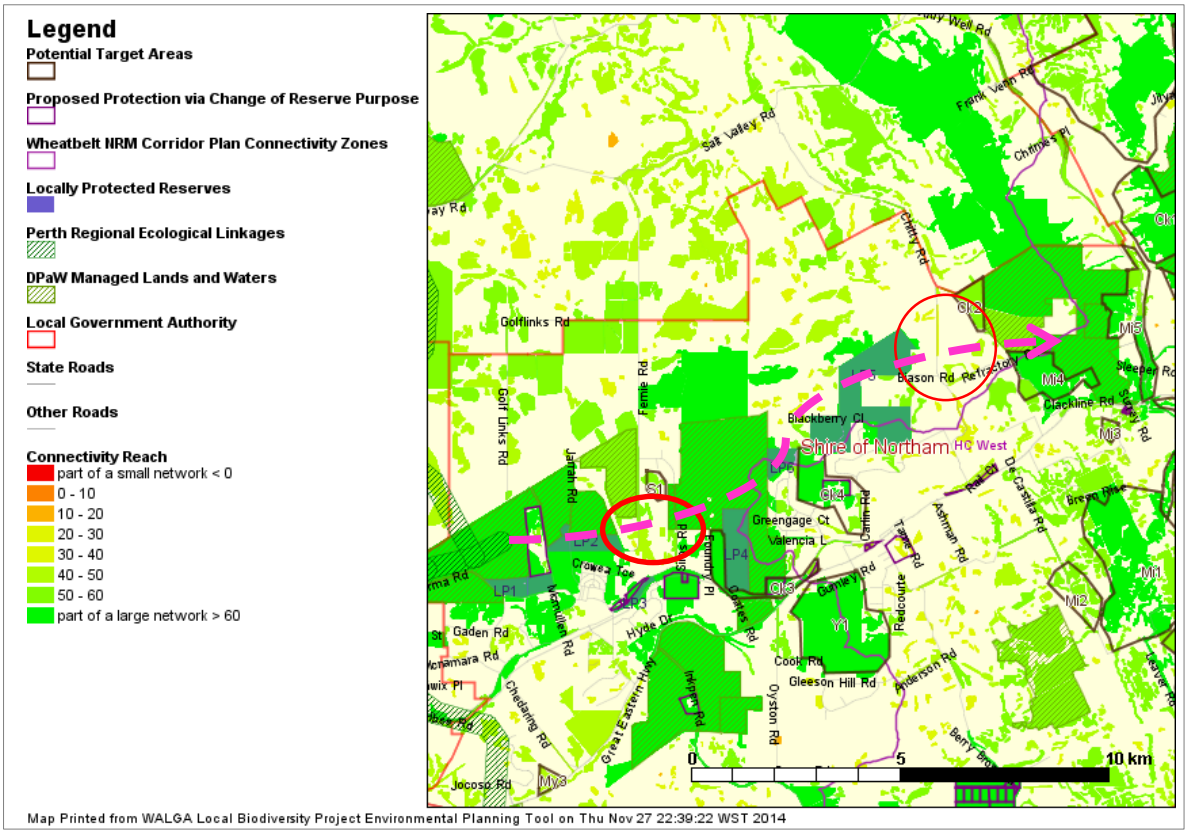

Figure 18: An example of a regional ecological linkage (dashed line) with gaps between stepping stones (red circles) over native vegetation by Connectivity Reach.

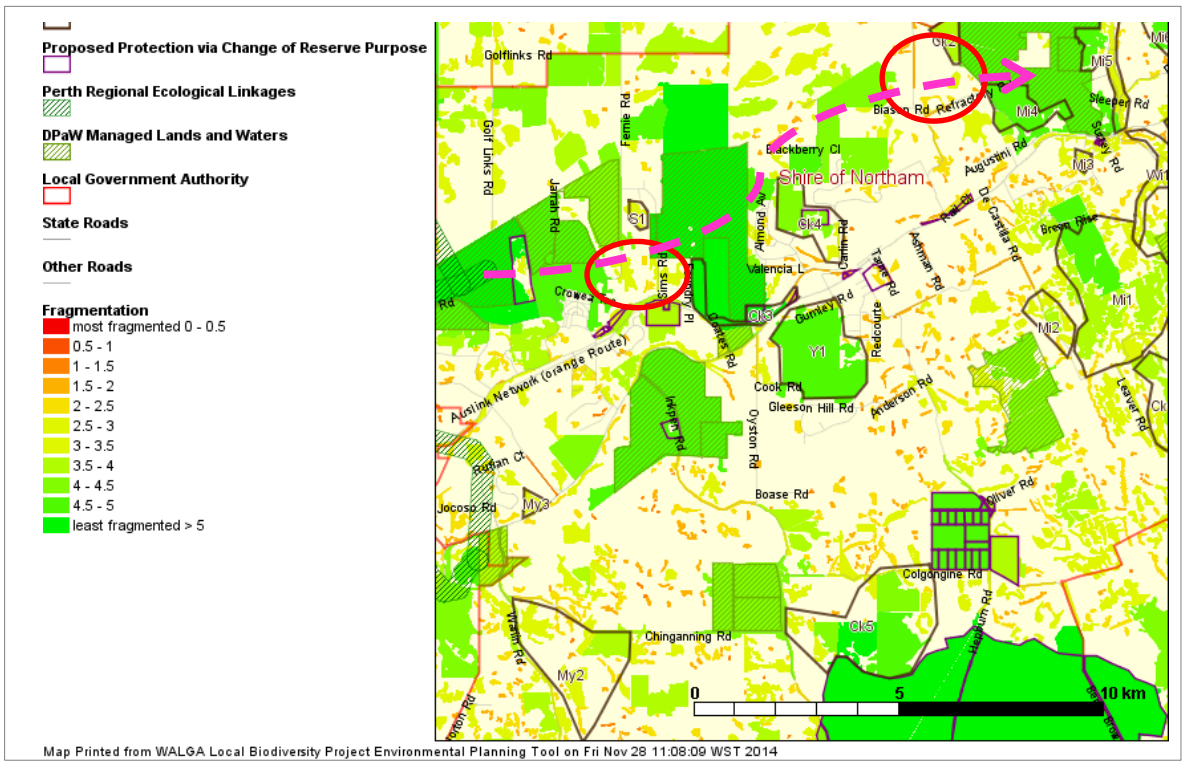

Figure 19: An example of a regional ecological linkage (dashed line) with gaps between stepping stones (red circles) over native vegetation by Fragmentation.

Scenario modelling undertaken in the Perth Metropolitan Region (Perth Biodiversity Project 2013; Local Biodiversity Program 2014) shows that if native vegetation was retained only where it is already protected, then connectivity between these protected areas would be significantly reduced and Fragmentation and Regional Connectivity values (see Appendix G) would be significantly decrease. It is reasonable to conclude that the long term viability of the remaining protected areas would be significantly reduced.

Another example of good opportunities to improve landscape connectivity is provided by the network of waterways in the Wheatbelt portion of the Shire. Widening the buffers and connecting significant vegetation within 1,000-2,000m of the foreshores of watercourses will improve the functioning of the ecological linkages these rivers form and link often isolated reserves and significant natural areas with other areas in the catchment (see Figure 20 and 21). Restoration of vegetation to reduce the edge effect and consolidate remaining patches of vegetation will improve the connectivity quality between the identified conservation priority natural areas.

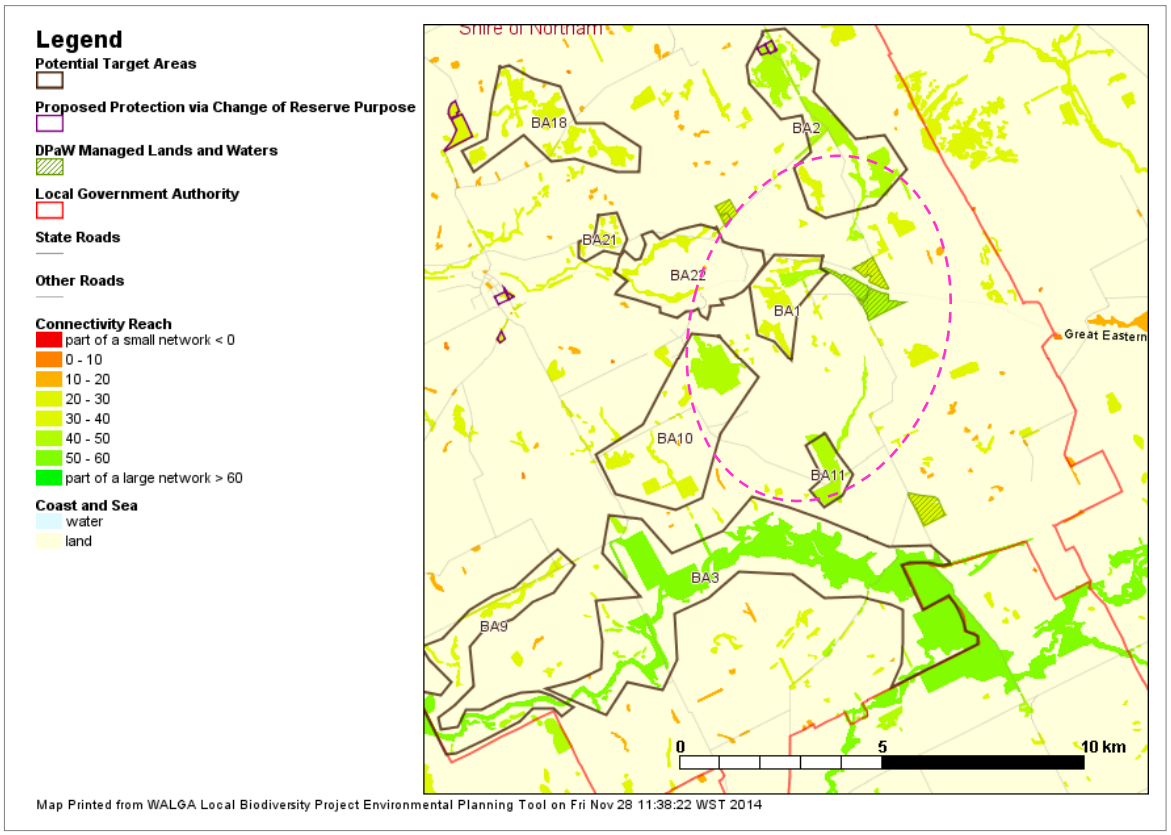

Figure 20: Connectivity Reach values in the eastern parts of the Shire of Northam. Dashed line identifies a priority area where native vegetation restoration would improve connectivity between conservation reserves and other natural areas in the landscape.

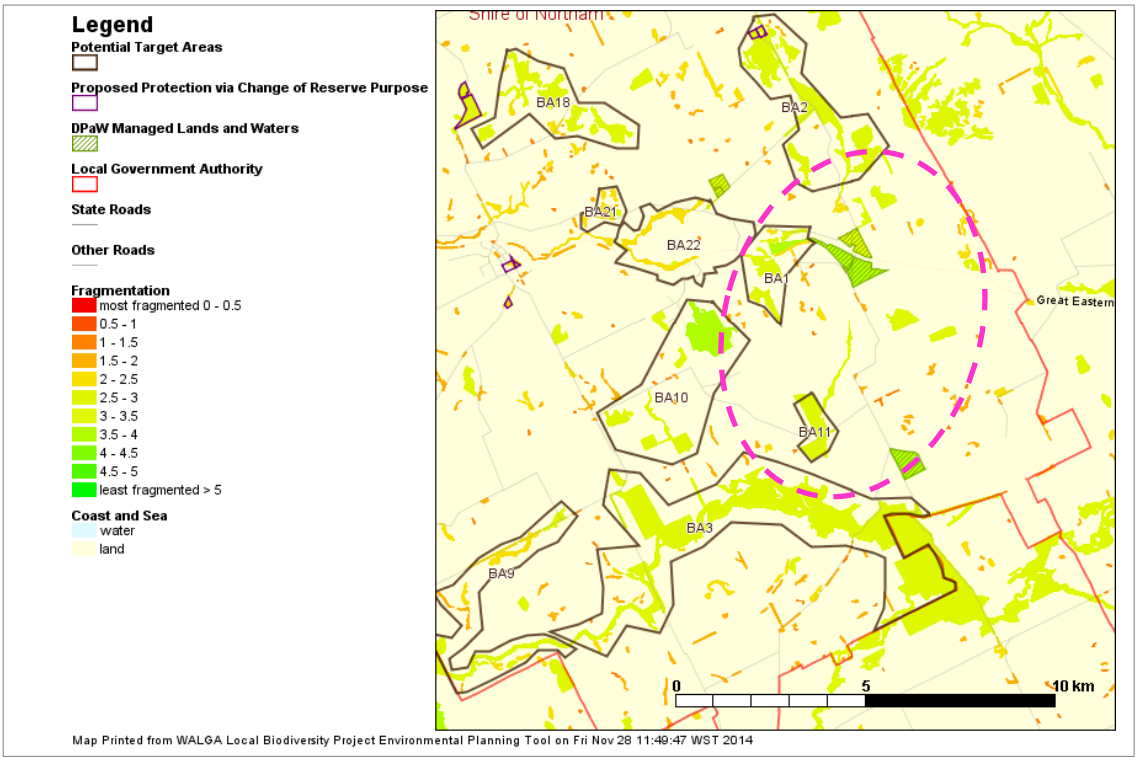

Figure 21: Fragmentation values in the eastern portion of the Shire are significantly lower than in the Jarrah Forest (see Figure 19).

When identifying areas to be retained and managed as parts of a regional or local ecological linkage the following guiding principles are recommended (del Marco *et al* 2004, Davis and Brooker 2008, Molloy *et al* 2009):

Guiding Principles for Establishing Ecological Linkages

Aim for a heterogeneous matrix of habitats rather than a homogenous one. Utilise an existing nati vegetation matrix and complex landscapes with minimal disturbance.

The widest possible diversity of habitat types should be sought within a linkage with similar habita preferably less than 500m -1000m apart.

Where continuous stands of native vegetation are not available, ecological linkages should be ma of remnants that form stepping stones between larger intact patches.

Provision of large regional linkages to localised corridors is preferable in supporting a wide range communities and species, supporting their movement over a number of generations.

Regional corridors should be 500m wide where possible and a minimum of 300m wide.

The number of linkages connecting to any given patch should be maximized as this improves ove connectivity and long-term viability.

Ecological linkages should be selected along directions that facilitate normal species migration an species and assemblages adapt to climate change. For example, linkages may be North-South, E West, to high points in the landscape and along watercourses. Patches at high points in the lands where they are visible from other patches, are important for species dispersal and home range utilisation.

Re-vegetation is a viable strategy for establishing or strengthening corridors in cleared landscape priority given to opportunities to expand existing remnant vegetation. Aim to form continuous vege linkages or corridors at least 100m wide. If this is not possible, ensure stepping stones of reconstr or created habitat are at least 2ha to 4ha in size and no more than 500m to 1000m apart.

Avoid or mitigate impacts of gaps in linkages caused by roads and other barriers to fauna mobility

Open canopies over highly disturbed understorey may be of little value, except for highly mobile s

Although the current degree of connectivity for many large conservation reserves in the Shire of Northam is encouraging, the maintenance and improvement of connectivity within gaps should be a priority. However, efforts to improve the connectivity of significant habitats in the Shire will only be effective if a similar effort is made outside the Shire boundary. This can be achieved via partnerships with regional organisations that have the capacity to deliver natural resource management projects across several administrative boundaries.

In the Wheatbelt portion of the Shire, vegetation along waterways provides good opportunities

4 Implementation

To achieve the Local Biodiversity Strategy vision and objectives, several types of implementation mechanisms will be initiated. Figure 22 shows which implementation tools will be utilised to meet the Shire's local biodiversity objectives. In addition, a clear community and stakeholder engagement strategy is needed, to ensure active participation. Establishment of an Environmental Officer or Natural Resource Management Officer position within the Shire would ensure coordination of activities and timely implementation of the proposed action.

The Shire should consider the establishment of a Natural Resource Management Reference Group to inform and support the implementation of the Shire's Local Biodiversity Strategy. The reference group could include representatives from the following agencies and community groups with expertise in natural resource management including Department of Parks and Wildlife, Department of Water, Greening Australia, Avon Valley Environmental Society Inc, Wheatbelt NRM, and Conservation of Avon River Environment (CARE).

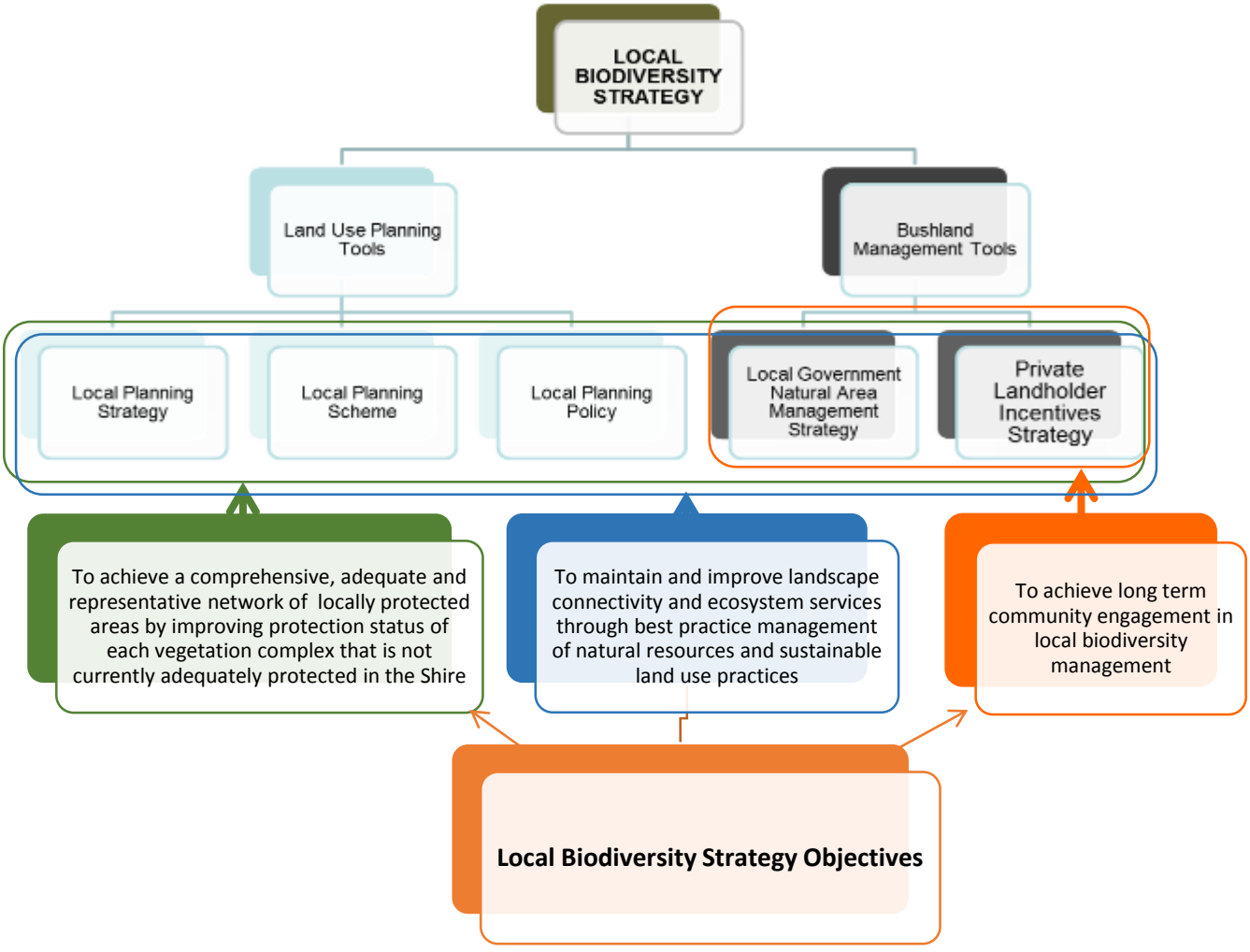

Figure 22: Link of Local Biodiversity Strategy Objectives to Implementation Tools.

4.1 Integration of biodiversity into the local planning framework

Integration of local biodiversity conservation objectives into the local planning framework is the key to ensuring that the approach to considering biodiversity in decision-making is transparent and consistent, ensuring long-term achievement of objectives.. There are numerous examples in Western Australia where Local Governments are improving the biodiversity provisions of their planning frameworks. Best practice examples recorded to date were published by the Local Biodiversity Program in 2012 (http://pbp.walga.asn.au/Publications/IntegrationofBiodiversityintoLocalLandUse.aspx).

The Shire of Northam's Local Planning Strategy (2013) and Local Planning Scheme No 6 (2014) already include numerous provisions for biodiversity. To achieve the local biodiversity objectives outlined in this Strategy, further planning considerations are recommended:

- Local Conservation Reserves - Extend the area classified as 'Conservation of Flora and Fauna by including significant local government reserves, by amending the scheme and changing the classification of current reserves.
- Rural Conservation zoning – consider the introduction of a new zone to formalise protection of natural vegetation on private rural land when rural subdivision is being considered.
- Extension of the Special Control Area for Avon, Mortlock River and Spencers Brook to other significant watercourses.
- Adoption of Local Planning Policy/Policies – provide guidance.
- Consider an amendment to conservation designation on Local Planning Strategy maps and inclusion of adopted Target Areas (see section 3.2).

Local planning strategy

- Consider amending the 'Conservation' designations on Local Planning Strategy maps, including Target Areas and local conservation reserves, after biodiversity values have been confirmed by field surveys (see proposed list of reserves in Table 5, Appendix D).
- Incorporate into the Local Planning Strategy the proposed protection targets for native vegetation (as outlined in Table 3 of this document)

Local planning scheme

- Local Conservation Reserves
  - Classify additional reserves as Reserves for Conservation of Flora and Fauna, subject to confirmation of values in the field, by amending the relevant scheme maps and seeking to change reserve purposes (see list in Appendix D, Table 5);

  - Request that those agencies responsible for managing 11 high conservation value reserves (see Appendix D, Table 5) undertake to have the current reserve purposes altered under the Land Administration Act 1997 to include conservation.

- Rural Conservation zone – introduce a new zone to formalise protection of natural vegetation on private land. Registering properties with a covenanting agency will provide additional protection and increased opportunities for landholders to access external support for their management activities. (See Table 8).

Local planning policy

  - To establish the Local Biodiversity Strategy as a valid planning consideration as a document forming clear conservation objective and facilitating the aim of the Local Planning Scheme to 'protect, conserve and enhance the environmental values and natural resources of the Scheme area including the protection of remnant vegetation and the rehabilitation and revegetation of degraded land'. Definition of the minimal standards for surveys to confirm biodiversity assets, conditions and establish effective management.
  - Provide guidance for Rural, Rural Residential & Rural Smallholding and if introduced the new Rural Conservation zones regarding local priority biodiversity assets to be retained and restored within the Scheme provisions.
  - Provide guidance for Avon-Mortlock, Landscape Protection & Spencers Brook Special Control Areas regarding ways of preserving the ecological values of special landscapes, the rivers and their riparian zones and building their resilience. The Avon River Recovery Plan (Water and Rivers Commission, 1999), the Mortlock Rovers and Spencer's Brook foreshore assessment reports (Water and Rivers Commission, 2002 and 2003) include specific recommendation
  - Provide guidance for the establishment of ecological linkages.

It is recommended that guidance is provided to landowners and planners on how Local Natural Areas need to be considered in each of the zones and land use categories. These recommendations are summarised in Table 11 and should be included as provisions in the Shire's Local Planning Strategy and Local Planning Scheme update.

Table 11: Summary of recommended strategies/provisions for biodiversity conservation in the Shire's Local Planning Strategy and Scheme.

Land use category	Guidance/provisions
Residential	Retain natural areas in good or better condition in Public Open Space (POS) while maintaining an adequate active recreation function. Natural areas of high conservation values should be transferred into a reserve with conservation and passive recreation purpose.

Land use category	Guidance/provisions
	All streetscaping should use local species (Link to the development of a Landscaping Policy). Encourage use of local specie in private gardens, in particular the front yards. (link to the potential local plants subsidy scheme)
	For natural areas already retained in POS, are listed in this document in Table 5, Appendix D and indicative conservation values are confirmed via field assessment, change the vesting for conservation (under the *Land Administration Act 1987*) and classify as 'Conservation of flora and fauna' in the LPS No 6.
Rural Residential (1-4ha)	On zoned land not yet developed, require redesign of structure/subdivision plans where significantly improved retention/protection of native vegetation could be achieved.
	Limit fencing within native vegetation
Rural Smallholdings (4-40ha)	Where considering further subdivision of lands zoned Rural Smallholdings (as identified in the Local Planning Strategy), avoid lands covered in native vegetation, in particular those within Target Areas. Where feasible, subdivide portions of cleared lands and classify portions on lots larger than 20ha as Rural conservation or similar.
	Where rural residential subdivision is being proposed to replace Rural Smallholdings, require subdivision design that will maximise protection of native vegetation, with vegetation located in large parcels. Consider requiring cluster forms of subdivisions where fencing would be limited to the building envelopes to minimise vegetation fragmentation. To reduce need for further fencing, opportunities to align property boundaries with strategic fire breaks should be encouraged.
	Extend the current zone provisions in the Scheme No 6 to require all development to be located outside native vegetation and outside adequate buffers to waterways. Clearing for a single house will only be considered if no other alternative locations are available. Any other clearing shall be limited to clearing required for fencing, vehicular access and bushfire safety purposes.
	Where opportunities become available, reserve large parcels of native vegetation for conservation (purchased as offsets under the Commonwealth and State environmental approval process).
	Consider offering natural area management assistance (private landholder incentives) with emphasis on lands within Target Areas.
Rural	Extend the current zone provisions in the Scheme No 6 to require all development to be located outside native vegetation and outside adequate buffers to waterways. Clearing for a single house will only

Land use category	Guidance/provisions
	be considered if no other alternative locations are available. Any other clearing shall be limited to clearing required for fencing, vehicular access and bushfire safety purposes.
	Where rural type subdivision is being proposed, require subdivision design that will maximise protection of native vegetation, with vegetation located in large parcels. Consider requiring cluster forms of subdivisions where fencing would be limited to the building envelopes to minimise vegetation fragmentation. Fencing of isolated stands of vegetation should be required. To reduce need for further fencing, opportunities to align property boundaries with strategic fire breaks should be encouraged.
	When considering subdividing rural zoned land, examine opportunities to rezone parcels with high conservation value vegetation as Rural Conservation.
	Where opportunities become available, reserve large parcels of native vegetation for conservation (purchased as offsets under the Commonwealth and State environmental approval process).
	Consider offering natural area management assistance (private landholder incentives) with emphasis on lands within Target Areas.
Rural Conservation	**Consider introducing new conservation type zoning into the Local Planning Scheme No 6: it would apply to private lands classified as 'Conservation' in the Local Planning Strategy and will assist in achieving** **Proposed objectives (from the Shire of Chittering Local Planning Scheme No 6):** • *To maximise the long-term protection and management of significant environment values.* • *To minimise the fragmentation of, and where deemed relevant, promote ecological linkages between, these values.* • *To ensure that development is compatible and integrated with these values.* • *To create lot/s that are of sufficient size to sustain the long-term protection and management of these values.* • *Encourage innovative subdivision design, such as consolidated cluster style development, that maximises the long-term protection and management of these values.*
	Consider offering natural area management assistance (private landholder incentives) with emphasis on lands within Target Areas.
Development conditions for lands zoned Rural Conservation, Rural	**The following general clauses should apply to the development and use of land in these rural zones (adapted from the Shire of Chittering Local Planning Scheme No 6):**

Land use category	Guidance/provisions
Smallholdings and Rural Residential	Subdivision shall be generally in accordance with a Structure Plan prepared in accordance with Council policy or any subsequent variation approved by the Council and the Western Australian Planning Commission. An application for subdivision of land in these zones is to be accompanied by a Structure Plan prepared in accordance with Council policy which indicates and addresses the following but is not limited to: (a) lot sizes, dimensions and identification of building envelopes or building exclusion areas; (b) areas to be set aside for public open space, pedestrian access ways, horse trails, community facilities, etc, as may be considered appropriate; (c) strategic firebreaks; (d) any Catchment Management Plan recommendations; (e) any part of the natural environment which is required to be protected from degradation or required for landscape, biodiversity protection and maintenance of connectivity; (f) an assessment of the presence and impacts of Dieback in consultation with Council and the appropriate State government environmental agency and the ability of the subdivision design and works to mitigate against the spread and effect of Dieback; (g) any facilities which the purchasers of the lots will be required to provide (e.g. their own potable water supply, liquid or solid waste disposal, etc.); (h) areas where conventional septic tanks may not be suitable; (i) The description of adjoining land(s) and their uses; (j) Remnant vegetation and any land affected by rare and endangered flora and fauna; (k) Location of watercourses, drainage lines and areas of inundation and the distance of any infrastructure from these. (l) identify the area/s that need to comply with an approved Environmental Management Plan. (m) in the Rural Conservation zoning, provide evidence of an agreement with a covenanting agency that the property meets the criteria and the conservation covenant will be registered on title.
Reserved Land	Include natural areas in Public Open Space identified in the Local Biodiversity Strategy as of high conservation value within a Local Reserve classified ‘Conservation of Flora and Fauna’ in the LPS No 6.
	Retain other natural areas on land vested in or managed by the Shire except where land is required for another purpose and alternative location on cleared land is not practicable.
	Manage natural areas for conservation on all lands classified ‘Conservation’ and vested in the Shire.
	Liaise with relevant government agencies regarding the management of other reserved lands, vested and managed by them for various purposes other than conservation. Pursue possibility of improving the protection levels for natural area within these reserves via change of reserve purpose under the Land Administration Act

Land use category	Guidance/provisions
	1987, classification in the Local Planning Scheme No 6 or by covenanting.
Special Control Area – Avon & Mortlock Rivers ad Spencers Brook	Extend its provisions to Target Areas BA8, MR1, MR2, MR3, BA14, Av2, BA8, BA9.

4.2 Bushland Management Tools

4.2.1 Local Government Natural Area Management Strategy

With over 450 hectares of significant native vegetation within reserves vested in the Shire, it is important to ensure that the biodiversity values of these reserves are maintained. Lack of resources for natural area management can be a major issue. However, maintaining natural areas in good condition is significantly less expensive than maintaining highly landscaped parks. Greater opportunities to access external funding through various State, Federal government or Lotterywest programs are available for managing natural areas, especially when working in partnership with the local community.

In some Local Government areas there are close partnerships between the Local Government and local landcare groups, often including financial assistance to support the group. Landcare groups and a proposed Northam NRM Reference Group could provide expertise in natural resource management and community engagement in reserve management, and access to other funding sources for specific restoration projects in local reserves or on some private land.

The Southern Brook Catchment Landcare group is one local example of a community driven NRM group have successfully attracted significant external resources to implement both on-ground works and planning activities. This group provides a model for how other community groups can achieve local priority NRM outcomes. The Shire's future support of community groups could only strengthen local outcomes and achieve some of the actions identified in this strategy.

The Southern Brook Catchment group has recently completed a catchment plan and supporting maps that will fast-track and strengthen the group's ability to attract resources and evaluate their progress against their goals. The Catchment Plan identifies local actions and builds on past restoration activities within the catchment. This information was not available for the whole Shire at the time of preparation of this document but is critical to site specific planning. The Southern Brook Catchment Plan can be downloaded via the following link: http://www.wowcinema.com.au/files/Catchment%20Report.pdf.

To assist with prioritising investment, it is recommended that a Strategic Plan for Reserve Management is developed by the Shire, following the WALGA's Guidelines for Bushland Management (PBP and SWBP 2009). Although the Guidelines document focusses on Perth and parts of the south west of Western Australia, the proposed procedures for prioritisation are applicable to other regions. One of the key steps is recording the ecological values and threats to these values for each reserve using the Natural Area Initial Assessment Templates (Del Marco *et al* 2004) which were adapted to the Wheatbelt Region (Julia Murphy, Greening Australia WA, personal comment).

To minimise the spread of weeds and diseases between natural areas, it is critical that all Shire operational and engineering staff as well as contractors providing maintenance works along roads, recreational reserves and other public lands, undertaking post-fire clean-up or any other work that involve soil movement or disturbance, are aware and apply best practice procedures to prevent the spread of dieback, weeds and damage to native vegetation or fauna habitat. Requirements for maintenance of adequate hygiene practices during any operations involving movement of soil, plant material or use of machinery in conservation reserves should be clearly stipulated in contracts for future works within the Shire.

4.2.2 Private Landholder Incentives Strategy

With 54% (over 18,500 hectares) of the Shire's native vegetation retained on private land, private landholder support for retaining vegetation and maintaining biodiversity values is critical to conserving biodiversity in the Shire and in the region.

The State Government and not-for-profit organisations such as Greening Australia (16 years based in the Northam Shire) have programs and significant experience with devolved grants and the active engagement and support of private landholders in natural resource management. Some programs are already active in the Shire, such as the DPaW's *Land for Wildlife* program with 28 properties registered in the Shire and Greening Australia's landscape scale Living Mortlock project that facilitates the management of remnant vegetation (terrestrial & riparian), revegetation of very significant areas of predominately private land. . Further information on conditions and incentives of covenanting programs available in Western Australia is available via the following link http://www.dpaw.wa.gov.au/management/off-reserve-conservation/nature-conservation-covenant-program .

The issue of landowner support will need to be addressed where vegetation retention and its management is stipulated as a land development condition. Although vegetation can be relatively easily retained on private land through scheme provisions, the long-term biodiversity values of that vegetation can deteriorate unless it is adequately managed.

It is recommended that before developing a private landholders incentive strategy, the Shire facilitates wider discussion with its community, the proposed Natural Resource Management Reference Group and incentives providers to identify the most effective and acceptable incentives to the local community.

Past experience shows that incentives should be tailored to local community needs. The types of support to consider include:

- Technical advice on best practice on-ground management considering site specific plant communities and threats, including fire risk management with minimal impact on vegetation (provided for example by the City of Greater Geraldton, Shire of Chittering through the Chittering Landcare Centre, City of Busselton, Shires of Mundaring, Serpentine-Jarrahdale);
- Assistance and support with grant applications for external funding to support rehabilitation or restoration projects;
- Advice on availability of conservation covenanting programs;
- Rate rebates on lands under conservation covenants (used in the Shire of Serpentine-Jarrahdale and the Shire of Busselton)
- Annual small grants (up to $10,000-$20,000 allocated annually) to private landholders (used for example in the Cities of Mandurah, Armadale and Cockburn) towards weed control, fencing or habitat restoration.
- Provision of subsidised local plants with site specific advice on appropriate species selection.

4.3 Communication

To effectively engage the local community and other land managers in the Shire, it is important to maintain consistent communication on the Shire's objectives for biodiversity conservation. This should be facilitated by:

- Including all Local Biodiversity Conservation mapping on the Shire's information system available to all internal services, including planning, engineering and infrastructure maintenance.
- Preparing a landscaping plan for residential areas and streetscapes, using local species. Proposed revegetation and plantings including major works and documents such as the Bernard Park Landscape Master Plan should detail the proposed species used in these planting. The proposed Northam NRM Reference Group should be consulted to ensure that appropriate local species (and provenance seed) is used in Shire plantings.
- The Shire encourage the use of local species in private gardens and produce a booklet that identifies local species suitable for landscaping purposes Some examples of local species lists for landscaping purposes can be found at Perth NRM (http://www.perthregionnrm.com/media/69113/PerthNRM-coastal-gardens-A5_LR.pdf) and Chittering Landcare Centre http://chitteringlandcare.org.au/reports-publications/native-species-planting-lists/

- Informing State agencies such as the Department of Planning, Department of Water, Department of Parks and Wildlife about the outcomes of the Local Biodiversity Strategy.

- Referring to the findings of the Local Biodiversity Strategy when providing comments on initiatives by State Agencies.
- Referring to the findings of the Local Biodiversity Strategy when providing comments on subdivision and scheme amendment proposals.
- Facilitating discussions with peak natural resource management groups such as Wheatbelt NRM or Greening Australia, local landcare groups or other not-for-profit organisations active in the Shire to develop potential partnerships that will support on-ground management on public and private lands.
- Facilitating discussions with local Aboriginal leaders to investigate opportunities for their involvement in promoting the cultural values of natural areas in the Shire.
- Reporting to the local community at least every two years on progress with implementation.

4.4 Local Government Capacity Building

Implementation of a Local Biodiversity Strategy is best delivered where a local government employs adequately qualified staff with expertise in natural resource management that can coordinate activities across local government services and facilitate partnerships with relevant stakeholders, including the local community.

Where limited Local Government resources do not allow for an employment of staff with specialist expertise, forming a close relationship with an active and skilled landcare group can provide and alternative. An example of such arrangement is the agreement between the Shire of Chittering and the Chittering Landcare Centre. However, these are most effective in areas with a history of working together.

Considering the expected growing population in the Shire of Northam due to its proximity to Perth and the growing interest in high quality rural living, it is recommended that the Shire considers employing an Environmental Officer that will be responsible for the implementation of the Local Biodiversity Strategy and other initiatives such as the recovery and management of the Avon River and its pools, community engagement in reserve management and sourcing external funding for reserve management.

The effectiveness of the Environmental Officer role will increase with the establishment of a Natural Resource Management Reference Group (under the provisions of the *Local Government Act 1995*), consisting of relevant stakeholders and community representatives with relevant expertise in natural resource management.

5 Action Plan

Priority: High – complete by 2016-2017
Medium – complete by 2018-2021

Action	Priority	Responsibility	Key Performance Indicator
Integration into the land use planning framework			
Confirm the conservation values of the selected Land Administration Act 1997 reserves proposed for change of purpose, or change of classification of reserve to Conservation of Flora and Fauna in the planning scheme (Appendix D, Table 5).	High (2015-2016)	Shire to engage adequately qualified consultant/Environmental Officer	All reserves assessed using the NAIA[17] templates and report on recommendations for reserve purpose change made.
Scheme Amendment to change the classification of selected high conservation reserves to Conservation of Flora and Fauna (vested in the Shire)	High	Development Services	All selected reserves with confirmed high conservation values classified for Conservation of Flora and Fauna in the LPS No 6
Scheme Amendment to change the classification of selected high conservation reserves (vested in State agencies)	Medium	Development Services	90% of selected reserves reserved for Conservation of Flora and Fauna
Introduction of a new Rural Conservation zone, or amend Rural, Rural Residential and Rural Smallholding zone provisions	High	Development Services	New zone provisions adopted by the Council and the WAPC
Amend Conservation designations on Local Planning Strategy maps to include adopted Target Areas and local conservation reserves	Medium	Development Services	Local Planning Strategy Amendment adopted by the Council and the WAPC
Develop a number of Local Planning Policy/Policies (see section 4.1)	High	Development Services	Local Planning Policy adopted by the Council
Local Government Natural Area Management			
Develop a strategic 5 year management plan for all conservation reserves using the information collected via NAIA Templates	High	Shire to engage adequately qualified consultant/Environmental Officer	Strategic Management Plan adopted by the Council

[17] NAIA Templates – Natural Area Initial Assessment Templates (Del Marco et al 2004).

Action	Priority	Responsibility	Key Performance Indicator
Develop and implement best-practice procedures for all Shire staff and contractors working and accessing natural areas and managing infrastructure assets	Medium-High	Environmental Officer/Engineering Services/Community Infrastructure/Development Services	Best practice procedures part of induction of new staff, part of contractual agreements for all works potentially within or near protected natural areas
Investigate the feasibility of forming a *Biosecurity Group* in partnership with adjoining Local Governments	Medium	Environmental Officer/Corporate Services	Report to the Council prepared on the outcomes of the investigation.
Implement the strategic reserve management plan	Medium	Environmental Officer/Community Infrastructure	At least 80% of conservation reserves being actively managed by 2020
Increase riparian vegetation cover and condition on lands managed by the Shire (focusing on upper reaches and northern shores of priority waterways)	Medium	Environmental Officer/Community Infrastructure	By 2020, at least 10% increase in riparian vegetation cover achieved along waterways on lands managed by the Shire.
Private landholder support			
Facilitate private landholder consultation to identify the most desirable incentives for biodiversity conservation on private land	High	Environmental Officer/Community Services	At least 30% of private landholders actively engaged in the survey
Prepare and implement a private landholder incentives strategy to support biodiversity conservation on private lands.	Medium	Shire to engage adequately qualified consultant/Environmental Officer	Private landholders incentive strategy adopted by the council
Facilitate riparian vegetation restoration on private lands		Development Services/ Environmental Officer through new partnerships formed	By 2020, at least 5% increase in riparian vegetation cover along waterways in private ownership.
Communication			
Integrate all Local Biodiversity Strategy mapping into the Shire's information system	High (2014-2015)	Development Services	Mapping accessible to all Shire services
Develop and promote sustainable landscaping strategy for residential areas and streetscaping	Medium	Shire to engage adequately qualified consultant/Development Services/Engineering	All new subdivisions and streetscape upgrades in

Action	Priority	Responsibility	Key Performance Indicator
		Services/Community Infrastructure	accordance with the landscaping strategy
Facilitate discussions with local Aboriginal leaders to investigate opportunities for their involvement in promoting the cultural values of natural areas in the Shire	High	Community Services/Environmental Officer	Shire officer to attend at least 2 meetings per annum of local elders group
Facilitate discussions with the Wheatbelt NRM, adjoining Local Governments, DPaW and other relevant stakeholders on identification of regional ecological linkages.	Medium	Environmental Officer/Development Services	Priority local ecological linkages identified.
Develop a monitoring and reporting schedule	High	Environmental Officer/Development Services/Corporate Services	Bi-annual report on progress with implementation of the Local Biodiversity Strategy and on the status of biodiversity in the Shire presented to the Council and the community
Undertake a review of the feasibility and effectiveness of the proposed implementation actions every 5-7 years.	Medium	Environmental Officer/Development Services	Results of the review with recommendations on further actions presented to the Council
Local Government capacity building			
Contract or employ Environmental Officer services to include natural area management, submission of grant applications to obtain external funding for reserve management and facilitate partnerships with other relevant stakeholders and the community in reserve management, restoration and support to private landholders.	High	Corporate Services	In 2015-16 budget, provision for Environmental Officer services is approved and provided
Form partnerships with not-for-profit groups active in the Shire to facilitate reserve management and private	High	Environmental Officer/Community Infrastructure	At least one working partnership formed

Action	Priority	Responsibility	Key Performance Indicator
landholder support for biodiversity management			
Establish a Natural Resource Management (NRM) Reference Group to facilitate partnerships in implementing the Local Biodiversity Strategy objectives and other NRM priorities (e.g. Avon River and other priority waterways recovery)	High	Corporate Services/Environmental Officer	NRM Reference Group meeting on regular basis

The period report should report on the progress against the Key Performance Indicators and the timelines presented in the above table but also report on the following:

- Level of improvement in protection levels for all under represented vegetation complexes (% protected)
- Retention status for native vegetation.
- % of conservation reserves actively managed (change in condition when feasible)
- Hectares of natural areas re-vegetated (within reserves and on private land, including information on plant survival success rate)
- Water quality in the Avon and Mortlock Rivers
- Status of fencing along priority waterways
- Status of improved connectivity within identified linkages, including vegetation within road reserves identifies as high conservation value
- Fauna status (observations).

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GLOSSARY

Adequate refers to how much of each ecosystem should be sampled to provide ecological viability and integrity of populations, species and ecological communities at a bioregional scale. The concept of adequacy incorporates ecological viability and resilience of ecosystems for individual protected areas and for the protected area system as a whole (National Reserve System Task Group, 2009).

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 fauna (Bush Forever, Vol 1 & 2). 'Bushland' falls into the following condition classes: Pristine, Excellent, Very Good and Good (after Keighery 1994).

Comprehensive refers to the degree to which the full range of regional ecosystems recognisable at an appropriate scale within and across each IBRA bioregion is included within protected areas (National Reserve System Task Group, 2009).

Connectivity refers to the degree of connection between natural areas. Effectiveness will vary according to the type and mobility of different species.

Ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore, no particular scale is specified (Environmental Protection Authority 2003). The criteria in this document are based on using vegetation complexes as a means of interpreting ecological communities (except for threatened ecological communities).

Under the Environment Protection and Biodiversity Conservation Act 1999, ecological communities are similarly defined as assemblage of native species that:

- inhabits a particular natural area
- meets the additional criteria specified in the regulations made for the purposes of this definition.

Ecological linkages are non-contiguous natural areas that connect larger natural areas by forming stepping stones that allow the movement over time of organisms between these larger areas.

Endemic refers to a species having a natural distribution confined to a particular geographical region.

Habitat is the natural environment of an organism or community, including all biotic (living) or abiotic (non-living) elements; a suitable place for an organism or community to live (Environmental Protection Authority 2004). This term can be applied at a range of scales (Environmental Protection Authority 2004). Vegetation can become a reasonable surrogate for outlining habitat when its main components, structure and associated landform are also

described (Environmental Protection Authority 2004). Habitat can be occupied by an organism or community continuously, periodically or occasionally or can have once been occupied and still have the potential for organisms of that kind to be reintroduced (Williams et al 2001).

IBRA Bioregion or subregion as determined by the Interim Biogeographic Regionalisation for Australia (IBRA), is a region defined by a combination of biological, social and geographical criteria rather than geopolitical considerations; generally, a system of related, interconnected ecosystems. Region descriptions seek to describe the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation (Commonwealth of Australia 2010). A subregion is a subdivision of a bioregion which contains distinctive geomorphic units that closely align with land capability and development potential (Commonwealth of Australia 2010).

Local Natural Areas (LNAs) are natural areas that exist outside of Bush Forever Sites (Swan Coastal Plain), the DPaW Managed Lands and Regional Parks.

Native vegetation is indigenous aquatic or terrestrial vegetation. It does not include vegetation that was intentionally sown, planted or propagated unless that vegetation was sown, planted or propagated as required under the Environmental Protection Act 1986 or another written law; or that vegetation is of a class declared by regulation to be included in this definition. Native vegetation does not include dead vegetation unless that dead vegetation is of a class declared by regulation to be included in this definition. Native vegetation does include non-vascular plants (for example, mosses, fungi, algae) and marine plants (seagrass, macro algae [seaweed]). Native vegetation is more than trees and includes understorey and groundcover plants.

Natural area is used to describe an area that contains native species or communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open water bodies (lakes, swamps), or waterways (rivers, streams, creeks – often referred to as channel wetlands, estuaries), springs, rock outcrops, bare ground (generally sand or mud), caves, coastal dunes or cliffs (adapted from Environmental Protection Authority 2003). Note that natural areas exclude parkland cleared areas, isolated trees in cleared settings, ovals and turfed areas.

Regionally significant bushland is a component of remnant vegetation that collectively aims to form a comprehensive, adequate and representative system of conservation areas (Environmental Protection Authority 2003). In order for bushland areas to fall into this category, they need to be part of the existing or proposed conservation system or to meet, in part or whole, a range of criteria which are outlined in Appendix 3 of Environmental Protection Authority (2003).

Representativeness: Comprehensiveness considered at a finer scale (IBRA subregion), and recognizes that regional variability within ecosystems is sampled within the reserve system. One way of achieving this is to aim to represent each regional ecosystem within each IBRA sub-region (National Reserve System Task Group, 2009).

Reserves are lands designated under the *Land Administration Act 1987.* They are areas of Crown land reserved for various public purposes, for example, parks, recreation, drainage or a range of public purposes. The reserve is identified by a number, for example, Reserve No.

12345. Reserves may be vested, leased or Crown Granted in Trust. Crown Reserves have varying levels of protection depending on the purpose of the reserve.

Target Areas are areas that highlight areas where good opportunities exist to improve the protection status of under-represented vegetation complexes in the Shire. Six Target Areas focus on buffers of important waterways. It should be noted that it is not intended that all vegetation mapped within these Target Areas will be formally protected or all lands considered for restoration. Target Area boundaries are designed to be indicative only and include already cleared areas or even portions of areas where development has been approved. Target Areas are not to be interpreted as areas where development is prohibited. They should be used to identify areas where any remaining vegetation and other natural areas are of conservation significance and their retention and protection should be a priority when deciding on future land use planning.

Vegetation complexes (as defined by Heddle, Loneragan & Havel 1980; Mattiske & Havel 1998). Vegetation complexes are based on the pattern of vegetation at a regional scale as they reflect the underlying key determining factors of landforms, soils and climate. In the area covered by the Perth and Peel Regions, there was a reliance on the underlying landform and soils as defined and mapped by Churchward and McArthur (1980) and a major review of the forest climates by Gentilli (1989).

Viability (as in ecological viability) is the likelihood of long-term survival of a particular ecosystem or species.

APPENDIX A: Local Planning Framework Summary

Shire of Northam Local Planning Strategy (2013)

The following strategies and actions have been identified in the Local Planning Strategy to facilitate the achievement of the Strategy's vision and objectives for the environment and natural resources, which are:

- Protect, conserve and enhance the environmental values and natural resources of the Shire for the benefit of current and future generations while providing appropriate development opportunities to promote the local economy.
- Protect privately owned land recognised as Conservation on Strategy maps to provide for possible future inclusion into State Nature Reserves.

Strategies (Section 5.1.4)

- Promote the planning, protection, management and sustainable use of the Shire's natural resources.
- Provide for the rehabilitation and revegetation of degraded land.
- Facilitate the long term protection of areas of local and regional conservation significance in Crown ownership throughout the Shire.
- Support land use change and development that demonstrates positive environmental outcomes or reduces the degree of negative impact on the environment.
- Discourage land use development and/or subdivision on privately owned land recognised as Conservation on the Strategy maps.
- Promote and support community involvement in environmental groups and rehabilitation of the natural environment.
- Facilitate a strategic approach for the long term protection of natural areas.

Actions (Section 5.1.5)

- Give due consideration to land capability and suitability when making decisions about the future use and development of land within the Shire that has potential to have significant negative environmental impacts (ONGOING)
- Identify areas of local and regional conservation significance in Crown ownership throughout the Shire and classify them as 'Conservation' reserve in Local Planning Scheme No. 6 (IMMEDIATELY)
- Support the preparation and implementation of management plans for public and privately owned land identified as being of high conservation value (ONGOING)
- Prepare, adopt and regularly review local planning policies to control development affecting: native remnant vegetation;…wetlands identified as being of international, national or state significance… (SHORT TERM)
- Incorporate provisions in Local Planning Scheme No. 6 that can be applied both generally and specifically to facilitate the protection, management and sustainable use of the Shire's natural resources (IMMEDIATELY)
- Incorporate 'Special Control Area' provisions in Local Planning Scheme No. 6 specific to the Avon or Mortlock River systems and apply the provisions accordingly to ensure that any future development and use of land adjacent to these river systems is appropriately located, preserves their ecological values and landscape qualities and does not adversely affect their capacity to convey floodwaters or give rise to any further land degradation (IMMEDIATELY & ONGOING)
- Consult with the Western Australian Local Government Association (WALGA) and Wheatbelt Natural Resource Management Inc. to determine the feasibility and cost of

preparing a local biodiversity strategy consistent with WALGA's Local Government Biodiversity Planning Guidelines to facilitate the protection and management of natural areas within the Shire (SHORT TERM)

Shire of Northam Local Planning Scheme No. 6 (2013) – an extract of provisions for biodiversity

1.6 Aims of the Scheme
(i) protect, conserve and enhance the environmental values and natural resources of the Scheme area including the protection of remnant vegetation and the rehabilitation and revegetation of degraded land

3.2 Local Reserves
Conservation of Flora and Fauna

4.2.8 Rural Zone
To protect land from land degradation and further loss of biodiversity by:
(i) Minimising the clearing of remnant vegetation and encouraging the protection of existing remnant vegetation;
(ii) Encouraging the development of and the protection of corridors of native vegetation;
(iii) Encouraging the development of environmentally acceptable surface and sub-surface drainage works; and
(iv) Encouraging rehabilitation of salt affected land.

4.2.10 Rural Smallholding Zone
•To provide for the use of land for rural living purposes in a rural setting on lots generally ranging in size from 4 to 40 hectares while preserving the amenity of such areas, ensuring landscape protection and conservation and controlling land use impacts.

5.25 Extractive and mining industries

5.25.1 The development of **extractive and mining industries** that are not covered by the Mining Act 1978 in the Scheme Area will only be supported by the local government under the following circumstances –
(a) where the extraction of minerals or basic raw materials does not unreasonably affect the natural environment or amenity in the locality of the operation during or after excavation;

5.25.2 All applications for planning approval for the establishment of extractive and mining industry operations in the Scheme area are to be accompanied by a management plan and report which –
(a) describes the physical characteristics of the excavation site including significant environmental features;

5.30 Development in the Rural Residential and Rural Smallholding Zones

5.30.1 The provisions applicable to a specific area of **Rural Residential or Rural Smallholding** zoned land in Schedule 11 & 12 shall specify any additional provisions considered appropriate to the particular site to achieve the objectives of the Scheme and the relevant zone. If a provision in Schedule 11 & 12 conflicts with any other provision of the Scheme, the provision in Schedule 11 & 12 shall prevail.

5.30.2 The subdivision of any land within the Scheme area classified Rural Residential or Rural Smallholding zone shall generally be in accordance with a structure plan prepared pursuant to clause 5.31. The subdivision of existing Rural Residential or Rural Smallholdings lots that do not have adopted structure plans will generally not be supported.

5.30.6 The local government or the Western Australian Planning Commission may require the provision of building envelopes or building exclusion areas for any land proposed to be subdivided in the Rural Residential or Rural Smallholdings zone. These shall be –
(c) located to avoid any native vegetation or any area recognised for protection or rehabilitation as shown on the approved structure plan and/or environmental management plan;

5.30.11 No local native trees or shrubs shall be felled or removed from any lot classified Rural Residential or Rural Smallholding zone other than within an approved building envelope except where in the opinion of the local government –
(a) such trees and shrubs are dead, diseased or dangerous;
(b) the establishment or maintenance of a firebreak is required under a regulation or local law;
(c) it is necessary to allow for the construction or maintenance of vehicle access, fences or essential service infrastructure; or
(d) it is necessary to provide for the reduction of any existing or potential fire hazard.

5.30.14 The subdivision of any land within the Scheme area classified Rural Residential or Rural Smallholding zone will be conditional upon the subdivider preparing and implementing an Environmental Management Plan to the satisfaction and approval of the local government. The plan shall include details of –
(b) all vegetation protection areas;
(c) measures for the protection, revegetation and maintenance of landscape buffers along seasonal watercourse and wetlands

5.30.16 All landscape buffer, tree preservation, revegetation and/or stream protection areas shown on an approved structure plan and/or Environmental Management Plan are to be protected from livestock by fencing or other means to the satisfaction of the local government and the requirements thereof are to be detailed within the Environmental Management Plan.

5.31.4 **Structure Plan Form and Content**

A Structure Plan is to contain such detail as, in the opinion of the local government and Western Australian Planning Commission, is required to satisfy the planning requirements for the structure plan area, and should include the following details –
(c) key opportunities and constraints of the structure plan area including landform, topography, hydrology, landscape, vegetation, soils, conservation and heritage values, ownership, land use, roads and services;
(d) conservation and environmental values including bushland, wetlands, streams and water courses, foreshore reserves and setbacks, environmental policy areas and urban water management areas;

6. Special Control Areas

6.2 SCA1 – Avon and Mortlock Rivers Special Control Area

6.2.1 PURPOSE
The purpose of the **Avon & Mortlock Rivers Special Control Area** is to –
(a) Preserve the ecological values of the Avon and Mortlock Rivers as a significant drought refuge for freshwater fishes and water birds;

(b) Avoid development that would negatively impact upon the ecological values and landscape qualities of the area

6.2.5 Conditions of Approval
The local government's approval to any subdivision and/or development on any land within the Avon & Mortlock Rivers Special Control Area may be conditional upon one or more of the following –
(a) Planting and/or retention of vegetation;
(b) Fencing of remnant vegetation;
(c) Control of stock along wetland and foreshore areas;
(d) Prohibition of dwellings and effluent disposal systems within 100 metres of wetland and foreshore areas;
(g) Preparation of conservation management plans; and
(h) Preparation and registration of restrictive covenants and/or deeds of agreement to secure performance of land management agreements.

6.3 SCA2 – Landscape Protection Special Control Area

6.3.1 PURPOSE
THE PURPOSE OF THE **LANDSCAPE PROTECTION SPECIAL CONTROL AREA** IS TO -
(b) Avoid development which would negatively impact upon the ecological values and landscape qualities of the area

6.4 SCA4 – Spencers Brook Special Control Area

6.4.1 PURPOSE
THE PURPOSE OF THE **SPENCERS BROOK SPECIAL CONTROL AREA** IS –
(a) To preserve the ecological values of the river and riparian zone

8.2 Permitted Development
Except as otherwise provided in the Scheme, for the purposes of the Scheme the following development does not require the planning approval of local government –
(b) the erection on a lot of a single house including any extension, ancillary outbuildings and swimming pools, except where –
(vi) the development is within 50 metres of a Major and/or Regional Road reserve where the reserve/s abut land classified Rural zone, Rural Smallholding zone and Rural Residential zone;

SCHEDULE 2 — ADDITIONAL USES

A2.	Lot 102 (967) Northam-Toodyay Road, Katrine on Deposited Plan 55137	Group Farming The purpose of the 'group farming' use is to permit the establishment of more than one residence on the property to facilitate opportunities for rural living in the context of a commitment to the protection and enhancement of the agricultural and environmental status of the land and its rural landscape values.

SCHEDULE 3 — RESTRICTED USES

R2	Part Lot 4396 Great Eastern Highway and Part Lot 31 Oyston Road, Bakers Hill (zoned 'Agriculture-Local)	One Residential Dwelling, Home Occupation, Bed & Breakfast and/or Cottage Industry

3. Clearing
3.1. Clearing shall only be permitted within a building envelope.
3.2. Should a tree within a building envelope be identified by an independent Flora/Fauna Study as significant in respect to providing habitat for native fauna or being an outstanding specimen, the local government may require the tree to be retained notwithstanding Clause 3.1 above.
3.3. Clearing may be permitted, subject to local government approval, for the construction of a driveway for vehicular access to a building envelope. Only one driveway shall be permitted per lot and clearing shall minimise impacts on native flora and fauna.
3.4. Revegetation of areas damaged during the construction of a building or driveway may be required at the local government's discretion.
3.5. Fallen timber shall not be removed or cleared from areas outside the building envelope where it abuts large areas of remnant vegetation or areas that are identified for vegetation protection.

SCHEDULE 11 — RURAL RESIDENTIAL ZONES

RR5.	Various lots in the vicinity of Anderson Road, Gleeson Hill Road & Glenmore Drive, Wundowie as shown on the Scheme Map.	1. All Vegetation Management Areas shown on the approved structure plan shall be re-vegetated by the planting of locally native species and protected from fire and excessive grazing.
RR7.	Various lots in the vicinity of Fernie & Sims Roads, Bakers Hill as shown on the Scheme Map.	1. The minimum permitted lot size shall be 2.0 hectares. 3. All Vegetation Management Areas shown on the approved structure plan shall be re-vegetated by the planting of locally native species and protected from fire and excessive grazing.
RR12.	Loc 21630 (23), Loc 25089 (81), Loc 25088 (91), Loc 21631 (11) and Loc 25087 (99) Foundry Place and Loc 21632	3. Prior to the local government's adoption of any proposed structure plan, a flora and fauna survey shall be undertaken to the specifications and satisfaction of the local government and the Department of Environment and Conservation.

RR25.	(188) Coates Road, Wundowie Loc 3709 (L1) Chitty Road and Lot 340 (127) Augustini Road, Bakers Hill	2. The subdivider shall prepare and implement an Environmental Management Plan to the satisfaction and approval of the local government prior to the subdivision of the land. The plan shall include:- (a) vegetation protection except that necessary to provide for the provision of roads, other infrastructure and building development within building envelopes as approved by the local government; (c) "Watercourse Protection Areas" the extents of which are to be determined after consultation with the relevant government agency, and where the following will apply

APPENDIX B: National Vegetation Information System (NVIS) Information Hierarchy

Hierarchical Level	Description	NVIS structural/floristic components required
I	**Class**	Dominant growth form for the ecologically or structurally dominant stratum
II	**Structural Formation**	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
III	**Broad Floristic Formation**	Dominant growth form, cover, height and dominant land cover genus for the upper most or the ecologically or structurally dominant stratum.
IV	**Sub-Formation**	Dominant growth form, cover, height and dominant genus for each of the three traditional strata. (i.e. Upper, Mid and Ground)
V	**Association**	Dominant growth form, height, cover and species (3 species) for the three traditional strata. (i.e. Upper, Mid and Ground)
VI	**Sub-Association**	Dominant growth form, height, cover and species (5 species) for all layers/sub-strata.

Source: **National Vegetation Information System, Version 6.0**
Executive Steering Committee for Australian Vegetation Information (ESCAVI)
Department of the Environment and Heritage, 2003
ISBN 0 642 54953 2

http://www.environment.gov.au/node/18930

APPENDIX C: Description of vegetation mapped in the Shire of Northam

Key:

	Darling Plateau
	Uplands
	Depressions and Swamps on Uplands
	Valleys
	Valley floors and swamps

Vegetation complexes (Havel & Mattiske 1998)	**Description**
Bindoon - Bi	Woodland of *Eucalyptus loxophleba* on the slopes, flanked by woodlands of *Eucalyptus wandoo - Eucalyptus accedens* on the breakaways and upper slopes in the peri-arid zone.
Cooke - Ce	Mosaic of open forest of *Eucalyptus marginata* subsp. *marginata-Corymbia calophylla* (subhumid zone) and open forest of *Eucalyptus marginata* subsp. *thalassica - Corymbia calophylla* (semi-arid and arid zones) and on deeper soils adjacent to outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on granite rocks and associated soils in all climate zones, with some *Eucalyptus laeliae* (semiarid), and *Allocasuarina huegeliana* and *Eucalyptus wandoo* (mainly semiarid to peri-arid zones).
Coolakin - Ck	Woodland of *Eucalyptus wandoo* with mixtures of *Eucalyptus patens*, *Eucalyptus marginata* subsp*. thalassica* and *Corymbia calophylla* on the valley slopes in arid and peri-arid zones.
Goonaping - G	Mosaic of open forest of *Eucalyptus marginata* subsp*. marginata* (humid zones) and *Eucalyptus marginata* subsp. *thalassica* (semi-arid to peri-arid zones) on the sandy-gravels, low woodland of *Banksia attenuata* on the drier sandier sites (humid to peri-arid zones) with some *Banksia menziesii* (northern arid and peri-arid zones) and low open woodland of *Melaleuca preissiana - Banksia littoralis* on the moister sandy soils (humid to peri-arid zones).
Michibin - Mi	Open woodland of *Eucalyptus wandoo* over *Acacia acuminata* with some *Eucalyptus loxophleba* on valley slopes, with low woodland of *Allocasuarina huegeliana* on or near shallow granite outcrops in arid and peri-arid zones.
Murray 2 - My2	Open forest of *Eucalyptus marginata* subsp. t*halassica - Corymbia calophylla - Eucalyptus patens* and woodland of *Eucalyptus wandoo* with some *Eucalyptus accedens* on valley slopes to woodland of *Eucalyptus*

	rudis - Melaleuca rhaphiophylla on the valley floors in semiarid and arid zones.
Pindalup - Pn	Open forest of *Eucalyptus marginata* subsp. *thalassica - Corymbia calophylla* on slopes and open woodland of *Eucalyptus wandoo* with some *Eucalyptus patens* on the lower slopes in semi-arid and arid zones.
Swamp - S	Mosaic of low open woodland of *Melaleuca preissiana - Banksia littoralis*, closed scrub of Myrtaceae spp., closed heath of Myrtaceae spp. and sedgelands of Baumea and Leptocarpus spp. on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones.
Williams - Wi	Mixture of woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla*, low forest of *Casuarina obesa* and tall shrubland of Melaleuca spp. on major valley systems in arid and peri-arid zones.
Yalanbee - Y5	Mixture of open forest of *Eucalyptus marginata* subsp. *thalassica - Corymbia calophylla* and woodland of *Eucalyptus wandoo* on lateritic uplands in semiarid to peri-arid zones.
Yalanbee - Y6	Woodland of *Eucalyptus wandoo - Eucalyptus accedens*, less consistently open forest of *Eucalyptus marginata* subsp. *thalassica - Corymbia calophylla* on lateritic uplands and breakaway landscapes in arid and peri-arid zones.

Vegetation Association (Beard)	**Description**
4	Medium woodland; marri & wandoo
352	Medium woodland; York gum
511	Medium woodland; salmon gum & morrel
694	Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions
946	Medium woodland; wandoo
1006	Medium woodland; jarrah, wandoo & powderbark
1048	Mosaic: Shrublands; melaleuca patchy scrub / Succulent steppe; samphire
1049	Medium woodland; wandoo, York gum, salmon gum, morrel & gimlet
3003	Medium forest; jarrah & marri on laterite with wandoo in valleys, sandy swamps with teatree and Banksia

APPENDIX D: Retention and protection status of vegetation in the Shire of Northam

Note: There are limitations of the native vegetation extent mapping, such as:

- the preferential mapping of treed landscapes, leading to some mapping of areas that are parkland cleared or completely degraded;
- the inclusion of areas that are approved for through development approvals and/or clearing permits;
- inclusion of re-vegetation sites that do not represent original native ecosystems present prior to clearing.

The statistics on native vegetation retention are therefore considered to be an over-estimate of the native vegetation remaining in the field. For example if the figures show that 40% of the pre-European (or pre-clearing) extent of a vegetation type remains, it would be expected that in fact about 30% of vegetation is present at the time of publication of those statistics. Therefore, when comparing the local or regional vegetation retention and protection status of vegetation against the accepted thresholds of 10%, 30% or 17% of their pre-European extent, the actual figures of 15%, 40% and 20% are used (Del Marco *et al* 2004).

The following statistics were generated by the Local Biodiversity Program using the following datasets:

- 2013 native vegetation extent mapping (Department of Agriculture and Food)
- DPaW managed lands (Department of Parks and Wildlife, 2013)
- Pre-1750 Vegetation Complexes - Complete Coverage captured by Mattiske and Havel for the Regional Forest Agreement (Department of Conservation and Land Management, 2003)
- Pre-European vegetation mapping by Beard, 1980 (Department of Agriculture and Food)
- Local Planning Scheme No 6 (2014) zones and reserves (Department of Planning, 2014)
- Crown reserves (Landgate, 2013)
- IBRA regions and sub-regions (version 7.1) (Australian Government, 2013)
- Local Government boundaries (Landgate, 2013)
- Land for Wildlife property boundaries (Department of Parks and Wildlife, 2014)

Table 1: Native vegetation status in the Shire of Northam (based on Beard vegetation associations mapping)

Source: Government of Western Australia. (2013). *2013 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of June 2013.* WA Department of Parks and Wildlife, Perth. https://www2.landgate.wa.gov.au/web/guest/downloader
Columns B, K, L, M & N added by the Local Biodiversity Program (2014)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Vegetation Association	Pre-European Extent	Proportion (%) of the State-wide pre-European extent in the Shire.	Current Extent	% Remaining	IUCN I - IV in Pre-European Extent^	IUCN I - IV in Current Extent	% Current Extent Protected (IUCN I - IV) for Conservation (proportion of Pre-European Extent)	% Pre-European Extent in IUCN I - IV (proportion of Pre-European Extent)	Current Extent in All DPaW-Managed Land	% Current Extent in All DPaW-Managed Land (proportion of Current Extent)	17% of the pre-European extent of vegetation complexes in the region (ha)	Proportion the Shire of Northam should contribute to the conservation of 17% of pre-European regional extent (ha) L=K*B/100	Area protected in local conservation reserves	Area required to improve protection status of vegetation complexes at regional and local level (ha) N=L-E-M
4	22579	<1	9780	43	2200	2165	10	10	2425	25	175618	1756		0
352	66825	9.20	7541	11	307	291	0	0	291	4	112572	10356	13	10036
511	531	<1	67	13					0	0	16380	163		163
694	7309	2.00	415	6	100	17	0	1	17	4	29593	591		491
946	16	0.03	4	26					0	0	8408	3		3
1006	13907	31.00	6060	44	1487	1464	11	11	1567	26	7634	2366		880
1048	772	5.50	372	48					0	0	2349	129	23	107
1049	14933	1.80	852	6					0	0	141675	2550		2550
3003	16253	24.50	8818	54	2594	2550	16	16	3777	43	11296	2767		174
Total	143125		33908	24	6688	6487		5	8077	24				

Regional significance (IBRA region - AW & JAF)
- <10% or 1500ha remaining regionally
- <30% remaining and <17% protected regionally
- <30% remaining regionally
- <17% protected regionally

Local significance
- <10% remaining locally
- <30% remaining locally
- <17% protected locally
- locally rare and unprotected

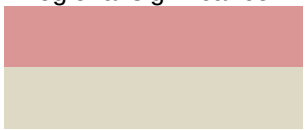
Table 2: 2013 Native vegetation extent by vegetation complexes – Shire of Northam (Local Biodiversity Program, 2014)

	A	B	C	D	E	F	G	H	I	J	K	L	M
Vegetation complexes by Havel & Mattiske (1998)	**Pre-European extent (ha)**	**Proportion of pre-European regional extent in the Shire**	**2013 Remnant vegetation extent (ha)**	**% of pre-European extent remaining in the Shire**	**In DPaW managed for conservation ***	**% of pre-European extent protected in the Shire**	**DPaW managed other**	**DPaW managed State Forest**	**Local Natural Areas**	**Portion of LNA protected (local conservation reserves& zoning)**	**17% of the pre-European extent of vegetation complexes in the region (ha)**	**Proportion the Shire of Northam should contribute to the conservation of 17% of pre-European regional extent (ha) L=K*B/100**	**Area required to improve protection status of vegetation complexes at regional and local level (ha) M= L-E-J**
Bindoon - Bi	4763	13.21%	1005.78	21.12%		0.00%			1005.78	0.00	6129	809.71	809.71
Cooke - Ce	470	1.28%	413.93	88.07%	217.69	46.32%			196.24	0.00	6252.00	79.90	0.00
Coolakin - Ck	8538	5.20%	2214.86	25.94%	320.18	3.75%	2.38		1892.31	2.38	27929.00	1451.46	1128.90
Goonaping - G	258	0.94%	201.87	78.25%	116.62	45.20%	7.62		77.63	0.00	4669.00	43.86	0.00
Michibin - Mi	9095	5.41%	3010.38	33.10%	274.10	3.01%	233.02		2503.25	205.38	28565.00	1546.15	1066.67
Murray 2 - My2	1407	2.37%	335.10	23.82%	23.87	1.70%			311.22	0.00	10084.00	239.19	215.32
Pindalup - Pn	10562	6.32%	6094.44	57.70%	1966.96	18.62%		921.52	3205.40	49.68	28415.00	1795.54	0.00
Swamp - S	29	0.05%	12.84	44.29%		0.00%			12.84	0.00	9121.00	4.93	4.93
Williams - Wi	1124	3.88%	318.19	28.31%		0.00%			318.19	0.00	4927.00	191.08	191.08
Yalanbee - Y5	10382	8.20%	5479.79	52.78%	1544.70	14.88%	26.49	287.78	3619.65	112.61	21523.00	1764.90	107.59
Yalanbee - Y6	16466	8.30%	7571.72	45.98%	1961.86	11.91%	109.86		5500.00	551.51	33725.00	2799.22	285.85
Total	63094		26658.91	42.25%	6426.00	10.18%	379.37	1209.30	18642.52	921.56			3810.04

Note: these statistics only apply to the western portion of the Shire, to the extent of the vegetation complex mapping by Havel and Mattiske (2003)

Legend:

Regional significance



<30% remaining and <17% protected regionally

<17% protected regionally

Local significance

<30% remaining locally

<17% protected locally

locally rare and unprotected

Note: for the determination of thresholds, the following actual figures were used: for 30% used 40%, for 17% used 20%

* DPaW managed for conservation: Formal Reserves = Existing National Parks, Nature Reserves, Cons Parks, 5(g) Reserves

Local Natural Areas = natural areas outside DPaW managed lands

Table 3: 2013 native vegetation extent of Beard vegetation associations and the Local Planning Scheme No 6 land uses (Local Biodiversity Program, 2014)

Beard Vegetation Association	4	352	511	694	946	1006	1048	1049	3003	Total
Avon Wheatbelt	211.96	7197.15	65.54	391.58	4.13	0.00	361.16	813.79	0.00	9045.32
COMMERCIAL		0.11								0.11
CONSERVATION OF FLORA & FAUNA	13.23	299.81		16.84						329.88
HIGHWAY	0.35	4.11								4.45
INDUSTRIAL		1.03								1.03
LIGHT & SERVICE INDUSTRY		2.32								2.32
LOCAL ROAD		1.12								1.12
MAJOR ROAD	1.23	64.74		4.53				11.29		81.79
PARKS AND RECREATION	6.23	153.53		1.22			34.42	3.51		198.90
PUBLIC PURPOSES	30.40	237.96		19.71			18.10	0.41		306.57
RAILWAY		23.10		0.11				0.00		23.21
RECREATION		68.77								68.77
REGIONAL ROAD	0.61	4.39								5.00
RESIDENTIAL		2.57								2.57
RURAL RESIDENTIAL	0.82	95.45								96.27
RURAL SMALLHOLDING	11.84	72.39								84.22
RURAL	145.19	5841.79	65.54	349.18	4.13		308.64	798.59		7513.05
SPECIAL RESIDENTIAL	2.07	64.15								66.23
SPECIAL USE		259.81								259.81
Jarrah Forest	9390.97	68.21	0.00	0.00	0.00	5938.50	0.00	0.00	8606.90	24004.57
RURAL	4302.71	63.38				2480.41			3236.73	10083.23
CONSERVATION OF FLORA & FAUNA	1056.46	2.00				1935.49			1201.39	4195.35

Beard Vegetation Association	4	352	511	694	946	1006	1048	1049	3003	Total
HIGHWAY	6.14	0.80								6.94
INDUSTRIAL						15.49			6.54	22.03
MAJOR ROAD	84.75					7.65			11.84	104.24
PARKS AND RECREATION	182.57					302.48			45.21	530.26
PUBLIC PURPOSES	2307.73	0.07				868.05			1394.47	4570.32
RESIDENTIAL						2.47			7.51	9.98
RURAL RESIDENTIAL	25.13	1.27								26.40
RURAL SMALLHOLDING	310.52					326.44			60.44	697.41
SPECIAL RESIDENTIAL	3.70	0.69								4.39
STATE FOREST	1111.27								2627.58	3738.85
TOURIST									15.18	15.18
Total	**9602.93**	**7265.36**	**65.54**	**391.58**	**4.13**	**5938.50**	**361.16**	**813.79**	**8606.90**	**33049.89**

Note: Total extent for some of the Beard vegetation association shown in this table is different to that shown in Table 1. This is mainly due to the gaps in the local planning scheme land uses dataset.

Table 4: 2013 native vegetation extent by vegetation complexes and Local Planning Scheme No 6 land uses (Local Biodiversity Program, 2014)

	CONSERVATION OF FLORA & FAUNA	INDUSTRIAL	MAJOR ROAD	PARKS AND RECREATION	PUBLIC PURPOSES	RESIDENTIAL	RURAL SMALLHOLDING	RURAL	SPECIAL USE	STATE FOREST	TOURIST	Total
Bindoon - Bi			2.89	0.02	19.61			887.93	91.61			1002.06
Cooke - Ce	176.90							200.02		39.66		416.58
Coolakin - Ck	323.81		0.62	215.47	2.24		106.13	1494.88				2143.15
Goonaping - G			0.95		20.23			62.77		115.40		199.35
Michibin - Mi	273.33		74.25	34.75	21.36		166.44	2390.05				2960.19
Murray 2 - My2	23.87		2.62	2.53	0.34		6.01	274.28			10.42	320.08
Pindalup - Pn	568.72	22.03	8.19	4.14	1884.47	8.73	55.31	1069.55		2340.73		5961.87
Swamp - S							2.30	10.54				12.84
Williams - Wi			11.88	16.04	17.15		24.26	220.62	3.13			293.08
Yalanbee - Y5	1472.03		6.77	84.46	861.36	1.25	177.46	2283.47		469.92	4.76	5361.48
Yalanbee - Y6	1620.18		15.20	138.66	1467.42		238.51	3210.64	8.77	775.49		7474.87
Total	4458.84	22.03	123.39	496.07	4294.17	9.98	776.43	12104.74	103.51	3741.20	15.18	26145.55

Note: these statistics only apply to the western portion of the Shire, to the extent of the vegetation complex mapping by Havel and Mattiske (2003) – see Figure 4.1.

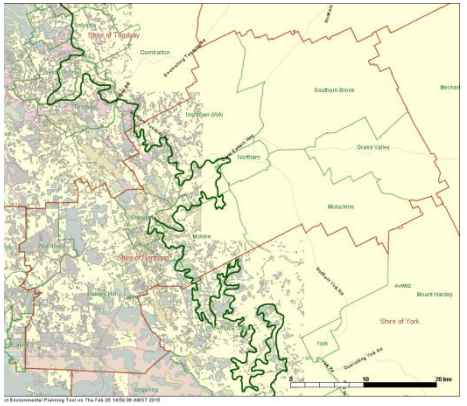


Figure 4.1: The extent of vegetation complex mapping by Havel and Mattiske (2003) in the Shire of Northam. The dark green line represents the boundary between the Jarrah Forest and Wheatbelt bio-regions.

Table 5: List of Crown reserves proposed to have their purpose changed to include "Conservation", and the extent of native vegetation remaining in these reserves (Local Biodiversity Program, 2014)

	Vegetation Complexes					BVAs				Total		
Reserve Number and Purpose Colouring identifies land use classification in the LPS No 6	Coolakin - Ck	Michibin - Mi	Pindalup - Pn	Yalanbee - Y5	Yalanbee - Y6	4	352	694	1049		Records of threatened species or ecological communities	Notes*
R 420 (Recreation & Parkland)							32.9			32.9	Vu	#1 Northam
R 2602 (Historic Watering Place)							0.41			0.41		In BA21; #2 Grass Valley
R 3203 (Sand & Gravel Quarry)							12.7	18.5		31.2		#3 Grass Valley
R 3308 (Recreation)	1.60									1.6		#1 Bakers Hill
R 4200 (Recreation and Golf Course)	7.12				0.00					7.1		#3 Bakers Hill
R 5645 (Water)							2.91			2.9		
R 6305 (Water)									7.2	7.2		#1 Meenar
R 9251 (Parks & Recreation)							1.26			1.26		#10 Grass Valley
R 11619 (Recreation)				45.9						45.9		#1 Wundowie
R 15384 (Parklands)									2.4	2.4		In BA14; #2 Jennapullin
R 18954 (Recreation)							1.54			1.5		#11 Grass Valley
R 19542 (Recreation)		1.40								1.4		#2 Clackline, Add adjoining R16349 (#1 Clackline))
R 25225 (Recreation and Golf Links)				37.60						37.6		#6 Wundowie
R 25785 (Recreation)	4.74				12.15					16.9		in Ck4; #6 Bakers Hill
R 25796 (Rubbish Depot)			2.08	8.32						10.4		
R 26840 (Rubbish Disposal)						49				48.9	PEC	#2 Northam
R 28043 (Recreation)	2.69	4.79								7.5		

	Vegetation Complexes					BVAs				Total		
Reserve Number and Purpose Colouring identifies land use classification in the LPS No 6	**Coolakin - Ck**	**Michibin - Mi**	**Pindalup - Pn**	**Yalanbee - Y5**	**Yalanbee - Y6**	**4**	**352**	**694**	**1049**		**Records of threatened species or ecological communities**	**Notes***
R 32143 (Community Purposes)							6.74			6.7		In Wi1; #1 Mokine
R 38973 (Recreation Trotting Training Track)			9.31	0.18						9.5		In LP1
R 39381 (Public Recreation)							2.93			2.9		In Bi7; #1 Katrine
R 41452 (Recreation- Motor Cycle Sports)							14.5			14.5		#12 Northam - proposed to sell for residential development (2011)
R 41559 (Public Recreation)							9.62			9.6		In BA7; #2 Katrine
R 41937 Rubbish Disposal)				4.86								In LP2
R 43247 (Public Recreation)							0.41			0.41		
R 43255 (Public recreation)							0.73			0.73		#30 Northam
R 44700 (Recreation & Parkland)		13.45			19.80	55	11.6			100	T	In BA12; #5 Northam
R 51213 (Municipal Purposes)						26	29.2			55	PEC	
Reserves not managed by the Shire Reserve Number (purpose)	**Coolakin - Ck**	**Michibin - Mi**	**Pindalup - Pn**	**Yalanbee - Y5**	**Yalanbee - Y6**	**4**	**352**	**694**	**1049**			**Management responsibility/ Locality**
R 23746 (Railway/Quarry)	2.76				12.81					15.6		Westrail/Bakers Hill
R 26947 (Sewage Treatment)			6.83							6.8		Water Corporation/ Wundowie
R 293 (Parklands)		3.52								3.5		Department of Planning/Mokine

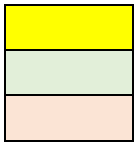
	Vegetation Complexes					BVAs				Total		
Reserve Number and Purpose Colouring identifies land use classification in the LPS No 6	**Coolakin - Ck**	**Michibin - Mi**	**Pindalup - Pn**	**Yalanbee - Y5**	**Yalanbee - Y6**	**4**	**352**	**694**	**1049**		**Records of threatened species or ecological communities**	**Notes***
R 30185 (Government Requirements)	1.70									1.7		ESA#, adjoins another 2.2ha mapped as ESA. Bakers Hill
R 30393 (Zoological Garden)	206.00	8.27			108.00					322.3		Zoological Gardens Board/Bakers Hill
R 30718 (Agricultural College)							80.7			80.7		Department of Training/ Muluckine
R 35531 (Public Recreation)							4.6			4.6		Department of Planning/Northam
R 35961 (Public Recreation)							8.2			8.2		Department of Planning- Subject to 20A/Northam
R 40985 (Water Supply)					2.25					2.25		Water Corporation
R 6203 (Reservoir/Catchment)			1872.24	717.33	1380.23					3970		Water Corporation/ Bakers Hill
Total in selected reserves:	**226.61**	**31.42**	**1890.47**	**814.21**	**1537.5**	**130**	**221**	**18.5**	**9.7**	**4872**		

* Corresponding reference number in the Shire of Northam Land Rationalisation Strategy (2011)
*TA identification label
#ESA – Environmentally Sensitive Areas are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005* under section 51B of the Environmental Protection Act. ESA identify areas with high conservation value where vegetation clearing exemptions do not apply.

Key: Local Planning Scheme land uses

Conservation of Flora and Fauna

Parks and Recreation



Public Purposes
Rural
Residential

Table 6: 2013 native vegetation extent within Unallocated Crown Land in the Shire of Northam (Local Biodiversity Program, 2014)

IBRA regions	Vegetation complex	2013 extent (ha)
Jarrah Forest	Coolakin - Ck	71.25
	Michibin - Mi	3.31
	Pindalup - Pn	62.91
	Yalanbee - Y5	176.88
	Yalanbee - Y6	489.34
Avon Wheatbelt	Beard vegetation association	
	4	2.02
	352	214.35
	511	1.05
	694	0.39
	1048	10.39
	1049	1.34
Total in the Shire		**1033.23**

Table 8: 2013 native vegetation distribution on properties registered with the *Land for Wildlife* (LWF) Program in the Shire of Northam (Local Biodiversity Program 2014)

LFW REG No.	Coolakin - Ck	Michibin - Mi	Murray 2 - My2	Pindalup - Pn	Yalanbee - Y5	Yalanbee - Y6	BVA 352	BVA 1048	BVA 1049	Total	Land use
177										2.20	Rural
179				34.29	5.68					39.97	Rural
348					2.47					2.47	Rural
394		1.95								1.95	Conservation of Flora and Fauna
404					0.28					0.28	Rural Residential
559							1.17			1.17	Rural
567	7.05	198.18				93.16				298.39	Conservation of Flora and Fauna
624							0.60			0.60	Rural
634		37.43				28.17				65.61	Rural
710							29.87			29.87	Rural
890				15.36	0.01					15.37	Rural
1003		1.60				1.15				2.75	Rural Smallholdings
1045						2.71				2.71	Rural Residential
1165							78.85	36.50		115.35	Parks and Recreation
1181							96.93			96.93	Parks and Recreation
1333						5.41				5.41	Rural Residential
1408							9.65			9.65	Conservation of Flora and Fauna
1485			11.88	0.30						12.17	Rural
1537					0.16					0.16	Rural
1620									6.32	6.32	Rural
1625							2.13			2.13	Rural
1639				7.97	3.46					11.43	Rural
1900							42.50	23.45		65.95	Rural
1998		0.24				3.69				3.93	Rural Smallholdings
2035		7.48								7.48	Rural

LFW REG No.	Coolakin - Ck	Michibin - Mi	Murray 2 - My2	Pindalup - Pn	Yalanbee - Y5	Yalanbee - Y6	BVA 352	BVA 1048	BVA 1049	Total	Land use
2149							5.60	31.39		36.99	Rural
2157									3.57	3.57	Rural
2416	16.18									16.18	Rural
Total	23.23	246.88	11.88	57.91	12.07	134.29	267.30	91.34	9.89	856.99	

Table 9: Opportunities to improve the protection status of vegetation types with inadequate protection in the Shire of Northam (Local Biodiversity Program, 2014)

						Distribution of vegetation complexes in land use categories providing good opportunities for vegetation retention/protection					
Vegetation complexes by Havel & Mattiske (1998)	**Area required to improve protection status of vegetation complexes at regional and local level (ha)**	Area of vegetation in Land for Wildlife (ha)	Area of vegetation in selected Shire vested reserves (ha)	Area of vegetation in other Crown reserves (ha)	Area of vegetation on Unallocated Crown Land (ha) (and not already protected via LPS6 provisions)	Parks & Recreation	Agriculture - Local	Agriculture - Regional	Rural Smallholdings	Total in land uses with good opportunities	Total remaining - 2013 (ha)
Bindoon - Bi	810	0	0	0	0	0.02	716.74	171.19		887.95	1005.78
Cooke - Ce	0	0	0	0	0		200.02			200.02	413.93
Coolakin - Ck	1129	23.23	14.55	210.46	71.2	215.47	1494.88		106.13	1816.47	2214.86
Goonaping - G	0	0	0	20.25	0		62.77			62.77	201.87
Michibin - Mi	1067	248.9	18.24	11.79	3.3	34.75	2303.23	86.82	166.44	2591.25	3010.38
Murray 2 - My2	215	11.88	0	0	0	2.53	274.28		6.01	282.82	335.10
Pindalup - Pn	0	61.6	11.39	1879.07	62.9	4.14	1069.55		55.31	1128.99	6094.44
Swamp - S	5	0	0	0	0		10.54		2.30	12.84	12.84
Williams - Wi	191	0.32	0	0	0	16.04	184.44	36.18	24.26	260.92	318.19
Yalanbee - Y5	108	13.4	96.87	717.33	176	84.46	2283.47		177.46	2545.40	5479.79
Yalanbee - Y6	286	134	31.95	1501	489	138.66	3074.96	135.69	238.51	3587.82	7571.72
Total	3810	493.33	173	4339.9	802.4					13377.24	26658.90
BVAs not covered by vegetation											

complex mapping											
352	10052	267.3	123.13	80.72	214.35	153.53	2553.79	3288.00	72.39	6067.70	7540.70
511	163	0	0	0	1.05	0.00	0.00	65.54		65.54	67.13
694	574	0	18.51	0	0.39	1.22	0.00	349.18		350.40	414.62
946	3	0	0	0	0	0.00	0.00	4.13		4.13	4.14
1048	107	91.4	0	0	10.39	34.42	0.00	308.64		343.06	371.76
1049	2550	9.89	9.65	3.34	1.34	3.51	0.00	798.59		802.10	851.56
Total:	13448	368.59	151.29	84.06	227.52	192.68	2553.79	4814.08	72.39	7632.93	9249.91

Regional significance

<10% remaining regionally

<30% remaining and <17% protected regionally

<17% protected regionally

Local significance

<10% remaining locally

<30% remaining locally

<17% protected locally

locally rare and unprotected

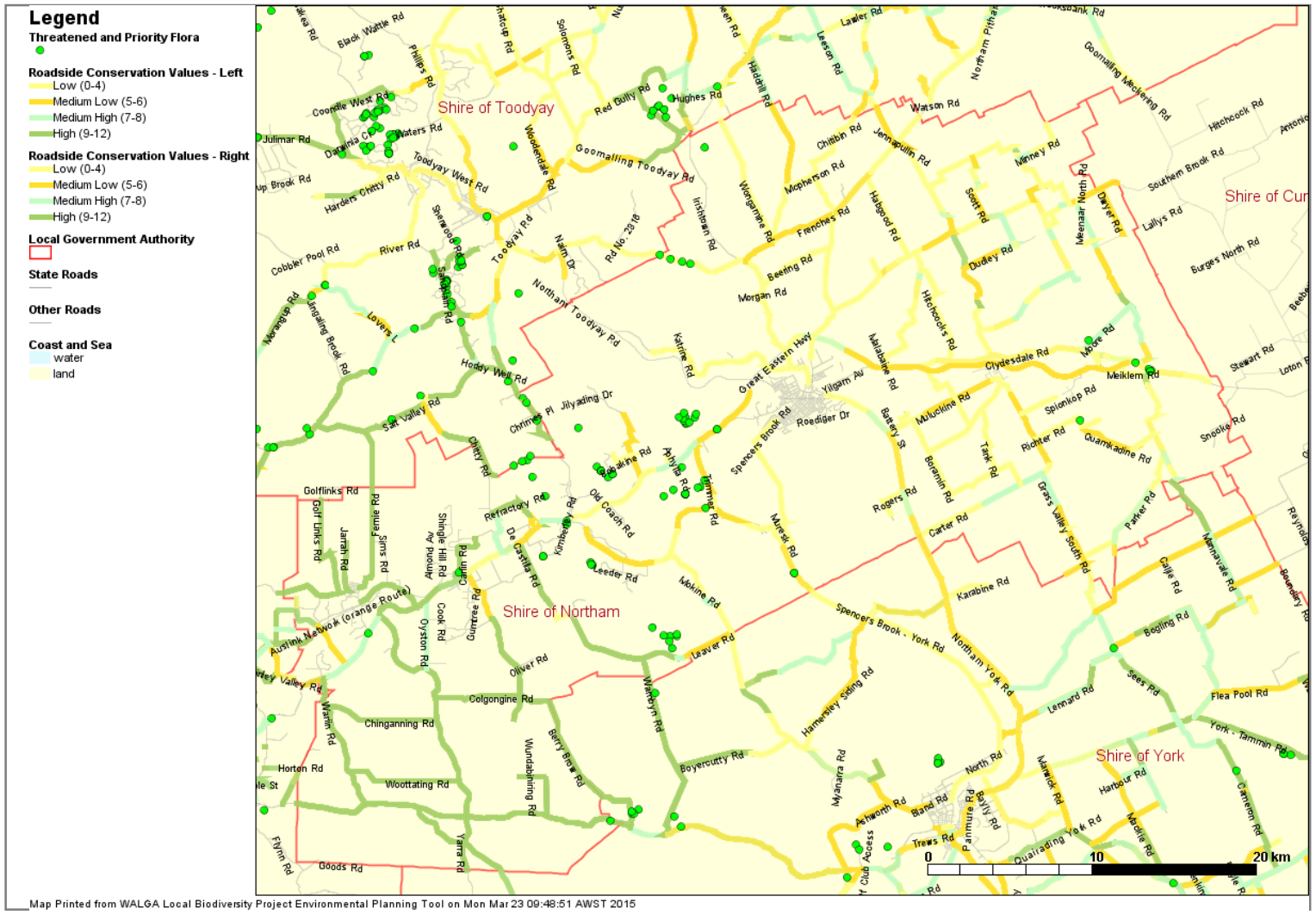
Note: for the determination of thresholds, the following actual figures were used: for 30% used 40%, for 17% used 20%

* DPaW managed for conservation:

Local Natural Areas = natural areas outside DPaW managed lands

remaining vegetation extent below the recommended minimal target

Figure 4.2: Conservation value of roadside vegetation in the Shire of Northam (1988-1996) and records of Threatened and Priority flora (DPAW 2014)



APPENDIX E: Shire of Northam species report Summary (NatureMap)

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA AND FAUNA

Sourced from: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation_code_definitions.pdf

T Threatened species

Listed as Specially Protected under the *Wildlife Conservation Act 1950*, published under Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Fauna that is rare or likely to become extinct are declared to be fauna that is in need of special protection

Flora that are extant and considered likely to become extinct, or rare and therefore in need of special protection, are declared to be rare flora

Species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such. The assessment of the conservation status of these species is based on their national extent.

X Presumed extinct species

Listed as Specially Protected under the *Wildlife Conservation Act 1950*, published under Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora).

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.

IA Migratory birds protected under an international agreement

Listed as Specially Protected under the *Wildlife Conservation Act 1950*, listed under Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), relating to the protection of migratory birds.

S Other specially protected fauna

Listed as Specially Protected under the *Wildlife Conservation Act 1950*. Fauna declared to be in need of special protection, otherwise than for the reasons mentioned for Schedules 1, 2 or 3, are published under Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Threatened Fauna and Flora are ranked according to their level of threat using IUCN[18] Red List categories and criteria. For example: Carnaby's Cockatoo (Calyptorynchus latirostris) is listed as 'Specially Protected' under the Wildlife Conservation Act 1950, published under Schedule 1, and referred to as a 'Threatened' species with a ranking of 'Endangered'.

CR Critically Endangered - considered to be facing an extremely high risk of extinction in the wild.

EN Endangered - considered to be facing a very high risk of extinction in the wild.

VU Vulnerable - considered to be facing a high risk of extinction in the wild.

A list of the current rankings can be downloaded from the Parks and Wildlife Threatened Species and Communities webpage at http://dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/

P Priority species

Species that maybe threatened or near threatened but are data deficient, have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Specially Protected Fauna) Notice or the Wildlife Conservation (Rare Flora) Notice, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation dependent species that are subject to a specific conservation program are placed in Priority 5.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1: Priority One: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under

[18] IUCN – International Union for Conservation of Nature.

immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: Priority Two: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3: Priority Three: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4: Priority Four: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

5: Priority Five: Conservation Dependent species

Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

NatureMap Species Report

Created on 19/03/2015

Current Names Only
Core Datasets Only
Method: Intersect
'Predefined Area Intersect'
Shire Boundary: NORTHAM
*identifies introduced or naturalised species
Conservation codes are defined in the previous section of Appendix E.

Species List

Abutilon cryptopetalum
Acacia acuminata Jam, Mangard
Acacia aphylla Leafless Rock Wattle **T**
Acacia applanata
*Acacia baileyana
Acacia barbinervis subsp. barbinervis
Acacia bidentata
Acacia campylophylla **P3**
Acacia celastrifolia Glowing Wattle
Acacia cupularis
Acacia drummondii subsp. drummondii
Acacia erinacea
Acacia huegelii
Acacia lasiocalyx Silver Wattle, Wilyurwur
Acacia lasiocarpa var. bracteolata
Acacia lasiocarpa var. sedifolia
Acacia latipes
Acacia latipes subsp. latipes
Acacia leptopetala
Acacia leptospermoides subsp. leptospermoides
Acacia lirellata subsp. lirellata **P3**
Acacia meisneri
Acacia microbotrya Manna Wattle, Kalyang
Acacia multispicata
Acacia nervosa Rib Wattle
Acacia preissiana
Acacia pulchella Prickly Moses
Acacia pulchella var. goadbyi
Acacia pulchella var. pulchella
Acacia pulchella var. reflexa
Acacia restiacea
Acacia saligna subsp. lindleyi
Acacia squamata
Acacia stenoptera Narrow Winged Wattle
Acacia thieleana
Acacia urophylla
Acacia willdenowiana Grass Wattle
Acaena echinata Sheep's Burr
Acanthagenys rufogularis Spiny-cheeked Honeyeater
Acanthiza apicalis Broad-tailed Thornbill, Inland Thornbill
Acanthiza chrysorrhoa Yellow-rumped Thornbill
Acanthiza inornata Western Thornbill
Acanthiza uropygialis Chestnut-rumped Thornbill
Acanthorhynchus superciliosus Western Spinebill
Accipiter cirrocephalus Collared Sparrowhawk
Accipiter fasciatus Brown Goshawk
Acrocephalus australis Australian Reed Warbler
Actinobole uliginosum Flannel Cudweed
Actitis hypoleucos Common Sandpiper **IA**
Adenanthos cygnorum subsp. cygnorum Common Woollybush
Aegotheles cristatus Australian Owlet-nightjar
Agraptocorixa eurynome
Agrostocrinum hirsutum

Agrostocrinum scabrum subsp. scabrum
Ainudrilus nharna
*Aira caryophyllea Silvery Hairgrass
*Aira cupaniana Silvery Hairgrass
Alboa worooa
Allocasuarina campestris
Allocasuarina huegeliana Rock Sheoak, Kwowl
Allocasuarina humilis Dwarf Sheoak
Alona cf. rectangula novaezelandiae
*Alopecurus myosuroides Slender Foxtail
Alyogyne hakeifolia
Amanita umbrinella
Amanita xanthocephala
*Amaranthus viridis Green Amaranth
Amblyomma triguttatum
Amperea micrantha **P2**
Amphibromus nervosus
*Amsinckia calycina Yellow Burrweed
Amyema linophylla subsp. linophylla
Amyema miquelii Stalked Mistletoe
Amyema miraculosa subsp. miraculosa
Amyema preissii Wireleaf Mistletoe
Aname mainae
Anas castanea Chestnut Teal
Anas gracilis Grey Teal
Anas platyrhynchos Mallard
Anas rhynchotis Australasian Shoveler
Anas superciliosa Pacific Black Duck
Anigozanthos bicolor Little Kangaroo Paw
Anigozanthos bicolor subsp. bicolor
Anigozanthos bicolor subsp. exstans **P3**
Anigozanthos humilis Catspaw
Anigozanthos humilis subsp. chrysanthus Golden Catspaw **P4**
Anigozanthos humilis subsp. humilis
Anigozanthos manglesii subsp. manglesii
Anisops baylii
Anisops hyperion
Anisops thienemanni
Anopheles annulipes
Antaresia stimsoni subsp. stimsoni Stimson's Python
Antechinomys laniger Kultarr
Anthocercis ilicifolia subsp. ilicifolia
Anthochaera carunculata Red Wattlebird
Anthochaera lunulata Western Little Wattlebird
Anthotroche pannosa Felted Anthotroche
Antichiropus variabilis
Antichtopauropus brevitarsus
Antiporus gilberti
Aphelia brizula
Aprasia repens Sand-plain Worm-lizard
Apus pacificus Fork-tailed Swift **IA**
Aquila audax Wedge-tailed Eagle
Aquila morphnoides subsp. morphnoides Little Eagle
Araneus senicaudatus
*Arctotheca calendula Cape Weed
Ardea intermedia Intermediate Egret
Ardea modesta Eastern Great Egret **IA**
Ardea novaehollandiae White-faced Heron
Ardea pacifica White-necked Heron
Ardeotis australis Australian Bustard
*Argemone ochroleuca subsp. ochroleuca
Argiope trifasciata
Aristida contorta Bunched Kerosene Grass
Aristida holathera var. holathera

Arrenurus balladoniensis
Artamus cinereus Black-faced Woodswallow
Artamus cinereus subsp. melanops Black-faced Woodswallow
Artamus cyanopterus Dusky Woodswallow
Artamus personatus Masked Woodswallow
Arthropodium dyeri
*Asparagus asparagoides Bridal Creeper
*Asparagus officinalis Asparagus
Aspidites ramsayi Woma **S**
Asterolasia grandiflora **P4**
Astroloma ciliatum Candle Cranberry
Astroloma compactum
Astroloma epacridis
Astroloma glaucescens
Astroloma pallidum Kick Bush
Astroloma serratifolium Kondrung
Atriplex amnicola Swamp Saltbush
*Atriplex prostrata Hastate Orache
Atriplex semibaccata Berry Saltbush
Atriplex suberecta
Austracantha minax
Austrochiltonia subtenuis
Austrolestes annulosus
Austrolestes io
Austropaxillus muelleri
Austrostipa campylachne
Austrostipa elegantissima
Austrostipa hemipogon
Austrostipa macalpinei
Austrostipa nitida
Austrostipa sp. Marchagee (B.R. Maslin 1407)
Austrostipa trichophylla
Austrostipa variabilis
*Avellinia michelii
*Avena barbata Bearded Oat
*Avena fatua Wild Oat
Aythya australis Hardhead
*Babiana angustifolia
Babingtonia camphorosmae Camphor Myrtle
Badumna insignis
Baeckea crispiflora
Banksia armata var. armata
Banksia attenuata Slender Banksia, Piara
Banksia bipinnatifida
Banksia bipinnatifida subsp. bipinnatifida
Banksia dallanneyi var. dallanneyi
Banksia dallanneyi var. mellicula
Banksia densa var. densa
Banksia drummondii subsp. hiemalis
Banksia fraseri var. fraseri
Banksia grandis Bull Banksia, Pulgarla
Banksia hewardiana
Banksia nobilis subsp. nobilis
Banksia proteoides King Dryandra
Banksia sessilis var. sessilis
Banksia sphaerocarpa var. sphaerocarpa Fox Banksia
Banksia squarrosa Pingle
Banksia squarrosa subsp. squarrosa
Banksia stuposa
Banksia undata var. undata
*Bartsia trixago
Battarrea stevenii
Baumea laxa
Baumea rubiginosa

Beaufortia incana
Bennelongia barangaroo
Berosus approximans
Berosus australiae
Berosus sp.
Bettongia penicillata subsp. ogilbyi Woylie, Brush-tailed Bettong **T**
Billardiera fraseri Elegant Pronaya
Billardiera fusiformis Australian Bluebell
Billardiera venusta
Biziura lobata Musk Duck
Blennospora drummondii
Boeckella triarticulata
Boerhavia schomburgkiana
Boronia busselliana
Boronia coerulescens subsp. spinescens
Boronia penicillata
Boronia ramosa subsp. anethifolia
Boronia scabra subsp. scabra
Boronia subsessilis
Borya laciniata
Borya scirpoidea
Borya sphaerocephala Pincushions
Bossiaea eriocarpa Common Brown Pea
Bossiaea ornata Broad Leaved Brown Pea
Bossiaea spinescens
Bostockia porosa
Brachionus plicatilis s.l.
Brachionus quadridentatus cluniorbicularis
*Brachychiton populneus Kurrajong
Brachyloma preissii subsp. lanceolatum
*Brachypodium distachyon False Brome
Brachyscome ciliaris
Brachyscome iberidifolia
Brachyurophis semifasciatus Southern Shovel-nosed Snake
*Brassica nigra Black Mustard
*Brassica x juncea Indian Mustard
*Brassica x napus
*Briza maxima Blowfly Grass
*Briza minor Shivery Grass
Bromus arenarius Sand Brome
*Bromus catharticus Prairie Grass
*Bromus diandrus Great Brome
*Bromus hordeaceus Soft Brome
*Bromus rubens Red Brome
Bulbine semibarbata Leek Lily
Burchardia congesta
Burchardia multiflora Dwarf Burchardia
Burhinus grallarius Bush Stone-curlew
Cacatua pastinator Western Long-billed Corella
Cacatua sanguinea Little Corella
*Cacatua tenuirostris Eastern Long-billed Corella
Cacomantis flabelliformis Fan-tailed Cuckoo
Cacomantis pallidus Pallid Cuckoo
Caesia micrantha Pale Grass Lily
Caesia sp. Wongan (K.F. Kenneally 8820)
Caladenia barbarossa Dragon Orchid
Caladenia denticulata
Caladenia doutchiae
Caladenia drummondii Winter Spider Orchid
Caladenia filifera
Caladenia flava Cowslip Orchid
Caladenia flava subsp. flava
Caladenia footeana
Caladenia hirta subsp. hirta

Caladenia integra Mantis Orchid, Smooth-lipped Spider Orchid **P4**
Caladenia longicauda subsp. eminens
Caladenia longicauda subsp. longicauda
Caladenia longiclavata Clubbed Spider Orchid
Caladenia nobilis
Caladenia pulchra
Caladenia reptans Little Pink Fairy Orchid
Caladenia reptans subsp. reptans
Caladenia sp. Brookton Hwy (G. Brockman GBB 547)
Caladenia x spectabilis
Calandrinia calyptrata Pink Purslane
*Calandrinia ciliata
Calandrinia eremaea Twining Purslane
Calectasia narragara
Calidris ruficollis Red-necked Stint **IA**
Callistemon phoeniceus Lesser Bottlebrush, Dubarda
Callitris pyramidalis Swamp Cypress
Calochilus stramenicola
Calothamnus quadrifidus subsp. quadrifidus
Calothamnus sanguineus Silky-leaved Blood flower, Pindak
Calyptorhynchus banksii Red-tailed Black-Cockatoo
Calyptorhynchus banksii subsp. naso Forest Red-tailed Black-Cockatoo **T**
Calyptorhynchus baudinii Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo **T**
Calyptorhynchus latirostris Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo **T**
Calytrix angulata Yellow Starflower
Calytrix breviseta subsp. stipulosa
Calytrix flavescens Summer Starflower
Calytrix fraseri Pink Summer Calytrix
Calytrix glutinosa
Calytrix gracilis
Calytrix leschenaultii
Calytrix oncophylla **P2**
Calytrix sapphirina
Calytrix strigosa
Calytrix sylvana
Calytrix violacea
Candonocypris novaezelandiae
*Capsella bursa-pastoris Shepherd's Purse
Carassius auratus
*Carduus pycnocephalus Slender Thistle
Carex inversa Knob Sedge
*Carpobrotus edulis Hottentot Fig
*Carrichtera annua Ward's Weed
*Carthamus tinctorius
Cassytha flava Dodder Laurel
Cassytha glabella forma dispar
Cassytha pomiformis Dodder Laurel
Cassytha racemosa Dodder Laurel
Casuarina obesa Swamp Sheoak, Kuli
Caustis dioica
*Cenchrus echinatus Burrgrass
*Centaurea melitensis Maltese Cockspur
*Centaurium tenuiflorum
Centipeda crateriformis subsp. crateriformis
*Centranthus macrosiphon
Centrolepis aristata Pointed Centrolepis
Centrolepis drummondiana
Centrolepis polygyna Wiry Centrolepis
Centrolepis sp. Kalannie (B.J. Lepschi et al. BJL 3517)
Cercartetus concinnus Western Pygmy-possum, Mundarda
Cercophonius sulcatus
Chalinolobus gouldii Gould's Wattled Bat
Chalinolobus morio Chocolate Wattled Bat
*Chamaecytisus palmensis Tagasaste

Chamaescilla corymbosa Blue Squill
Chamaescilla corymbosa var. corymbosa
Chamaescilla versicolor
Charadrius melanops Black-fronted Dotterel
Charadrius ruficapillus Red-capped Plover
Cheilanthes austrotenuifolia
Cheilanthes sieberi subsp. sieberi
Chenonetta jubata Australian Wood Duck, Wood Duck
*Chenopodium glaucum Glaucous Goosefoot
*Chenopodium murale Nettle-leaf Goosefoot
Cherax cainii Marron
Chironomus aff. alternans (V24)
Chironomus occidentalis
Chironomus tepperi
Chloris truncata Windmill Grass
*Chloris virgata Feathertop Rhodes Grass
Chordifex chaunocoleus **P4**
Choretrum chrysanthum
Chorizema aciculare subsp. laxum
Chorizema dicksonii Yellow-eyed Flame Pea
Christinus marmoratus Marbled Gecko
*Chrozophora tinctoria Turnsole
Chrysocephalum apiculatum
Chthonocephalus pseudevax Woolly Groundheads
*Cichorium intybus Chicory
Cincloramphus cruralis Brown Songlark
Cincloramphus mathewsi Rufous Songlark
Circus approximans Swamp Harrier
Circus assimilis Spotted Harrier
*Citrullus colocynthis
*Citrullus lanatus Pie Melon
Cladopelma curtivalva
Cladorhynchus leucocephalus Banded Stilt
Cletocamptus dietersi
Climacteris rufa Rufous Treecreeper
Colluricincla harmonica Grey Shrike-thrush
*Columba livia Domestic Pigeon
Comesperma calymega Blue-spike Milkwort
Comesperma integerrimum
Comesperma scoparium Broom Milkwort
Conospermum incurvum Plume Smokebush
Conospermum stoechadis subsp. sclerophyllum
Conostephium preissii
Conostylis aculeata Prickly Conostylis
Conostylis candicans subsp. candicans
Conostylis caricina subsp. caricina
Conostylis juncea
Conostylis prolifera Mat Cottonheads
Conostylis pusilla
Conostylis setigera Bristly Cottonhead
Conostylis setigera subsp. setigera
Coracina novaehollandiae Black-faced Cuckoo-shrike
Corvus bennetti Little Crow
Corvus coronoides Australian Raven
Corvus coronoides subsp. perplexus Australian Raven
Corymbia calophylla Marri
Corynoneura sp. (V49)
*Cotula bipinnata Ferny Cotula
*Cotula coronopifolia Waterbuttons
Coturnix pectoralis Stubble Quail
Cracticus nigrogularis Pied Butcherbird
Cracticus tibicen Australian Magpie
Cracticus tibicen subsp. dorsalis White-backed Magpie
Cracticus torquatus Grey Butcherbird

Craspedia variabilis
Crassula closiana
Crassula colorata var. acuminata
Crassula decumbens Rufous Stonecrop
Crassula decumbens var. decumbens
Crassula extrorsa
*Crassula natans
Crenadactylus ocellatus subsp. ocellatus Clawless Gecko
Crinia pseudinsignifera Bleating Froglet
Cryptandra intermedia
Cryptandra myriantha
Cryptandra nutans
Cryptandra pungens
Cryptoblepharus buchananii
Ctenophorus ornatus Ornate Crevice-Dragon
Ctenophorus reticulatus Western Netted Dragon
Ctenotus fallens
Ctenotus pantherinus subsp. pantherinus Leopard Ctenotus
*Cucumis myriocarpus Prickly Paddy Melon
Culicoides sp.
Cyanicula gemmata
Cyanicula ixioides subsp. candida **P2**
Cyanicula ixioides subsp. ixioides **P4**
Cyanostegia lanceolata Tinsel Flower
Cygnus atratus Black Swan
*Cygnus olor Mute Swan
Cymbopogon obtectus Silkyheads
*Cynara cardunculus subsp. flavescens
*Cynodon dactylon Couch
*Cyperus congestus Dense Flat-sedge
*Cyperus eragrostis Umbrella Sedge
Cyperus gymnocaulos Spiny Flat-sedge
*Dacelo novaeguineae Laughing Kookaburra
*Dactylis glomerata Cocksfoot
Dampiera alata Winged-stem Dampiera
Dampiera lavandulacea
Dampiera linearis Common Dampiera
Daphoenositta chrysoptera Varied Sittella
Dasyurus geoffroii Chuditch, Western Quoll **T**
*Datura inoxia
*Datura wrightii Hairy Thornapple
Daucus glochidiatus Australian Carrot
Daviesia angulata
Daviesia decurrens Prickly Bitter-pea
Daviesia hakeoides subsp. subnuda
Daviesia microphylla
Daviesia nudiflora
Daviesia nudiflora subsp. drummondii
Daviesia physodes
Daviesia preissii
Delma fraseri Fraser's Legless Lizard
Demansia psammophis subsp. reticulata Yellow-faced Whipsnake
Dendrocygna arcuata Wandering Whistling Duck, Chestnut Whistling Duck
Desmocladus asper
Desmocladus fasciculatus
Desmocladus virgatus
Diacypris spinosa
Dianella revoluta Blueberry Lily
Dianella revoluta var. revoluta
Dicaeum hirundinaceum Mistletoebird
Dichopogon capillipes
Dichopogon fimbriatus Chocolate Lily
Dichopogon preissii
Dicrastylis globiflora

Dicrastylis reticulata **P3**
Dicrotendipes pseudoconjunctus
Didymanthus roei
Dillwynia laxiflora
Dioscorea hastifolia Warrine, Wararn
Diplodactylus polyophthalmus
Diplodactylus pulcher
Diplolaena graniticola
Diplopeltis huegelii
Diuris corymbosa
Diuris porrifolia
Diuris sp. Western Wheatbelt (G.J. Keighery & N. Gibson 6951)
Dodonaea bursariifolia
Dodonaea ceratocarpa
Dodonaea larreoides
Dodonaea pinifolia
Dodonaea viscosa Sticky Hopbush
Dodonaea viscosa subsp. angustissima
Drakaea gracilis
Dromaius novaehollandiae Emu
Drosera bulbosa Red-leaved Sundew
Drosera callistos
Drosera erythrorhiza Red Ink Sundew
Drosera glanduligera Pimpernel Sundew
Drosera macrantha Bridal Rainbow
Drosera macrantha subsp. macrantha
Drosera macrophylla Showy Sundew
Drosera macrophylla subsp. macrophylla
Drosera macrophylla subsp. monantha
Drosera menziesii subsp. menziesii
Drosera miniata Orange Sundew
Drosera rosulata
Drosera spilos
Drosera stolonifera Leafy Sundew
Drosera stricticaulis Erect Sundew
Drosera subhirtella Sunny Rainbow
Drosera zonaria Painted Sundew
*Echinochloa crus-galli
*Echium plantagineum Paterson's Curse
Egernia kingii King's Skink
*Ehrharta calycina Perennial Veldt Grass
*Ehrharta erecta Panic Veldt Grass
*Ehrharta longiflora Annual Veldt Grass
Elanus caeruleus subsp. axillaris Australian Black-shouldered Kite
Elythranthera emarginata Pink Enamel Orchid
Eopsaltria georgiana White-breasted Robin
Epthianura albifrons White-fronted Chat
Epthianura tricolor Crimson Chat
*Eragrostis cilianensis Stinkgrass
*Eragrostis curvula African Lovegrass
Eragrostis dielsii Mallee Lovegrass
Eragrostis falcata Sickle Lovegrass
*Eragrostis mexicana
Eremaea blackwelliana **P4**
Eremaea pauciflora
Eremaea pauciflora var. pauciflora
Eremiascincus richardsonii Broad-banded Sand Swimmer
Eremophila decipiens subsp. decipiens
Eriachne ovata
Eriochilus dilatatus White Bunny Orchid
Eriochilus dilatatus subsp. undulatus
*Erodium botrys Long Storksbill
Erodium cygnorum Blue Heronsbill
*Erodium moschatum Musky Crowfoot

Erymophyllum ramosum subsp. ramosum
Erymophyllum tenellum
Eryngium pinnatifidum Blue Devils
Erythrogonys cinctus Red-kneed Dotterel
Eucalyptus accedens Powderbark Wandoo
Eucalyptus decurva Slender Mallee
Eucalyptus drummondii Drummond's Gum
Eucalyptus horistes
Eucalyptus lane-poolei Salmon White Gum
Eucalyptus loxophleba subsp. loxophleba York Gum
Eucalyptus loxophleba x wandoo **P4**
Eucalyptus marginata subsp. marginata Jarrah
Eucalyptus marginata subsp. thalassica Blue-leaved Jarrah
Eucalyptus pluricaulis subsp. pluricaulis
Eucalyptus rudis Flooded Gum, Kulurda
Eucalyptus salmonophloia Salmon Gum, Wurak
Eucalyptus wandoo Wandoo, Wondu
Eucalyptus wandoo subsp. wandoo
Eucypris virens
Eucyrtops latior
Eurostopodus argus Spotted Nightjar
Eylais sp.
Falco berigora Brown Falcon
Falco berigora subsp. berigora Brown Falcon
Falco cenchroides Australian Kestrel
Falco longipennis Australian Hobby
Falco peregrinus Peregrine Falcon **S**
Falco peregrinus subsp. macropus Australian Peregrine Falcon **S**
Falcunculus frontatus Crested Shrike-tit
Falcunculus frontatus subsp. leucogaster Western Shrike-tit, Crested Shrike-tit
*Fallopia convolvulus
*Festuca arundinacea Tall Fescue
Flavoparmelia rutidota
Frankenia conferta Silky Frankenia **T**
Frankenia glomerata Cluster Head Frankenia **P3**
*Frankenia pulverulenta
Fulica atra Eurasian Coot
*Fumaria bastardii
*Fumaria capreolata Whiteflower Fumitory
*Fumaria densiflora Denseflower Fumitory
*Fumaria muralis subsp. muralis
Gahnia australis
Galaxias occidentalis Western Minnow
*Galium divaricatum
Gallinula tenebrosa Dusky Moorhen
Gallirallus philippensis Buff-banded Rail
Gallus gallus
Gambusia sp.
Gastrolobium callistachys Rock Poison
Gastrolobium calycinum York Road Poison
Gastrolobium capitatum
Gastrolobium cyanophyllum
Gastrolobium epacridoides
Gastrolobium hamulosum Hookpoint Poison **T**
Gastrolobium hookeri
Gastrolobium ilicifolium
Gastrolobium microcarpum Sandplain Poison
Gastrolobium obovatum Boat-leaved Poison
Gastrolobium parviflorum
Gastrolobium parvifolium Berry Poison
Gastrolobium rotundifolium Gilbernine Poison **P3**
Gastrolobium spathulatum Poison Bush
Gastrolobium spinosum Prickly Poison
Gastrolobium stowardii

Gastrolobium trilobum Bullock Poison
Gastrolobium villosum Crinkle-leaved Poison
Gavicalis virescens Singing Honeyeater
Gehyra variegata
Geopelia cuneata Diamond Dove
Gerygone fusca Western Gerygone
Gilberta tenuifolia
*Gladiolus caryophyllaceus Wild Gladiolus
Glischrocaryon aureum Common Popflower
Glossopsitta porphyrocephala Purple-crowned Lorikeet
Glycine canescens Silky Glycine
Gnephosis tenuissima
Gompholobium knightianum
Gompholobium marginatum
Gompholobium preissii
Gompholobium shuttleworthii
Gompholobium tomentosum Hairy Yellow Pea
Gonocarpus cordiger
Gonocarpus nodulosus
Gonocarpus pithyoides
Goodenia berardiana
Goodenia coerulea
Goodenia convexa
Goodenia drummondii subsp. megaphylla
Goodenia glareicola
Goodenia helmsii
Goodenia occidentalis
Goodenia pinifolia Pine-leaved Goodenia
Goodenia pulchella subsp. Wheatbelt (L.W. Sage & F. Hort 795)
Grallina cyanoleuca Magpie-lark
Grevillea candolleana **P2**
Grevillea excelsior Flame Grevillea
Grevillea hookeriana subsp. hookeriana
Grevillea huegelii
Grevillea incurva
Grevillea oncogyne
Grevillea paniculata
Grevillea pilulifera Woolly-flowered Grevillea
Grevillea pimeleoides **P4**
Grevillea sp. Gunapin (F. Hort 308)
Grevillea synapheae subsp. synapheae
Grevillea uncinulata Hook-leaf Grevillea
Grevillea vestita subsp. vestita
Grevillea wilsonii Native Fuchsia
Guichenotia angustifolia
Guichenotia sarotes
Gymnometriocnemus sp. A
Gyrostemon ramulosus Corkybark
Haemodorum discolor
Haemodorum laxum
Haemodorum simplex
Haemodorum simulans
Hakea circumalata
Hakea erinacea Hedge-hog Hakea
Hakea incrassata Marble Hakea
Hakea lissocarpha Honey Bush
Hakea loranthifolia
Hakea platysperma Cricket Ball Hakea
Hakea preissii Needle Tree, Dandjin
Hakea ruscifolia Candle Hakea
Hakea scoparia subsp. scoparia
Hakea smilacifolia
Hakea spathulata
Hakea stenocarpa Narrow-fruited Hakea

Hakea trifurcata Two-leaf Hakea
Haliastur sphenurus Whistling Kite
Hamirostra melanosternon Black-breasted Buzzard
Heleioporus albopunctatus Western Spotted Frog
Heleioporus barycragus Hooting Frog
Heleioporus eyrei Moaning Frog
Helichrysum leucopsideum
Helichrysum macranthum
Heliotropium curassavicum Smooth Heliotrope
Hellyethira litua
Hemianax papuensis
Hemiandra pungens Snakebush
Hemicordulia tau
Hemigenia barbata
Hemigenia incana Silky Hemigenia
Hemigenia parviflora
Hesperoedura reticulata
Hibbertia acerosa Needle Leaved Guinea Flower
Hibbertia ancistrophylla
Hibbertia aurea
Hibbertia avonensis
Hibbertia commutata
Hibbertia diamesogenos
Hibbertia exasperata
Hibbertia hibbertioides var. hibbertioides
Hibbertia huegelii
Hibbertia hypericoides Yellow Buttercups
Hibbertia lasiopus Large Hibbertia
Hibbertia montana **P4**
Hibbertia pachyrrhiza
Hibbertia rupicola
Hibbertia subvaginata
Himantopus himantopus Black-winged Stilt
Hirundo neoxena Welcome Swallow
Holconia westralia
Homalosciadium homalocarpum
*Hordeum glaucum Northern Barley Grass
*Hordeum leporinum Barley Grass
Hovea pungens Devil's Pins, Puyenak
Hovea trisperma Common Hovea
Hyalosperma cotula
Hyalosperma demissum
Hyalosperma glutinosum subsp. glutinosum
Hybanthus calycinus Wild Violet
Hydrocotyle callicarpa Small Pennywort
Hydrocotyle pilifera
Hydrocotyle pilifera var. glabrata
Hydromys chrysogaster Water-rat **P4**
*Hyparrhenia hirta Tambookie Grass
Hypericum gramineum Small St John's Wort
Hyphydrus elegans
Hypocalymma angustifolium White Myrtle, Kudjid
Hypocalymma robustum Swan River Myrtle
*Hypochaeris glabra Smooth Catsear
Hypolaena exsulca
Idiommata blackwalli
Idiosoma nigrum Shield-backed Trapdoor Spider **T**
Ilyocypris australiensis
Ischnura heterosticta heterosticta
Isoetopsis graminifolia Cushion Grass
Isolepis cernua var. cernua
Isolepis congrua
Isolepis hookeriana Bristle Club Rush
Isolepis marginata Coarse Club-rush

*Isolepis prolifera Budding Club-rush
Isoodon obesulus subsp. fusciventer Quenda, Southern Brown Bandicoot **P5**
Isopeda leishmanni
Isopedella cana
Isopogon divergens Spreading Coneflower
Isopogon sp. Darling Range (F. Hort 1662)
Isotoma hypocrateriformis Woodbridge Poison
Isotoma scapigera Long-scaped Isotome
Isotropis cuneifolia subsp. cuneifolia
Isotropis drummondii Lamb Poison
Isotropis juncea Slender Lamb Poison
Ixobrychus flavicollis subsp. australis Australian Black Bittern **P1**
Jacksonia condensata
Jacksonia floribunda Holly Pea
Jacksonia furcellata Grey Stinkwood
Jacksonia restioides
Jacksonia sternbergiana Stinkwood, Kapur
*Juncus acutus Spiny Rush
*Juncus acutus subsp. acutus
*Juncus bufonius Toad Rush
*Juncus capitatus Capitate Rush
*Juncus hybridus
Juncus subsecundus Finger Rush
Kennedia coccinea Coral Vine
Kennedia prostrata Scarlet Runner
Kennedia stirlingii Bushy Kennedia
Keraudrenia integrifolia Common Firebush
*Kickxia elatine subsp. crinita
Kiefferulus intertinctus
Kingia australis Kingia, Pulonok
Labichea lanceolata subsp. brevifolia
Labichea punctata Lance-leaved Cassia
Lachnagrostis filiformis
Lachnagrostis preissii
Lachnostachys ferruginea Rusty Lambstail
Lachnostachys verbascifolia var. verbascifolia
Lagenophora huegelii
Lalage tricolor White-winged Triller
Lampona cylindrata
Lasiopetalum quinquenervium
Lasiopetalum sp. Northam (F. Hort 1196) **P2**
Lasiorhinus latifrons Southern Hairy-nosed Wombat
Lawrencella rosea
Laxmannia grandiflora
Laxmannia grandiflora subsp. grandiflora
Laxmannia ramosa subsp. ramosa
Laxmannia sessiliflora subsp. australis
Laxmannia squarrosa
Lechenaultia biloba Blue Leschenaultia
Lechenaultia floribunda Free-flowering Leschenaultia
Lechenaultia formosa subsp. Wheatbelt (R.J. Cranfield 4718)
Lechenaultia laricina Scarlet Leschenaultia **T**
Lecidea sarcogynoides
Leipoa ocellata Malleefowl **T**
Lepidosperma benthamianum
Lepidosperma brunonianum
Lepidosperma leptostachyum
Lepidosperma longitudinale Pithy Sword-sedge
Lepidosperma obtusum
Lepidosperma pubisquameum
Lepidosperma resinosum
Lepidosperma scabrum
Lepidosperma sp. P1 small head (M.D. Tindale 166A)
Lepidosperma squamatum

Lepidosperma tuberculatum
Leptoceras menziesii
Leptochloa fusca
Leptospermum erubescens Roadside Teatree
Lerista distinguenda
Leucochrysum fitzgibbonii
Leucopogon nutans Drooping Leucopogon
Leucopogon oxycedrus
Leucopogon polymorphus
Leucopogon propinquus
Leucopogon pubescens
Leucopogon pulchellus Beard-heath
Leucopogon sp. Gunapin (F. Hort 808)
Leucopogon sp. Northern Scarp (M. Hislop 2233)
Levenhookia leptantha Trumpet Stylewort
Levenhookia pusilla Midget Stylewort
Levenhookia stipitata Common Stylewort
Lialis burtonis
Lichenostomus leucotis White-eared Honeyeater
Lichmera indistincta Brown Honeyeater
Limnodynastes dorsalis Western Banjo Frog
*Limonium sinuatum Perennial Sea Lavender
*Linaria maroccana
Linum marginale Wild Flax
Liodessus inornatus
Liopholis multiscutata Bull Skink
Litoria moorei Motorbike Frog
Lobelia anceps Angled Lobelia
Lobelia cleistogamoides
Lobelia tenuior Slender Lobelia
*Lolium remotum Hardy Ryegrass
*Lolium rigidum Wimmera Ryegrass
Lomandra caespitosa Tufted Mat Rush
Lomandra collina Pale Mat Rush
Lomandra effusa Scented Matrush
Lomandra hermaphrodita
Lomandra micrantha Small-flower Mat-rush
Lomandra micrantha subsp. micrantha
Lomandra nigricans
Lomandra nutans
Lomandra preissii
Lomandra spartea
Lomandra suaveolens
Loxocarya striata
*Lupinus angustifolius Narrowleaf Lupin
Lycosa dimota
*Lysimachia arvensis Pimpernel
Lysinema pentapetalum
*Lythrum hyssopifolia Lesser Loosestrife
Macropus fuliginosus Western Grey Kangaroo
Macropus irma Western Brush Wallaby **P4**
Macropus robustus subsp. erubescens Euro, Biggada
Macrotis lagotis Bilby, Dalgyte **T**
Macrozamia fraseri
Macrozamia riedlei Zamia, Djiridji
Maireana brevifolia Small Leaf Bluebush
Malacorhynchus membranaceus Pink-eared Duck
Malleostemon tuberculatus
Malurus leucopterus White-winged Fairy-wren
Malurus splendens Splendid Fairy-wren
Manorina flavigula Yellow-throated Miner
Marianthus bicolor Painted Marianthus
Marianthus coeruleopunctatus Blue-spotted Marianthus
Meeboldina coangustata

Meeboldina scariosa
Megalopsalis leptekes
Megalurus gramineus Little Grassbird
Megaporus howitti
Megaporus sp.
Melaleuca brevifolia
Melaleuca hamata
Melaleuca holosericea
Melaleuca leptospermoides
Melaleuca marginata
Melaleuca radula Graceful Honeymyrtle
Melaleuca rhaphiophylla Swamp Paperbark
Melaleuca thyoides
Melaleuca trichophylla
Melaleuca viminea Mohan
Melaleuca viminea subsp. viminea
*Melinis repens
Melithreptus brevirostris Brown-headed Honeyeater
Melithreptus brevirostris subsp. leucogenys Brown-headed Honeyeater
Melopsittacus undulatus Budgerigar
Menetia greyii
Merops ornatus Rainbow Bee-eater **IA**
Mesocyclops brooksi
Mesomelaena preissii
Mesomelaena tetragona Semaphore Sedge
Metacyclops sp. 462
Microcorys ericifolia
Microeca fascinans Jacky Winter
Microlaena stipoides Weeping Grass
Microlaena stipoides var. stipoides
Micronecta gracilis
Micronecta robusta
Microtis orbicularis Dark Mignonette Orchid
Millotia myosotidifolia
Millotia tenuifolia Soft Millotia
Millotia tenuifolia var. tenuifolia Soft Millotia
Milvus migrans Black Kite
Mirbelia dilatata Holly-leaved Mirbelia
Mirbelia ramulosa
Mirbelia spinosa
Missulena occatoria
*Molineriella minuta Small Hairgrass
Monachather paradoxus
*Monoculus monstrosus
Monohelea sp. 1
*Monopsis debilis var. depressa
Monotaxis bracteata
Monotaxis grandiflora var. grandiflora
*Moraea flaccida One-leaf Cape Tulip
*Moraea fugax
*Moraea miniata Two-leaf Cape Tulip
*Moraea setifolia
Morelia spilota subsp. imbricata Carpet Python **S**
Muehlenbeckia adpressa Climbing Lignum
*Mus musculus House Mouse
Myiagra inquieta Restless Flycatcher
Mytilocypris ambiguosa
Mytilocypris tasmanica chapmani
*Narcissus tazetta subsp. italicus
*Narcissus tazetta subsp. tazetta
Necterosoma darwini
Necterosoma penicillatus
Necterosoma regulare
Necterosoma sp.

Neelaps bimaculatus Black-naped Snake
Neophema elegans Elegant Parrot
Neurachne alopecuroidea Foxtail Mulga Grass
Nicodamus mainae
*Nicotiana glauca Tree Tobacco
Nicotiana rotundifolia Round-leaved Tobacco
Nilobezzia sp. 1
Nilobezzia sp. 2
Ninox connivens Barking Owl
Ninox novaeseelandiae Boobook Owl
Nitocra reducta (sp. 5)
Notalina spira
Nycticorax caledonicus Rufous Night Heron
Nyctophilus geoffroyi Lesser Long-eared Bat
Nymphicus hollandicus Cockatiel
Ochthebius sp.
Ocyphaps lophotes Crested Pigeon
Oecetis sp.
*Oenothera speciosa White Evening Primrose
Olax benthamiana
Olearia elaeophila
Olearia lehmanniana
Olearia muricata Rough-leaved Daisy Bush
Olearia paucidentata Autumn Scrub Daisy
*Oncosiphon piluliferum
*Oncosiphon suffruticosum
Onychocamptus bengalensis
Onychohydrus scutellaris
Opercularia vaginata Dog Weed
Oreoica gutturalis Crested Bellbird
Orthetrum caledonicum
Orthrosanthus laxus var. gramineus Grass-leaved Orthrosanthus
*Oxalis flava Pinkbulb Soursob
*Oxalis glabra
*Oxalis purpurea Largeflower Wood Sorrel
Oxyura australis Blue-billed Duck **P4**
Pachycephala pectoralis Golden Whistler
Pachycephala rufiventris Rufous Whistler
Pachycephala rufiventris subsp. rufiventris Rufous Whistler
*Panicum capillare Witchgrass
*Papaver hybridum Rough Poppy
*Papaver rhoeas Field Poppy
Paracaleana triens
Paranacaena littoralis
Paranais litoralis
*Parapholis incurva Coast Barbgrass
Parasuta gouldii
Parasuta nigriceps
Pardalotus punctatus Spotted Pardalote
Pardalotus striatus Striated Pardalote
*Parentucellia latifolia Common Bartsia
Paspalidium constrictum Knottybutt Grass
*Paspalum vaginatum Salt Water Couch
*Passiflora filamentosa
Patersonia juncea Rush Leaved Patersonia
Patersonia rudis Hairy Flag
Patersonia rudis subsp. rudis
Pelecanus conspicillatus Australian Pelican
*Pentameris airoides False Hairgrass
*Pentameris airoides subsp. airoides
Pericalymma ellipticum Swamp Teatree
Persoonia angustiflora
Persoonia elliptica Spreading Snottygobble
Persoonia quinquenervis

Petroica goodenovii Red-capped Robin
Petrophile divaricata
Petrophile drummondii
Petrophile ericifolia subsp. subpubescens
Petrophile heterophylla Variable-leaved Cone Bush
Petrophile seminuda
Petrophile serruriae
Petrophile squamata subsp. northern (J. Monks 40)
Petrophile striata
*Petrorhagia dubia
Phalacrocorax carbo Great Cormorant
Phalacrocorax sulcirostris Little Black Cormorant
Phalacrocorax varius Pied Cormorant
*Phalaris aquatica Phalaris
*Phalaris minor Lesser Canary Grass
*Phalaris paradoxa Paradoxa Grass
Phaps chalcoptera Common Bronzewing
Phaps elegans Brush Bronzewing
Phascogale tapoatafa subsp. tapoatafa Southern Brush-tailed Phascogale, Wambenger **T**
Pheladenia deformis
Philotheca spicata Pepper and Salt
*Phyla canescens
Phylidonyris novaehollandiae New Holland Honeyeater
Phyllangium paradoxum
Phyllangium sulcatum
Phyllanthus calycinus False Boronia
*Phyllopodium cordatum
Physopsis spicata Hill River Lambstail
Phytophthora cinnamomi
Pilostyles hamiltonii
Pimelea angustifolia Narrow-leaved Pimelea
Pimelea argentea Silvery Leaved Pimelea
Pimelea brevifolia subsp. modesta
Pimelea ciliata subsp. ciliata
Pimelea imbricata var. piligera
Pimelea preissii
Pimelea suaveolens subsp. suaveolens
Pimelea sylvestris
Pithocarpa pulchella var. pulchella
Pittosporum angustifolium
*Plantago coronopus subsp. commutata
Platalea flavipes Yellow-billed Spoonbill
Platalea regia Royal Spoonbill
Platycercus icterotis Western Rosella
Platycercus spurius Red-capped Parrot
Platycercus zonarius Australian Ringneck, Ring-necked Parrot
Platycercus zonarius subsp. zonarius Port Lincoln Parrot
Platynectes sp.
Platysace cirrosa Karna
Pleuroxus cf. foveatus
*Poa annua Winter Grass
*Poa bulbosa Bulbous Blue Grass
*Poa pratensis Kentucky Bluegrass
Podargus strigoides Tawny Frogmouth
Podargus strigoides subsp. brachypterus Tawny Frogmouth
Podiceps cristatus Great Crested Grebe
Podolepis canescens Bright Podolepis, Grey Podolepis
Podolepis capillaris Wiry Podolepis
Podolepis lessonii
Podolepis tepperi
Podykipus leptoiuloides
Pogona minor subsp. minor Dwarf Bearded Dragon
Pogonolepis stricta
Poliocephalus poliocephalus Hoary-headed Grebe

*Polygonum bellardii
Polypedilum nubifer
*Polypogon monspeliensis Annual Beardgrass
Polytelis anthopeplus Regent Parrot
Pomatostomus superciliosus White-browed Babbler
Poranthera microphylla Small Poranthera
Porphyrio porphyrio Purple Swamphen
Porzana fluminea Australian Spotted Crake
Porzana pusilla Baillon's Crake
Porzana tabuensis Spotless Crake
Potamogeton ochreatus Blunt Pondweed
Prasophyllum elatum Tall Leek Orchid
Prasophyllum gracile
Prasophyllum hians Yawning Leek Orchid
Prasophyllum triangulare Dark Leek Orchid
Procladius paludicola
Prostanthera canaliculata
Pseudechis australis Mulga Snake
Pseudogobius olorum
Pseudonaja affinis subsp. affinis Dugite
Pseudonaja mengdeni Western Brown Snake
Pseudonaja modesta Ringed Brown Snake
Pseudophryne guentheri Crawling Toadlet
Pterochaeta paniculata
Pterodroma macroptera subsp. macoptera
Pterodroma mollis Soft-plumaged Petrel
Pteropus scapulatus Little Red Flying-fox
Pterostylis concava
Pterostylis recurva Jug Orchid
Pterostylis sargentii Frog Greenhood
Pterostylis sp. crinkled leaf (G.J. Keighery 13426)
Pterostylis vittata Banded Greenhood
Ptilotus declinatus Curved Mulla Mulla
Ptilotus divaricatus Climbing Mulla Mulla
Ptilotus drummondii Narrowleaf Mulla Mulla
Ptilotus drummondii var. drummondii Pussytail
Ptilotus humilis
Ptilotus manglesii Pom Poms, Mulamula
Ptilotus polystachyus Prince of Wales Feather
Ptilotus spathulatus
Ptychostomum angustifolium
*Puccinellia ciliata Puccinellia
Purnella albifrons White-fronted Honeyeater
Pyrorchis nigricans Red beaks, Elephants ears
Quinetia urvillei
Ramalina inflata subsp. australis
*Raphanus raphanistrum Wild Radish
Recurvirostra novaehollandiae Red-necked Avocet
Rhagodia drummondii
Rhagodia preissii
Rhipidura leucophrys Willie Wagtail
Rhodanthe citrina
Rhodanthe corymbosa
Rhodanthe laevis
Rhodanthe manglesii
Rhodanthe polycephala
Rhodanthe pygmaea
Rhodanthe spicata
Ricinocarpos undulatus
*Romulea rosea Guildford Grass
*Romulea rosea var. communis
Roycea spinescens
*Rumex pulcher subsp. woodsii
Ruppia maritima Sea Tassel

Ruppia megacarpa
Rytidosperma acerosum
Rytidosperma caespitosum
Rytidosperma occidentale
*Sagina apetala Annual Pearlwort
Santalum acuminatum Quandong, Warnga
Sarscypridopsis aculeata
Scaevola glandulifera Viscid Hand-flower
Scaevola lanceolata
Scaevola pilosa Hairy Fan-flower
Scaevola repens var. repens
Schenkia australis
Schoenus armeria
Schoenus clandestinus
Schoenus curvifolius
Schoenus hexandrus
Schoenus nanus Tiny Bog Rush
Schoenus sculptus Gimlet Bog-rush
Schoenus sp. A2 Kulin (B.G. Briggs 7939)
Schoenus sp. smooth culms (K.R. Newbey 7823)
Schoenus subfascicularis
Schoenus unispiculatus
Scholtzia involucrata Spiked Scholtzia
Scholtzia sp. Duck Pool (M.E. Trudgen MET 5427)
Selaginella gracillima Tiny Clubmoss
Senecio multicaulis subsp. multicaulis
Senecio pinnatifolius
Senna artemisioides subsp. filifolia
Senna charlesiana
Sericornis frontalis White-browed Scrubwren
*Silene gallica var. gallica
*Silene vulgaris Bladder Campion
Siloxerus filifolius
Siloxerus humifusus Procumbent Siloxerus
Siloxerus multiflorus
Simoselaps bertholdi Jan's Banded Snake
Smicrornis brevirostris Weebill
Sminthopsis crassicaudata Fat-tailed Dunnart
Sminthopsis gilberti Gilbert's Dunnart
*Solanum elaeagnifolium White Horse Nettle, Silverleaf Nightshade
Solanum hoplopetalum Thorny Solanum
Solanum lasiophyllum Flannel Bush, Mindjulu
*Solanum nigrum Black Berry Nightshade
*Solanum triflorum Threeflower Nightshade
*Solidago canadensis Goldenrod
*Sonchus asper Rough Sowthistle
*Sonchus oleraceus Common Sowthistle
*Sorghum halepense Johnson Grass
Sowerbaea laxiflora Purple Tassels
*Spergularia diandra Lesser Sand Spurry
Spergularia marina
Sphaerolobium medium
Spiculaea ciliata Elbow Orchid
Stackhousia monogyna
Stenanthemum coronatum
Stenanthemum emarginatum
Stenanthemum intricatum
Sternopriscus multimaculatus
Sternopriscus sp.
Stictonetta naevosa Freckled Duck
Stirlingia abrotanoides
Strepera versicolor Grey Currawong
*Streptopelia chinensis Spotted Turtle-Dove
*Streptopelia senegalensis Laughing Turtle-Dove

Stuckenia pectinata
Stylidium affine Queen Triggerplant
Stylidium amoenum Lovely Triggerplant
Stylidium androsaceum
Stylidium asteroideum Star Triggerplant **P3**
Stylidium brunonianum Pink Fountain Triggerplant
Stylidium calcaratum Book Triggerplant
Stylidium caricifolium Milkmaids
Stylidium ciliatum Golden Triggerplant
Stylidium dichotomum Pins-and-needles
Stylidium diuroides Donkey Triggerplant
Stylidium emarginatum Biddy-four-legs
Stylidium eriopodum
Stylidium exappendiculatum **P3**
Stylidium hispidum White Butterfly Triggerplant
Stylidium lateriticola
Stylidium leptophyllum Needle-leaved Triggerplant
Stylidium periscelianthum Pantaloon Triggerplant **P3**
Stylidium petiolare Horn Triggerplant
Stylidium piliferum Common Butterfly Triggerplant
Stylidium pubigerum Yellow Butterfly Triggerplant
Stylidium repens Matted Triggerplant
Stylidium schoenoides Cow Kicks
Stylidium sp. Bindoon (K.F. Kenneally 11405)
Stylidium sp. Darling Range (H. Bowler 371)
Stylidium striatum Fan-leaved Triggerplant **P4**
Stylidium xanthellum
Stylopauropoides lapicidarius
Stypandra glauca Blind Grass
Styphelia tenuiflora Common Pinheath
Sulcanus conflictus
*Symphyotrichum squamatum Bushy Starwort
Synaphea decorticans
Synaphea diabolica **P3**
Synaphea interioris
Synaphea sp. Darkin (F. Hort et al. 586) **P3**
Synaphea sp. Udumung (A.S. George 17058)
Synothele michaelseni
Synsphyronus callus
Tachybaptus novaehollandiae Australasian Grebe, Black-throated Grebe
Tachyglossus aculeatus Short-beaked Echidna
Tadorna tadornoides Australian Shelduck, Mountain Duck
Taeniopygia guttata Zebra Finch
Taeniopygia guttata subsp. castanotis Zebra Finch
Tanytarsus fuscithorax/semibarbitarsus
Tanytarsus sp. C (bispinosus)
Tasmanicosa leuckartii
Taxandria linearifolia
Tecticornia pergranulata subsp. pergranulata Blackseed Samphire
Templetonia sulcata Centipede Bush
Tetrapterum cylindricum
Tetraria octandra
Tetratheca confertifolia
Tetratheca hirsuta Black Eyed Susan
Tetratheca pilifera **P3**
Tetratheca similis **P3**
Tetratheca virgata
Thelymitra antennifera Vanilla Orchid
Thelymitra benthamiana Leopard Orchid
Thelymitra canaliculata Blue Sun Orchid
Thelymitra crinita Blue Lady Orchid
Thelymitra macrophylla
Thelymitra maculata
Thomasia foliosa

Thomasia glabripetala **T**
Thomasia glutinosa Sticky Thomasia
Thomasia glutinosa var. glutinosa
Thomasia macrocalyx
Threskiornis molucca Australian White Ibis
Threskiornis spinicollis Straw-necked Ibis
Thryptomene racemulosa
Thysanotus asper Hairy Fringe Lily
Thysanotus cymosus **P3**
Thysanotus gracilis
Thysanotus manglesianus Fringed Lily
Thysanotus multiflorus Many-flowered Fringe Lily
Thysanotus patersonii
Thysanotus scaber
Thysanotus sp. Twining Wheatbelt (N.H. Brittan 81/29)
Thysanotus sparteus
Thysanotus tenellus
Thysanotus tenuis **P3**
Thysanotus thyrsoideus
Thysanotus triandrus
Tiliqua occipitalis Western Bluetongue
Tiliqua rugosa subsp. rugosa
Tinytrema yarra
Todiramphus sanctus Sacred Kingfisher
Trachymene cyanopetala
Trachymene ornata Spongefruit
Trachymene pilosa Native Parsnip
Tribonanthes longipetala
Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564) **P2**
Trichocline spathulata Native Gerbera
Trichoglossus haematodus Rainbow Lorikeet
Trichosurus vulpecula subsp. vulpecula Common Brushtail Possum
Tricoryne elatior Yellow Autumn Lily
Tricoryne humilis
*Trifolium arvense var. arvense
*Trifolium campestre Hop Clover
*Trifolium subterraneum Subterranean Clover
*Trifolium tomentosum var. tomentosum
Triglochin isingiana
Tringa glareola Wood Sandpiper **IA**
Tringa nebularia Common Greenshank **IA**
Triplectides australis
Tripterococcus brunonis Winged Stackhousia
*Triticum aestivum Wheat
Trymalium angustifolium
Trymalium daphnifolium
Trymalium ledifolium
Trymalium ledifolium var. lineare
Turnix velox Little Button-quail
*Typha orientalis Bulrush, Cumbungi
Tyto alba subsp. delicatula Barn Owl
Tyto novaehollandiae subsp. novaehollandiae Masked Owl (southern subsp) **P3**
Underwoodisaurus milii Barking Gecko
*Urochloa panicoides
Urodacus armatus
Urodacus novaehollandiae
Urodacus planimanus
*Ursinia anthemoides Ursinia
*Ursinia anthemoides subsp. anthemoides
Usnea scabrida
*Vaccaria hispanica Cow Soapwort
Vanellus tricolor Banded Lapwing
Varanus gouldii Bungarra or Sand Monitor
Varanus tristis Racehorse Monitor

Velleia cycnopotamica
*Vellereophyton dealbatum White Cudweed
Venator immansueta
*Verbascum creticum
Verreauxia reinwardtii Common Verreauxia
Verticordia acerosa var. preissii
Verticordia brachypoda
Verticordia chrysantha
Verticordia densiflora var. cespitosa
Verticordia densiflora var. densiflora
Verticordia eriocephala Common Cauliflower
Verticordia huegelii var. stylosa
Verticordia insignis subsp. insignis
Verticordia pennigera
Verticordia picta Painted Featherflower
Verticordia serrata var. linearis **P3**
*Vicia sativa subsp. cordata
Vittadinia gracilis
*Vulpia bromoides Squirrel Tail Fescue
*Vulpia myuros forma megalura
*Vulpia myuros forma myuros
*Wahlenbergia capensis Cape Bluebell
Wahlenbergia gracilenta Annual Bluebell
Wahlenbergia preissii
Waitzia acuminata var. acuminata
Waitzia acuminata var. albicans
Waitzia nitida
*Watsonia meriana var. bulbillifera
Westralunio carteri Carter's Freshwater Mussel **T**
Wilsonia humilis Silky Wilsonia
Wurmbea dioica subsp. alba
Wurmbea drummondii York Gum Nancy
Wurmbea tenella Eight Nancy
Xanthagrion erythroneurum
Xanthoparmelia tasmanica
Xanthorrhoea drummondii
Xanthorrhoea preissii Grass tree, Palga
Xanthosia ciliata
Xanthosia huegelii
Xanthosia singuliflora
Xerochrysum bracteatum
Zosterops lateralis Grey-breasted White-eye, Silvereye

APPENDIX F: Ecological criteria for remnant vegetation prioritisation in the Shire of Northam (Adapted from Del Marco *et al* 2004)

Criteria	Spatial representation	Comments
Regional representation		
1_1 The area is of recognised International, National, State or Regional value	Fauna Habitat Zones from the RFA (2013) Land for Wildlife (2013) DPAW managed lands for conservation Local reserves with conservation purpose Priority Remnants (>500ha) from the Avon Regional Vegetation Prioritisation (WHRM, 2013-2014?)	
1_2 The area is of an ecological community with only 1500ha or 30% less of its pre-European extent remaining in IBRA region	Jarrah Forest: Bi, Ck, Mi, Wi, Wheatbelt portion: 4, 352, 511, 694, 946, 1048, 1049	Using 40% actual See Appendix D.
1_3 large (greater than 20 ha) area of remnant vegetation	Remnant vegetation patch equal or greater than 20ha (discrete area separated from other discrete area by >10m)	
1_4 The area is of an ecological community with only 1500ha or 17% or less protected in formal reserves in the Jarrah Forest IBRA region	Jarrah Forest: Bi, Ce, Ck, Mi, My2, Pn, Wi, Y5, Y6 Wheatbelt portion: 4, 352, 511, 694, 946, 1048, 1049,	Using 20% actual See Appendix D.
Local representation		
1_6a of an ecological community with 30% or less remaining within the LG area	Jarrah Forest: Bi, Ck, Mi, My2, Wi Wheatbelt: 352, 511, 694, 946, 1049	See Appendix D.
1_6b of an ecological community with 17% or less protected within the LG area	Jarrah Forest: Bi, Ck, Mi, My2, S, Wi, Y5, Y6 Wheatbelt: 4, 352, 511, 694, 946, 1048, 1049,	See Appendix D.
1_7 large (greater than 10ha) area of remnant vegetation	Remnant vegetation patch equal or greater than 10ha (discrete area separated from other discrete area by >10m)	
2 Rarity		
2_1 contains threatened ecological community		2014 DPAW records
2_2 contains priority ecological community		2014 DPAW records
2_3 contains declared rare flora	Threatened species records buffered (50m)	2014 DPAW records
2_4 contains records for threatened fauna	Threatened fauna records buffered (200m)	2014 DPAW records
2_5a Areas requiring investigation for Carnaby's Cockatoo feeding habitat	In Jarrah Forest – DPAW mapping (2011), outside Jarrah forest the following BVAs: 352, 511, 694, 946, 1049 used as surrogates	
2_5b Carnaby's breeding sites (confirmed and possible) with 12 km buffer		

Criteria	Spatial representation	Comments
2_5c Carnaby's roosting sites (confirmed and possible) with 6km buffer		
2_6 contains priority or other significant flora	Priority flora records buffered	2014 DPAW records
2_7 contains priority or other significant fauna	Priority fauna records and Birdlife Australia significant birding site mapping (2009)	2014 DPAW records
3 Maintaining ecological processes and protection of wetlands and streamline vegetation		
3_1 wetlands plus 50m buffer	Wheatbelt wetlands Including the South west agricultural zone wetlands (EPP policy wetlands) -	
3_2a riparian vegetation plus buffer	Hydrography lines buffered (20m) and intersected with remnant vegetation	
3_2b Avon River Pools and recognised conservation significance sections of Avon plus 200m buffer and sections of river foreshore mapped as being in good or better condition	High and Medium (with ecological values only) priority river pools: Katrine Pool, Burlog Pool, Glen Avon Pool, Northam Town River Pool , Northam "Forest" section of Avon River (as defined by the Stakeholder Reference Group, see Maps 1 and 2, Appendix B)	DoW foreshore condition mapping intersected with the surrogate layer for riparian vegetation (using A1-A3 and B1-B3 categories of condition).
3_3 granite outcrops	Wheatbelt wetlands mapping	

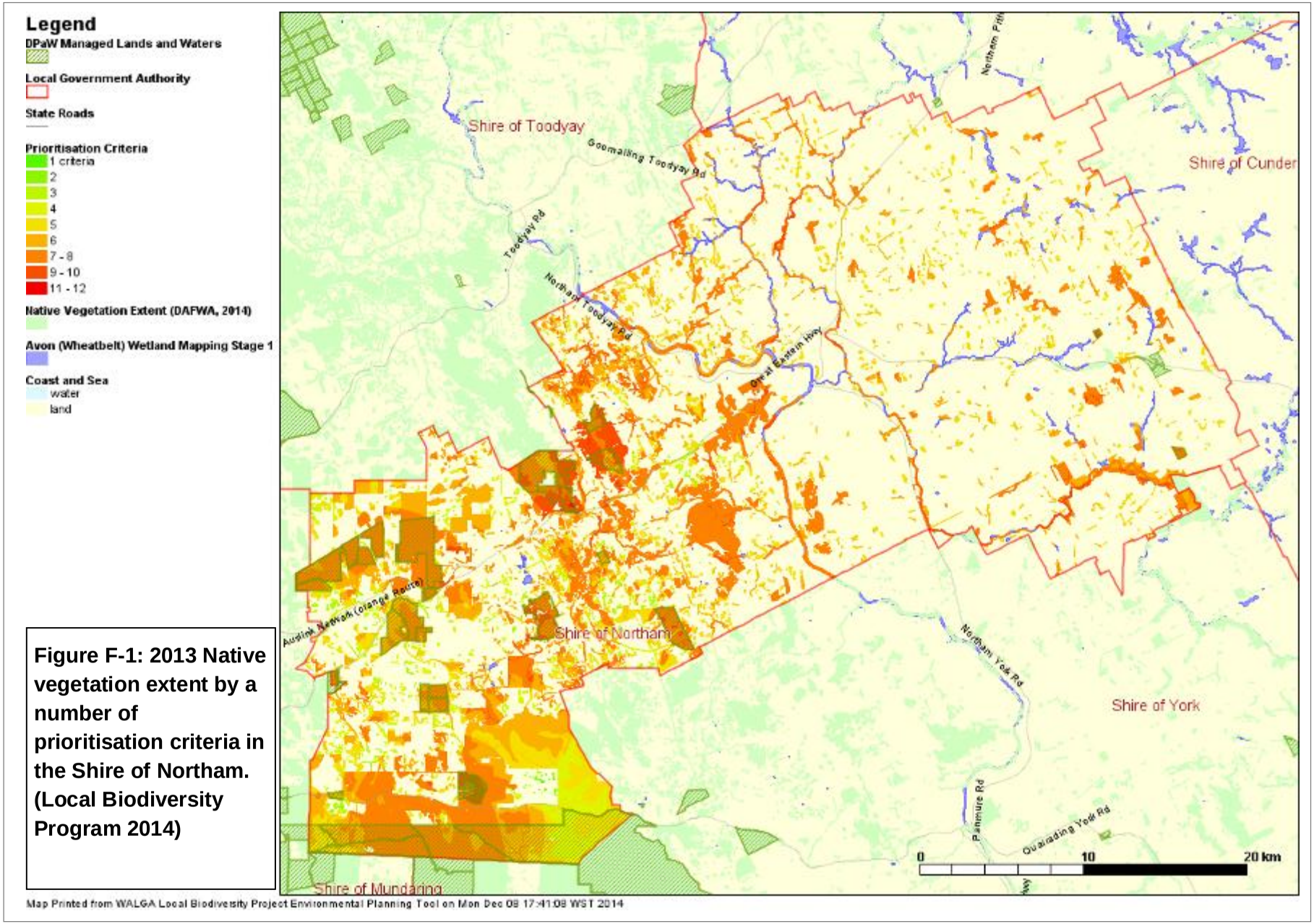


Figure F-1: 2013 Native vegetation extent by a number of prioritisation criteria in the Shire of Northam. (Local Biodiversity Program 2014)

APPENDIX G: A Morphological Classifier for Remnant Vegetation

By Teik Oh, Fluffy Software PL

Introduction

When planning for bushland reserves, designing a reserve with an "ideal" shape is an important consideration for effective long term management of biodiversity values. Assuming there are no topographical, planning or other constraints a circle is the ideal shape for a remnant as drawn on a 2-D map. A circle has the following properties:

- Minimum boundary length to area ratio for a size of patch;
- The most compact shape to represent a particular size of patch;
- Greatest self-connectivity. With a circle the average distance of any two randomly chosen points within the patch (over many samples) is lower than any other shape.

These properties correspond to conventional wisdom in bushland management and ecology of minimising boundary lengths of remnant vegetation (fencing and weed management costs) and maximising ecological connectivity.

Given that in most instances remnant vegetation is, by definition, "what's left" we don't have the luxury of reconfiguring remnant shapes but instead need measures for assessing the distribution and shape of remnants as they are.

Shape classifiers can give insight into the spatial properties of remnant patches – not just how large they are – but how their shapes, positions and sizes affect their ecological attributes particularly connectivity.

Shape classifiers produce a number to describe something about a shape. This paper examines a traditional and some new shape classifiers to see what they can tell us about remnant vegetation distribution.

Remnant vegetation in a landscape is comprised of a collection of physically separate patches. A patch may contain different types of vegetation but this variation is not considered in this discussion.

Perimeter to Area Ratio

Perimeter to area ratio is widely used as a measure of remnant management viability in bushland management:

PA = P / A;

where P = perimeter and A = area

This is based on an assumption that shorter boundaries and larger areas are good properties for a remnant so remnants with a low PA ratio are more viable than areas with a higher PA ratio. The measure is not dimensionless with the units being the inverse of length.

The definition is certainly intuitive but what does it look like when applied to a diverse range of remnants? Figure 1 shows PA ratio for remnants from the coast to the scarp with dark green patches having lowest PA ratio and red the highest values.

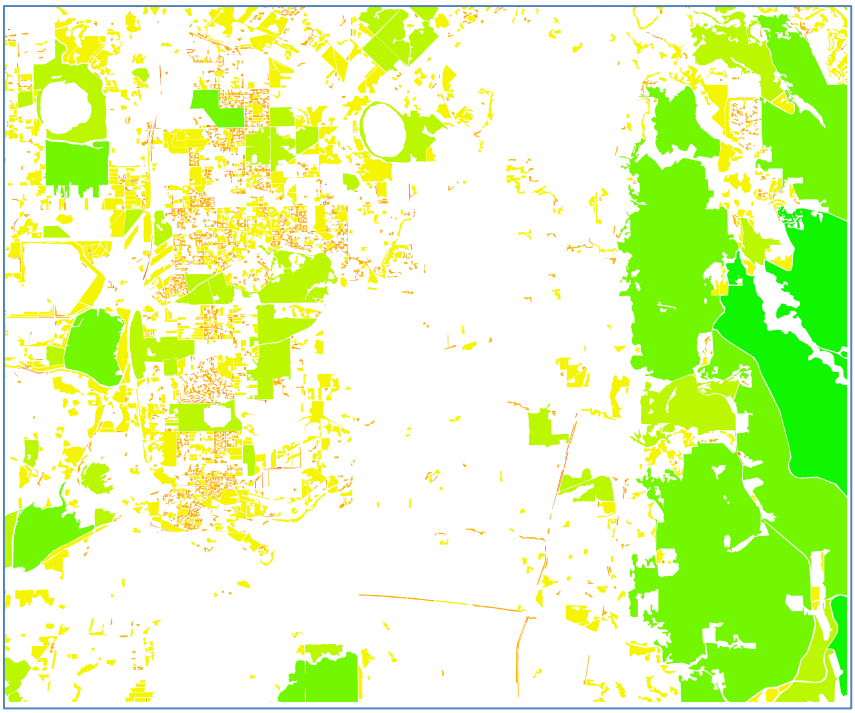


Figure 0-1: Remnant vegetation by perimeter to area ratio. (Dark green represents small PA ration and red represents large PA ratio)

When applied regionally we notice that patch size is the dominant parameter. As area varies to the square of length, large patches have a low PA ratio irrespective of their shape. Thin linear features are not well-distinguished from more compact shapes. Conversely, small areas have a high PA ratio.

However, the PA ratio doesn't tell us very much when looking across a diverse landscape.

Perimeter Squared to Area Ratio - Circularity

To counter the effect of patch size dominating PA ratio the following modification to the formula derived from the isoperimetric inequality for shapes (http://en.wikipedia.org/wiki/Isoperimetric_quotient) is introduced:

$P2A = P^2 / A$

By using the square of perimeter the formula is converted into a dimensionless measure of shape as the units cancel out.

Further, the measure is *scale-less* and is a pure measure of the *circularity* of a shape – how much like a circle it is. Circles have the lowest P2A ratio and as described in the introduction, circle is the "ideal" patch shape. The scale-less property means that a patch that has exactly the same boundary shape (e.g. rectangle) as one that is 10 times smaller (a smaller rectangle with same width to height ratio) will have the same P2A ratio.

Figure 2 represents the application of P2A ratio to the same area pictured in Figure 1. Green = low P2A ratio, red = high P2A ratio:

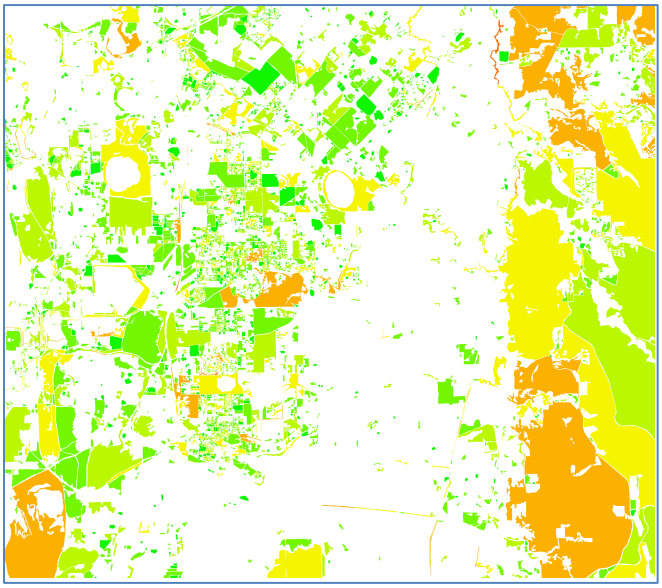


Figure 0-2: Application of P2A ratio. (Green = low, orange = large)

Compact patches are green and thin linear features are well identified as orange-red. Patches with a complicated boundary but otherwise compact show up as yellow-orange.

Shape and Scale

The P2A ratio provides a convenient single number to describe how close to the ideal circle the shape of a patch is. It is a scale-less measure independent of the size of the shape. However, much of our understanding of physical phenomena depends very much on scale – not just in the way we measure them but how we define them.

Consider a whole-of-state view of Western Australia. When displayed on a computer monitor and with the finite resolution of human vision we can perceive the Swan River estuary as a fairly simple shape. As we increase the magnification more detail of the estuary boundary and minor tributaries can be seen. As we zoom in further even minor tributaries become complicated shapes. At each zoom level we can see landscape features at a particular range of detail. Features that are too small cannot be seen and features that are very large may not be apparent because the rate of change of detail is low at the viewed scale.

So, it is desirable to create scale-dependent measures of a distribution of shapes such as remnant vegetation in a landscape to help understand scale-specific phenomena.

Buffered Boundary Classifier

A new scale dependent shape classifier is introduced. For a given remnant patch P, a new shape is created by buffering P by a fixed distance d. The classifier is calculated as:

C(P, d) = Area(P) / Area (P buffered d);

where Area() is a function calculating the area of a shape. C is a dimensionless measure as it is the ration of two areas. However, it is specified by d which is a distance and has a unit.

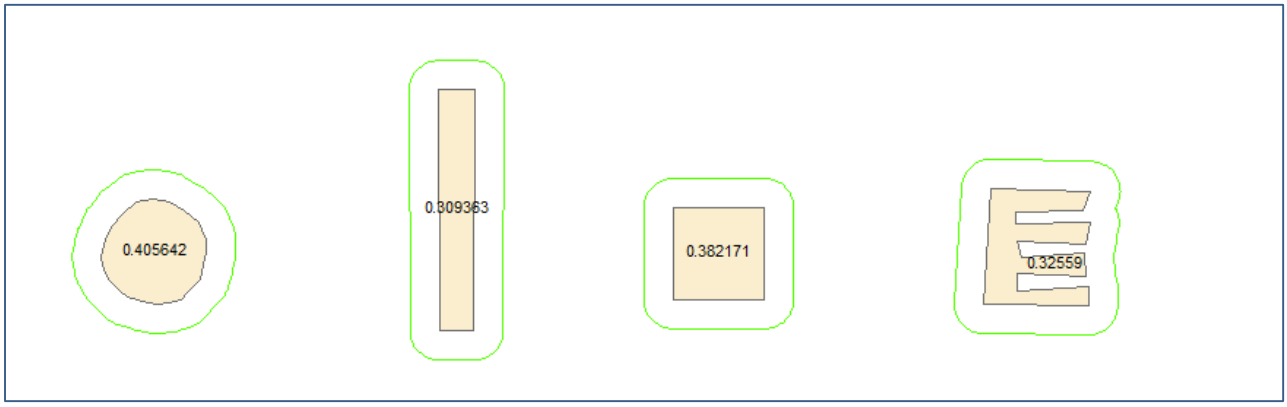


Figure 0-3: Changing Buffered boundary classifier value when applied to various shapes.

The shapes in Figure 3 are about the same size (10 units squared) with a buffer distance of 1 unit applied (green boundary). Shapes are labeled by calculated C value. Some observations:

- circle has highest C value – slightly larger than the square which is also very compact
- thin rectangle has lowest C value
- the fork shape has a higher value than you might expect given the complex shape but the distance between the fork tynes is < 1 unit.

Figure 4 shows the effect of reducing the buffer distance, d, to 0.1 units.

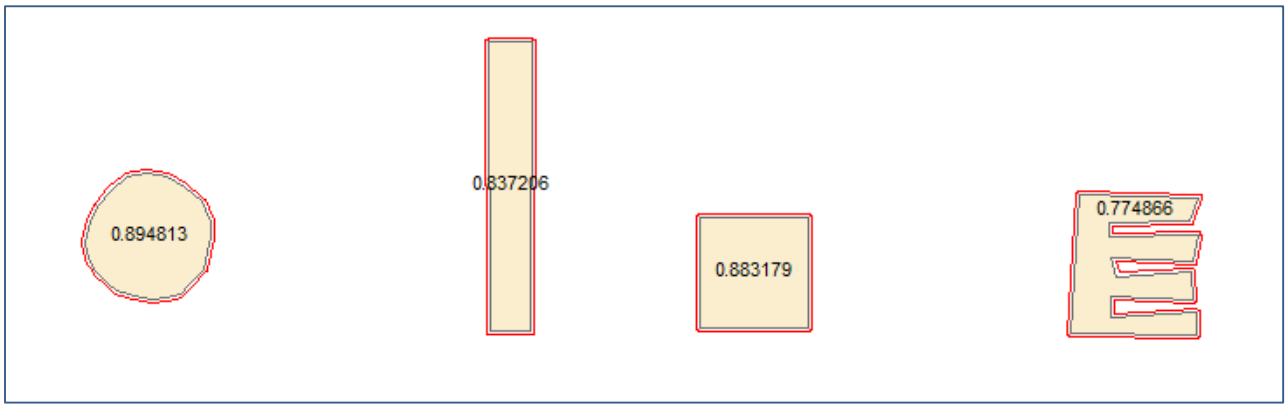


Figure 0-4: Effect of variation of the buffer on the value of the buffered boundary classifier.

Observations:

- circle and square have about the same values
- thin rectangle has moderate C value
- fork shape has lowest C value.

Figure 5 shows the effects of d being increased to 10 units. Buffered boundary classifier values are approximately the same for all the different shapes.

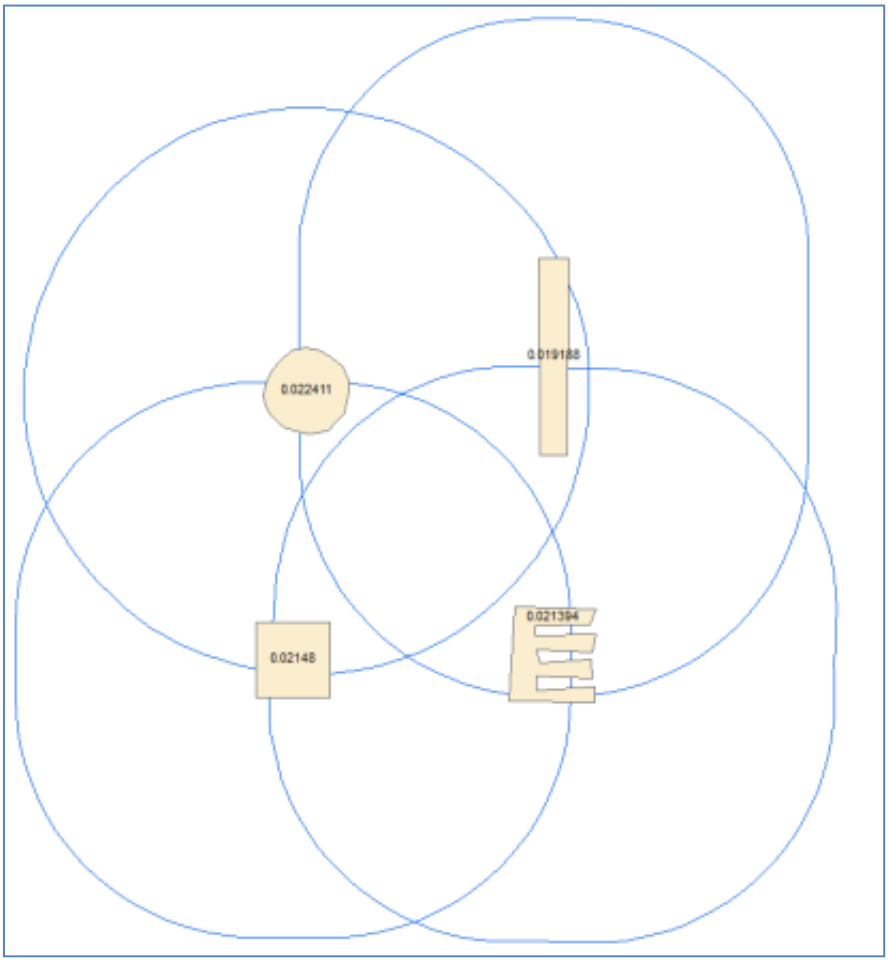


Figure 0-5: Effect of increased buffer distance on the buffered boundary classifier value.

What is happening? With d = 1, the classifier works well to discriminate differences in shape where the scale of change is about 1 unit in size. Thus it works well to pick out the thin rectangle. However, it fails to discriminate the fork shape which has shape changes < 1 unit in size (the fork tynes).

With d = 0.1, the fork tynes are discriminated but not the larger scale shape changes (thin rectangle vs square).

At d = 10, the features are all about the same at that scale and have similar C values. But you can imagine if the shapes were 10x in size in length and width then d = 10 will serve well to discriminate amongst them.

This suggests that for a given value of d there will be a range in size of shape features (variation from a circle of radius d) that it will be effective in discriminating.

Integrated Buffered Boundary Classifier

While it is very informative to look at C values for a range of d values separately, can the C equation be generalised to create a single measure for the whole landscape across a range of d values? The standard mathematical technique is to integrate C for a range of d [0, dmax].

As it is not possible to calculate the integral precisely we can approximate it by a finite sum

$C_S = \sum C(P, d)$

where d is an element of some set of values. But what set of values should be used? The set of d values should be chosen to represent characteristics of the input shapes (set of P).

Remnant Vegetation and the Buffered Boundary Classifier

What does the buffered boundary classifier inform us about remnant vegetation? By exploring C values for different d values you can get a sense of detail at different scales for the patch. Does it have fine detail or coarse detail? How close is it to circular at different scales?

When scales are combined in the integrated form we have a single number that can discriminate patches such that:

- low numbers correspond to small or poorly shaped patches
- high numbers correspond to large, compact patches.

Remnant Vegetation and Distribution

Consider the following typical illustration of remnant patches in a semi-developed area (Figure 6).

While we can classify the shape of each patch using any of the previously described classifiers it doesn't make much sense to consider patches by themselves. In the above example the patch highlighted is really part of a larger network of remnant vegetation. It may be separated from its neighbours by fences, firebreaks and small physical barriers but it isn't truly separated in an ecological sense. Animals and plant propagules such as pollen can easily be spread between adjacent patches.

So, shape classifiers need to be extended to consider the surrounding landscape. Two variations of the buffered boundary classifier were developed.

Figure 0-6: Example of remnant patch distribution.

Fragmentation

This is a variation of the buffered boundary classifier where the buffer area for a shape P is calculated but instead of the area of P being the dividend, the sum of all remnant vegetation within the buffered area is used as illustrated in Figure 7.

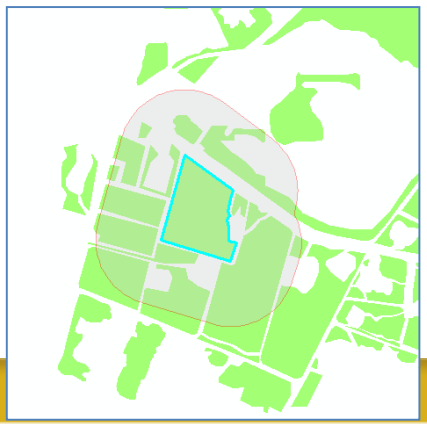


Figure 7: Remnant patches shown as part of a patch network within a d buffer.

So, fragmentation F can be written as:

F(S, P, d) = Area(S within P buf d) / Area (P buf d);

where S is the set of all remnants in the landscape. It can be written in integrated form as:

$F_S = \sum C(S, P, d)$.

The set of d's chosen for the Regional Framework for Local Biodiversity Conservation Priorities for Perth and Peel (RFLBCP) fragmentation measure are {10, 20, 50, 100, 250, 500 metres}. Figure 8 shows the results of C_{LS} mapped in the RFLBCP study area where low values of F_S are represented in red and high F_S values are green.

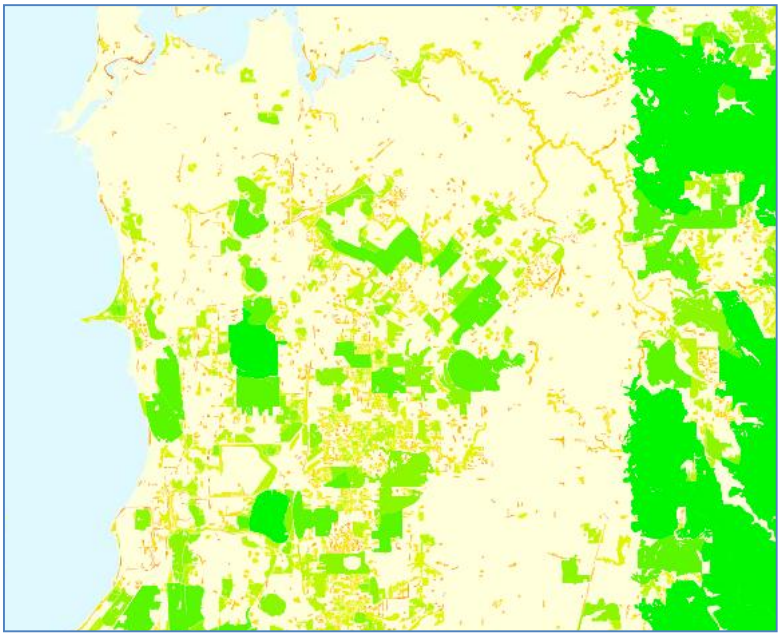


Figure 8: Remnant vegetation by 'Fragmentation' in the portion of the southern Metropolitan Region.

Fragmentation F_S discriminates patches such that:

- low numbers correspond to small, locally isolated or poorly shaped patches (red, orange)
- high numbers correspond to large, compact or locally well connected patches (green).

Regional Connectivity

A variation on fragmentation is regional connectivity where the buffer is calculated on not just the selected patch but all patches that can be reached from the patch by travelling no more than d distance, expressed by the following formula:

C(S, P, d) = Area(S within d of P) / Area ((S within d of P) buf d);

where S is the set of all remnants in the landscape. By using different values of d we can examine the potential range of an organism if it has a limited travel distance.

Figure 9 illustrates an example where a d of 20m is applied to the example patch used in Figures 6 and 7.

Figure 9: Illustration of patch network connectivity, Regional Density, with d value of 20 metres.

The example remnant vegetation patch is part of a large network of patches all within 20m of each other. More isolated patches form smaller groups or are by themselves.

The integrated form of Regional Connectivity, C_S, can also be calculated and applied with same values of d as F_S {10, 20, 50, 100, 250, 500m} (Figure 10).

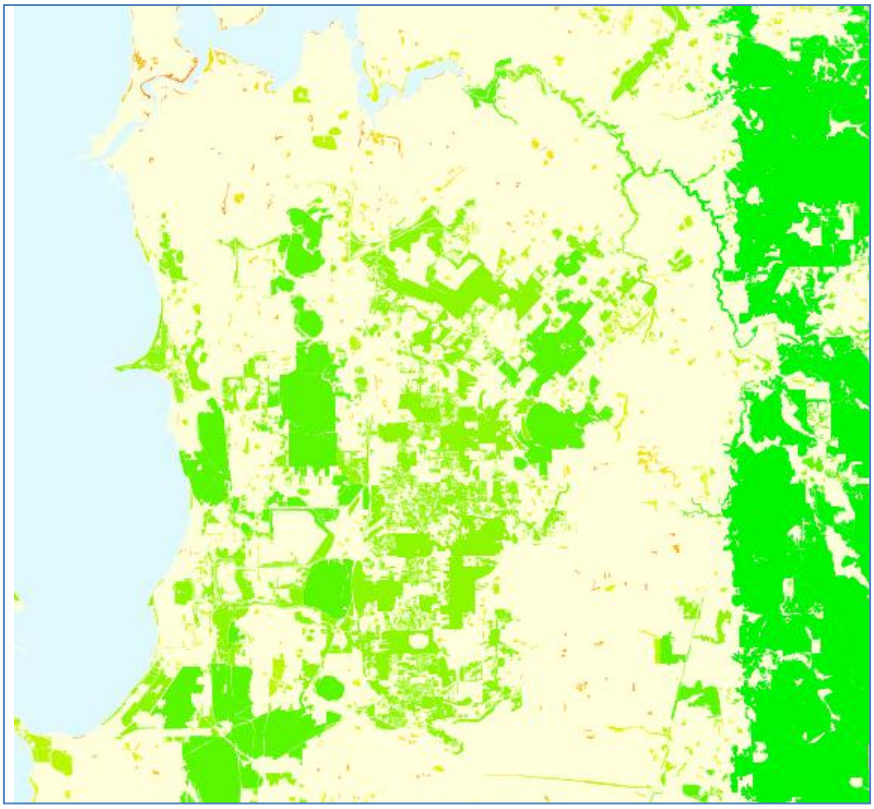


Figure 10: Remnant vegetation by 'Regional Density or Connectivity Quality" in the southern Metropolitan Region.

C_S discriminates patches such that:

- low numbers correspond to small, regionally isolated or poorly shaped patches (red, orange)
- high numbers correspond to large, compact or regionally well connected patches (green).

When comparing the Canning River system values for F_S (Figure 8) and C_S (Figure 10), the high C_S value suggests it has a strong role in connecting the region. However, a low F_S value suggests that it is a fragile system.

Reach

Regional density for a patch involves calculating the neighbouring patches that may be traversable from the patch at a particular distance. Restated from above:

C(S, P, d) = Area(S within d of P) / Area ((S within d of P) buf d);

where S is the set of all remnants in the landscape.

The dividend of that expression:

Area(S within d of P)

is the total area that can be accessed from a patch, P, by traversing no more than a patch gap of d. Calculated across the landscape, larger area indicates patches which are part of a larger connective

group than smaller areas. As there is tremendous variation within areas, a new parameter reach is calculated as follows:

$R(S, P, d) = \log_e(\text{Area}(S \text{ within } d \text{ of } P))$

The logarithm is taken to give a sense of the scale of the area. Summed across a range of d distances this gives:

$R_S = \sum \log_e(\text{Area}(S \text{ within } d \text{ of } P))$;

where d is an element of some set of distances e.g. {10, 20, 50, 100, 250, 500m}.

Considered across a landscape, higher reach values indicate patches which are part of larger connected networks than patches with smaller reach values.

Representing Connectivity Parameters

We don't know enough about connectivity parameters to say what constitutes "good" or "bad" for particular values. Consider regional density where we observe that:

- low numbers correspond to small, regionally isolated or poorly shaped patches
- high numbers correspond to large, compact or regionally well connected patches

How do you define a "low" or "high" number? Yet we need to be able to meaningfully symbolise a map so that patches can be shaded in some gradient such that someone looking at the map can discriminate between the various patches.

Initially, the approach was to use classfications internal to a study area ie. develop ranges for colouring the maps based on the distribution for that particular study. The connectivity measures have been used for over two years (as of June 2014) on several projects in varied parts of the south-west landscape from largely vegetated rural areas such as Augusta Margaret River to largely cleared areas such as central Perth. Over this time experience has allowed a standard scale to be developed that seems to describe well the different types of landscapes the connectivity measures have been applied to.

For map colouring, any colour gradation could be used such as red to green or light purple to dark purple to represent the spectrum of these parameters.

<u>Fragmentation</u>
Range : Legend description
[0,0.5) : most fragmented 0 - 0.5
[0.5,1) : 0.5 - 1
[1,1.5) : 1 - 1.5
[1.5,2) : 1.5 - 2
[2,2.5) : 2 - 2.5
[2.5,3) : 2.5 - 3
[3,3.5) : 3 - 3.5
[3.5,4) : 3.5 - 4
[4,4.5) : 4 - 4.5
[4.5,5] : 4.5 - 5
> 5 : least fragmented > 5

Regional Connectivity
Range : Legend description
[0,0.5) : small, poorly shaped or regionally isolated patches 0 - 0.5
[0.5,1) : 0.5 - 1
[1,1.5) : 1 - 1.5
[1.5,2) : 1.5 - 2
[2,2.5) : 2 - 2.5
[2.5,3) : 2.5 - 3
[3,3.5) : 3 - 3.5
[3.5,4) : 3.5 - 4
[4,4.5) : 4 - 4.5
[4.5,5] : 4.5 - 5
> 5 : large, compact or regionally well connected patches > 5

Reach
Range : Legend description
< 0 :part of a small network < 0
[0,10) : 0 - 10
[10,20) : 10 - 20
[20,30) : 20 - 30
[30,40) : 30 - 40
[40,50) : 40 - 50
[50,60] : 50 - 60
> 60 : part of a large network > 60

Viewing Changes in Connectivity Parameter Values – Scenario Modelling

A great potential of connectivity calculation is to model the effect of various scenarios such as clearing of vegetation for development or examining the effect of a proposed revegetation corridor. Such scenarios can be modelled by adding or removing patches to the study area and re-running the calculations.

Using Shape Classifiers to Explore Connectivity Scenarios in the Landscape

Can the shape classifiers described above provide diagnostic insight into remnant distribution and connectivity? The classifiers have fairly straightforward and simple definitions but are they useful and easily interpretable? The following examples are for reach, regional connectivity and fragmentation calculated for an area from Bold Park to Kings Park in Perth with three scenarios explored:

1 current remnant vegetation extent and significant wetlands

2 assuming Public Open Spaces can be vegetated to support connectivity of the mapped remnant vegetation

3 all remnant vegetation is cleared except for that in areas considered protected (Bush Forever Areas).

For the second analysis, a surrogate layer of areas that potentially could be re-vegetated was created by applying a 25 metres buffer along Public Open Space boundaries. Public Open Spaces were identified using the Local Planning Schemes overlapping the study area (sourced from the Department of Planning, January 2012).

Figures 11-13 show the three scenarios with a discussion following each section. The set of distances, d, used are {10, 20, 50, 100, 250, 500m}.

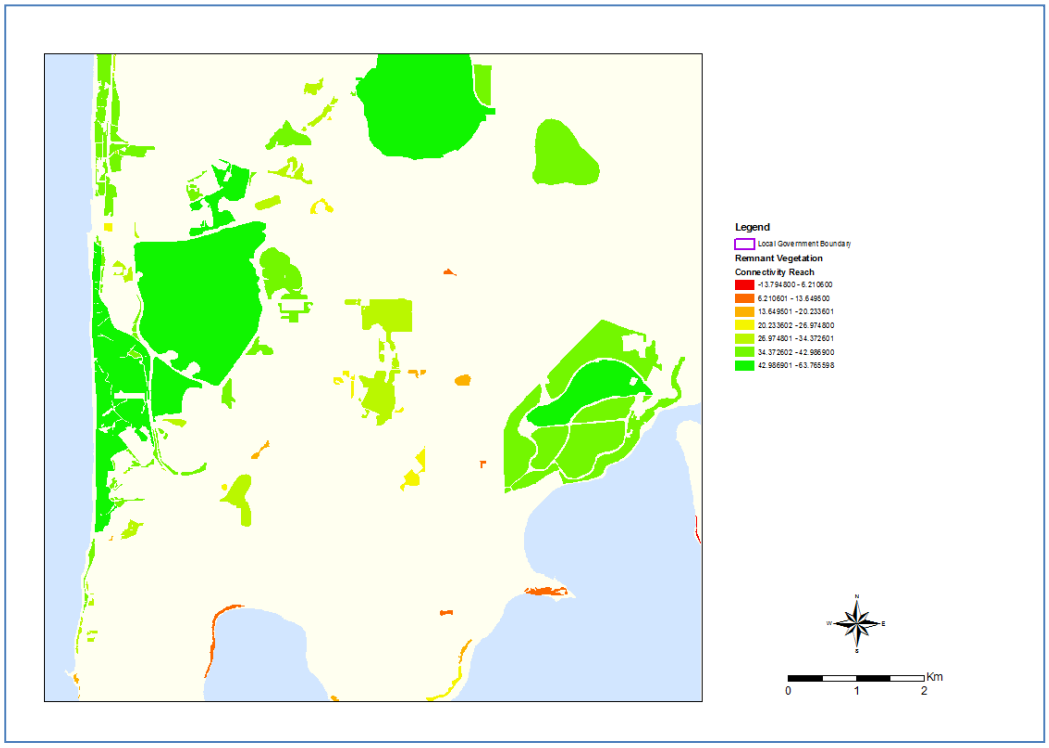


Figure 11: Application of 'Reach' classifier to the current extent of remnant vegetation.

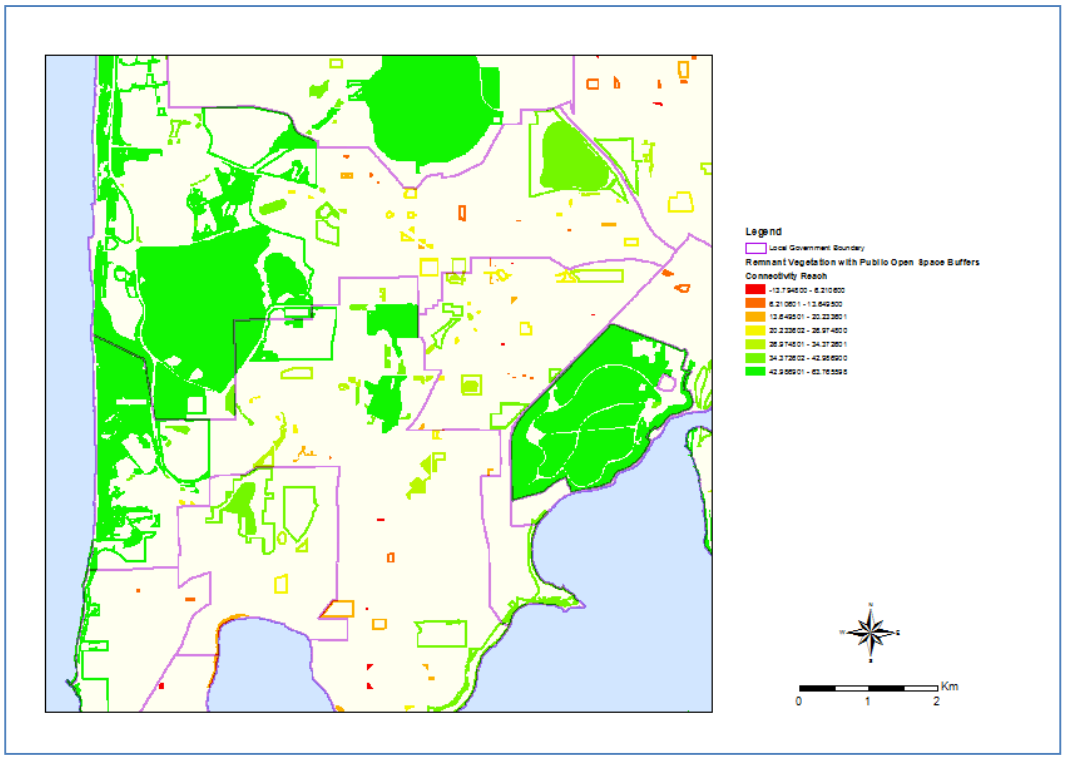


Figure 12: Application of 'Reach' classifier to current remnant vegetation, significant wetlands and buffers within Public Open Space.

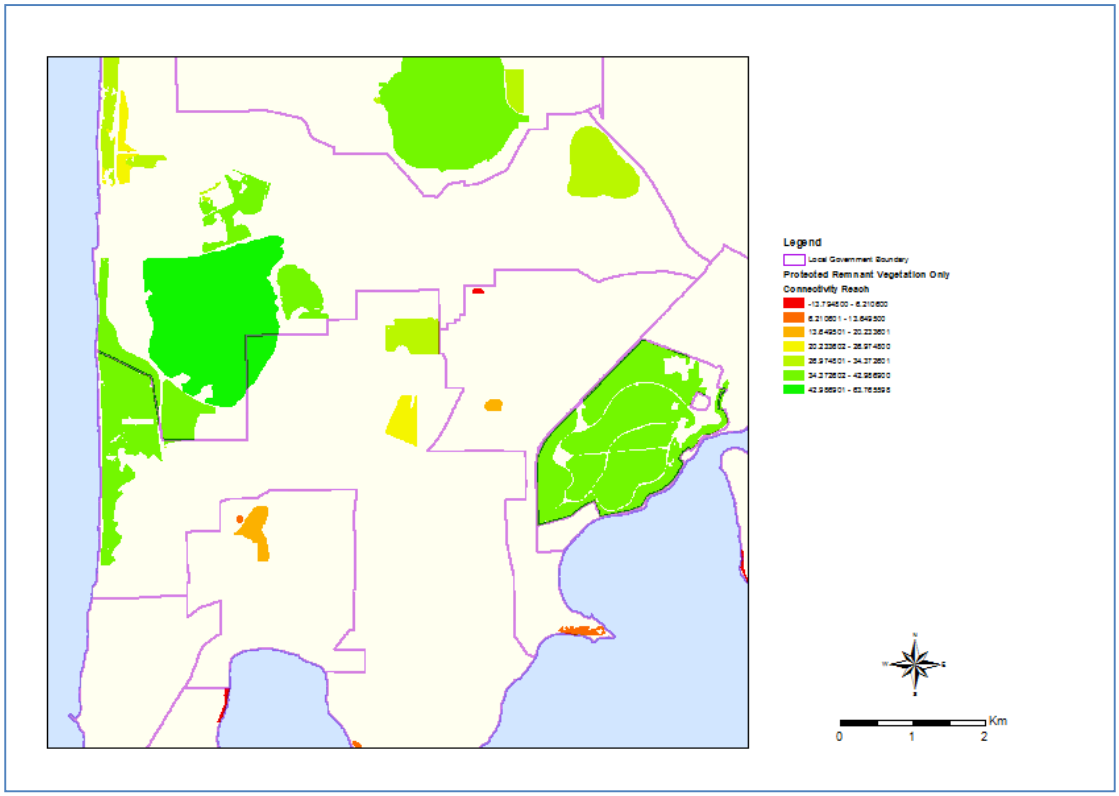


Figure 13: Application of the 'Reach' classifier to remnant vegetation and wetlands in areas considered protected.

Figure 11 forms the baseline, showing remnant vegetation as mapped in 2010. If vegetation corridors can be created to link the remnants then Reach improves significantly as shown in Figure12. The patches become part of larger networks, or, more “connected”. On the other hand, if remnant vegetation continues to be cleared with no linkages created then there is an overall decline in Reach (Figure13).

Another way to interpret Figure 12 is that the Public Open Space linkages that play a significant role in joining the landscape have a high Reach value (green). Perhaps this can be one way to identify significant linkages.

Application of Regional Connectivity to the three remnant vegetation extent scenarious

Regional Connectivity is a complementary parameter to Reach. While Reach describes the size of the connected network a patch is part of, the Regional Density describes the quality of connection (how far it deviates from the ideal circular shape) of the network.

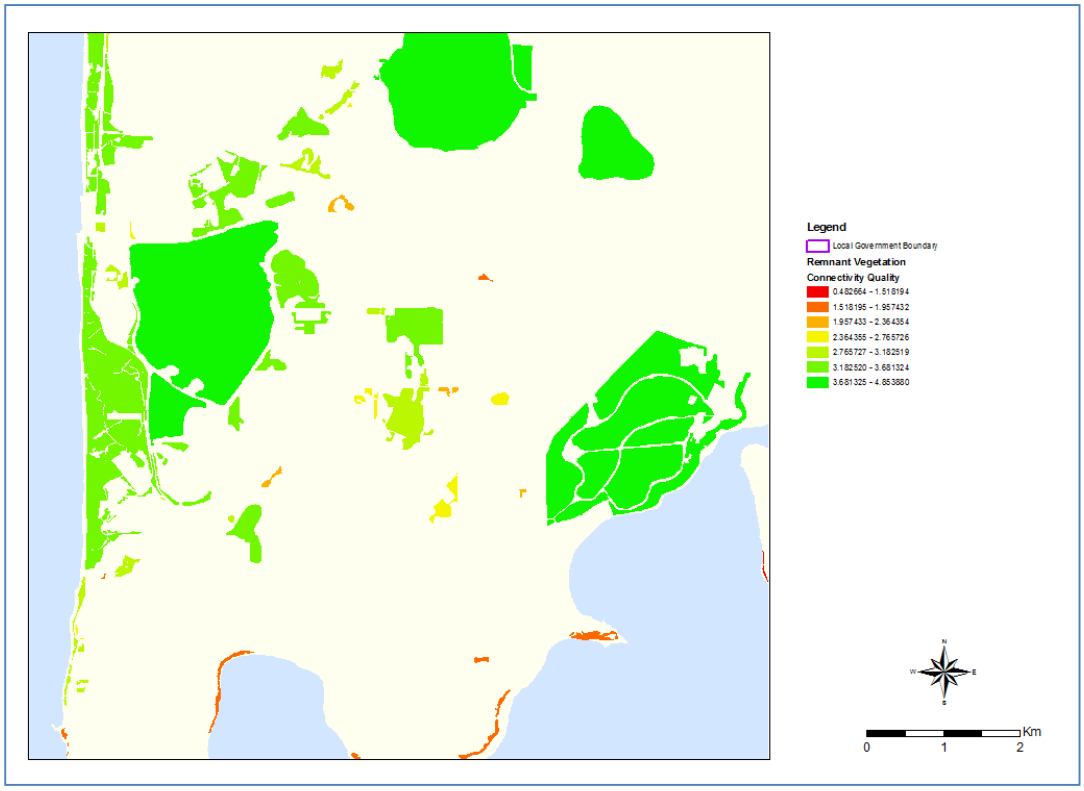


Figure 14: Remnant vegetation and significant wetlands by Regional Connectivity.

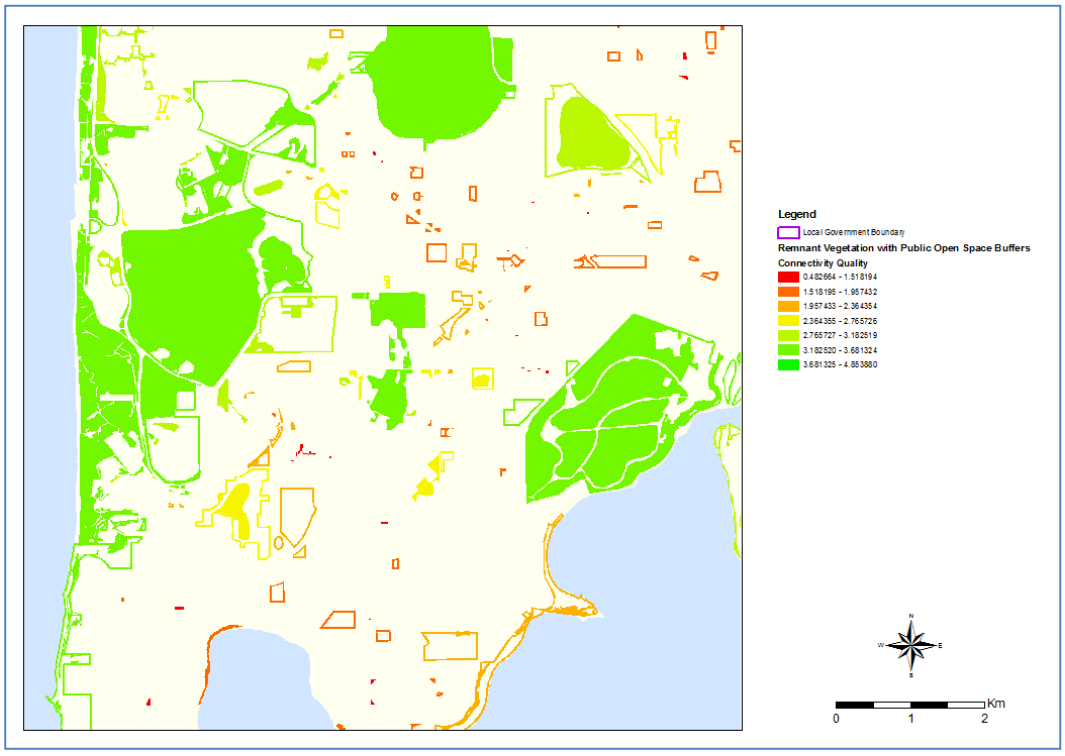


Figure 15: Application of Regional Connectivity to remnant vegetation, significant wetlands and buffered Public Open Space areas.

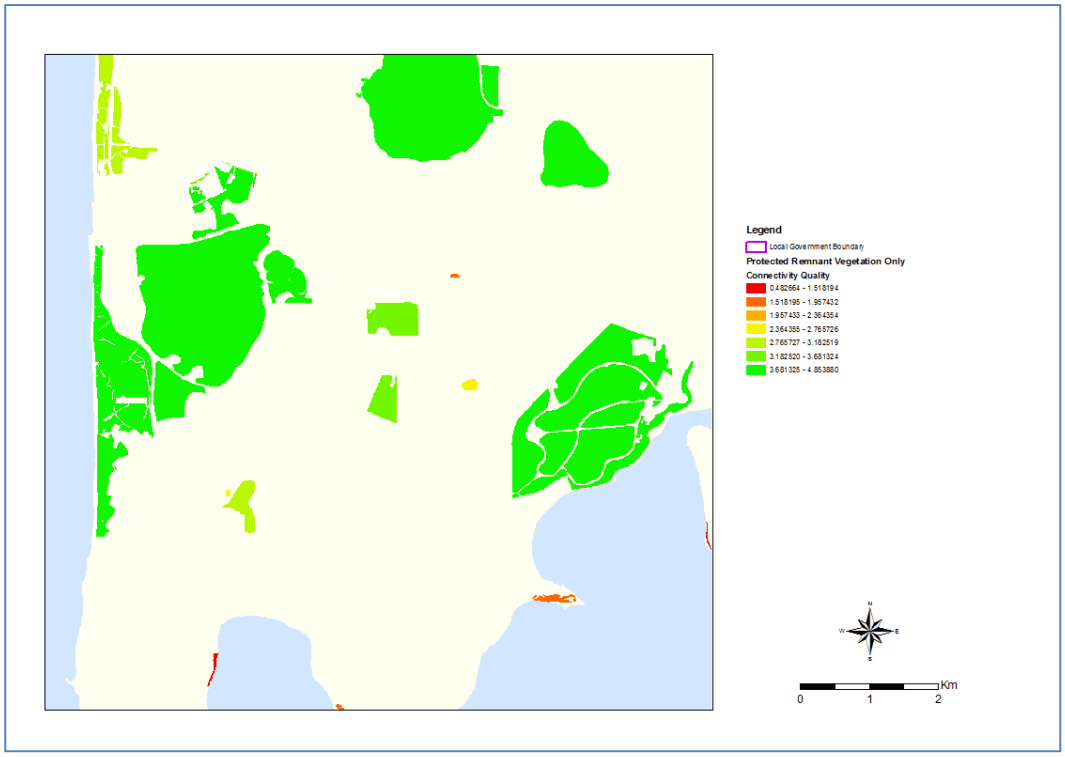


Figure 16: Effects of vegetation clearing on the value of Regional Connectivity in protected areas.

While Reach improves with the addition of Public Open Space (POS) linkages, Figure 15 shows Regional Connectivity decreases in some remnant patches following the inclusion of POS into the analysis. This is because the buffered POS areas used as surrogates are represented by thin linear features, that whilst helping to create larger networks are quite weak in themselves. Linkages can have the characteristic of difficult to manage remnants so they detract from the overall quality of the connected network.

Fragmentation

Fragmentation explores what is going around a patch, rather than the regional network it may be connected to.

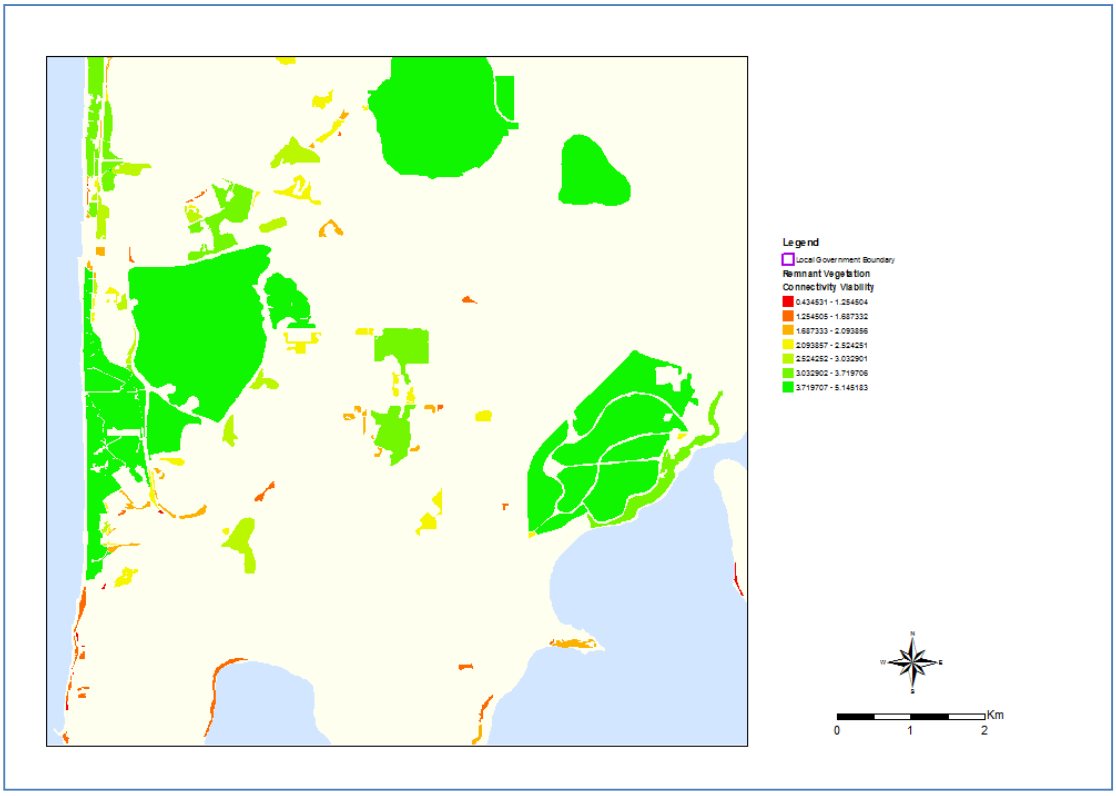


Figure 17: Remnant vegetation and significant wetlands by Local Density

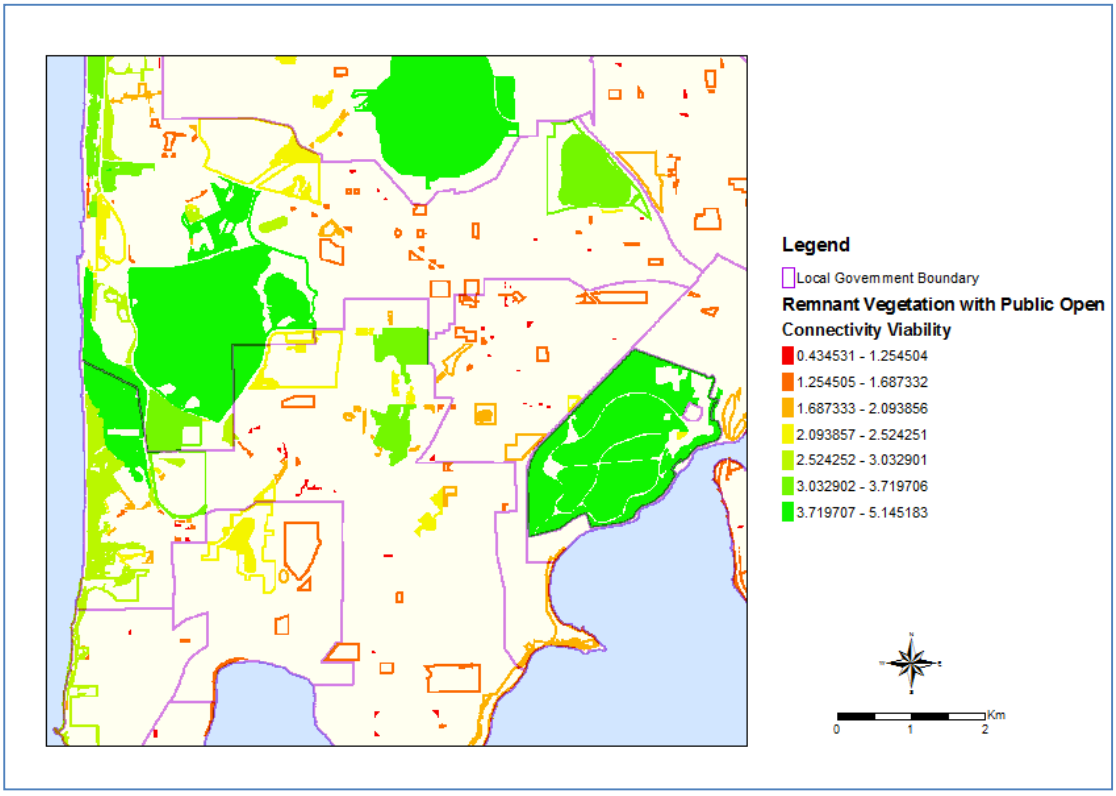


Figure 18: Application of Local Density to remnant vegetation, significant wetlands and buffered Public Open Space areas.

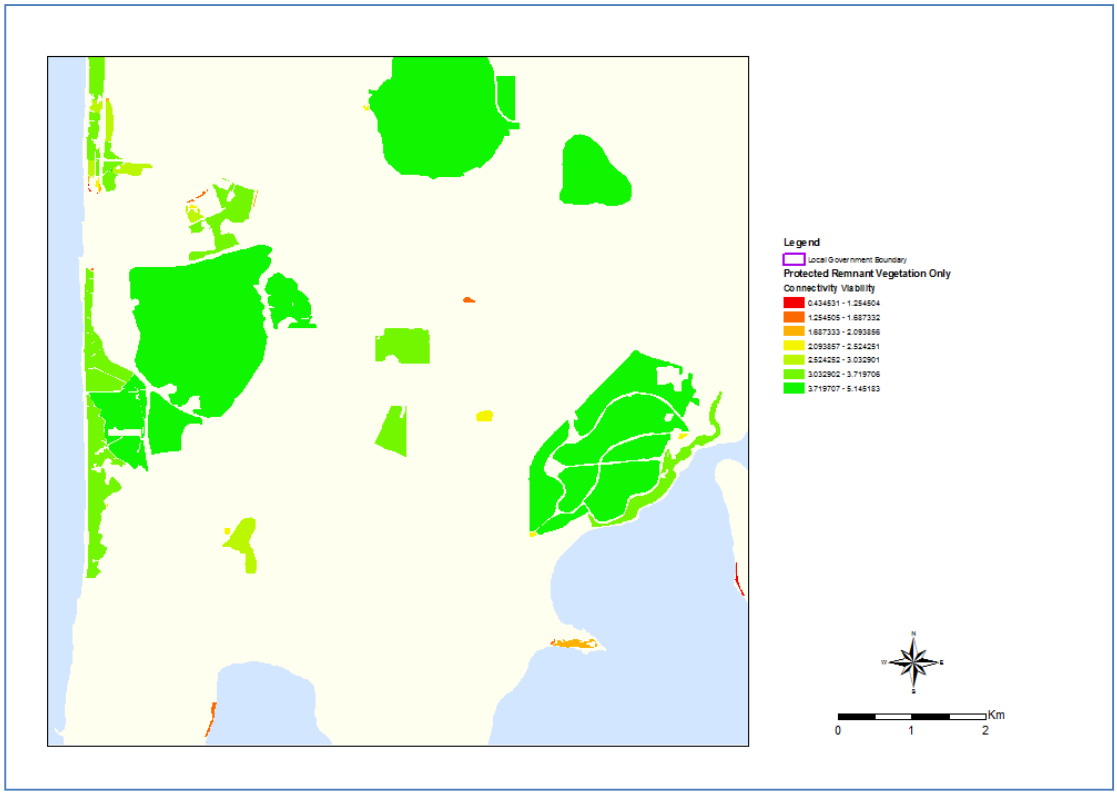


Figure 19: Effects of vegetation clearing on the value of Local Density in protected areas.

Fragmentation is not particularly affected by linkages or the removal of remnant vegetation (except in some cases where the shapes of the patches are changed). If we consider local density to be a surrogate for how viable a patch is in the landscape then, clearly, the thin linear features of linkages score a low viability score but they serve a role in joining the large, compact remnant vegetation patches such as Bold Park an Kings Park.

Together, all three indicators provide a useful insight into the distribution of vegetation in the landscape and the possible role linkages may play and the possible impact of further vegetation clearance.

APPENDIX H: Limitations of the native vegetation prioritisation and connectivity analysis

When referring to the results of mapping in this study, it is important to consider the limitations of the datasets used and thus the limitation of their interpretation:

- Remnant vegetation extent mapping is based on 1:20,000 scale and includes areas that are highly degraded as well as sites that were revegetated after being completely cleared. Therefore, vegetation retention and protection status represented as a percentage of the pre-clearing extent are considered over-estimates. Therefore, when comparing the local or regional vegetation retention and protection status against the accepted thresholds of 10%, 30% or 17%, the actual figures of 15%, 40% and 20% are used.
- Datasets representing threatened ecological communities, and rare and priority flora and fauna, do not necessarily represent the full extent of known records or a comprehensive listing of all threatened species and communities, as comprehensive-ness is dependent on the amount of surveying done in an area. Therefore absence of records should not be interpreted as absence of conservation priority flora, fauna or ecological community until the survey status for a locality is investigated. Field assessments are essential to confirm the presence or absence of significant biodiversity features.
- Mapping of granite outcrops, which are important refuge sites for flora and fauna is limited. More accurate mapping suitable for local level assessments should be used to inform future land use decisions.
- Local Planning Schemes are updated from time to time, as amendments are approved. When considering the study recommendations, it is important to consider the date of datasets used.
- The opportunities and constraints analysis does not consider basic raw material locations, Aboriginal Heritage sites or land subject to Native Title claims.
- Datasets that were created to act as surrogates for specific prioritisation criteria, such as riparian vegetation or potential feeding habitat for Carnaby's black cockatoos, are based on generalisations. The real extent of these features needs to be determined in the field.
- Buffers to waterways and wetlands represent the minimum width required, and might not be sufficient for some wetlands. Adequate buffers need to be determined after consideration of a range of local conditions. Some guidance is provided in the EPA Guidance Statement No 33 (2008) or visit the following website: http://www.dpaw.wa.gov.au/management/wetlands/conserving-and-managing-our-wetlands .

- The degree of connectivity assigned to each remnant patch is based on 2013 vegetation extent mapping (provided by DAFWA, 2013). Vegetation clearing since 2013 will affect connectivity values.
- Connectivity modelling does not consider the movement patterns of specific species , habitat requirements, or inner patch connectivity. For example, water bodies are included in the connectivity modelling and are considered a single patch including the adjoining fringing vegetation; but the open water would present a barrier to the movement of many terrestrial species. A proportion of open water within a remnant patch can also limit the availability of suitable habitat within that patch for a range of terrestrial fauna.

APPENDIX I: Target Areas – Notes on opportunities to improve protection status of priority vegetation

Vegetation complexes and Beard vegetation associations	**Notes/Comments** LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	**Area of vegetation within Target Areas (TA)** **(**Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
Bindoon-Bi Woodland of *Eucalyptus loxophleba* on the slopes, flanked by woodlands of *Eucalyptus wandoo-Eucalyptus accedens* on the breakaways and upper slopes in the peri-arid zone.	• 88% on lands zoned Rural – Agriculture (fragmented), 11% reserved for Public Purposes and zoned Special Use (SU4 in LPS 6, vegetation to be retained in 30m riparian buffer), 1% within Road reserves • No local formal protection • Several good opportunities within patches >40ha, most remnants <10ha • Mostly within a buffer of a confirmed breeding site of the Endangered Carnaby's black cockatoo. Bi1 – Includes property with existing provisions to protect and enhance the existing agricultural and environmental status of the land (Group Farming, A2, in LPS 6), Property listed on the State Register of Heritage Places (geological monument) Bi2 – smaller patches but along creeklines and while it might be difficult to achieve formal protection, support to landholders with fencing and management of threats will help to retain these larger remnants. Bi3 – within SU4 (LPS 6) – provision to protect vegetation and restoration. It is not feasible to protect 797ha of Bi within the Shire even though over 800ha is within the proposed TAs because of high level of fragmentation of vegetation representative of Bi. Larger patches in good condition and acting as stepping stones (with fragmentation index >3 and regional connectivity index >3.5) should be a priority for formal protection. Every opportunity to improve the protection status of this vegetation complex in the Shire should be explored. A large portion of vegetation within Bi1 and Bi4 is within the SCA Landscape Protection in LPS 6. Note: There is a large LFW property within the Shire of Toodyay adjoining the Shire of Northam boundary. Retention and protection of natural areas within Bi1 will provide important stepping stones between this LFW property and close-by DPAW reserves within the Shire.	In Bi1: Bindoon - Bi 642.90 ha In Bi2: Bindoon - Bi 34.41 ha In Bi3: Bindoon - Bi 36.78 ha In Bi4: Bindoon - Bi 91.99 ha Total in TAs: 808ha **Area required to achieve adequate local protection:** 797ha

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
	In LP Strategy – Bi1- Bi4 are mostly in Landscape Protection zones, except the largest remnant within Bi1 which is identified as Priority Resource and Extraction Area.	
Coolakin – Ck Woodland of *Eucalyptus wandoo* with mixtures of *Eucalyptus patens, Eucalyptus marginata* subsp. *thalassica* and *Corymbia calophylla* on the valley slopes in arid and peri-arid zones	225ha in reserves R30393, R4200, R28043, R25785 & R30185 recommended for purpose to include conservation. Ck3 includes R23746 & R30185 which adjoins a strip of land zoned Agriculture-Local between Koojedda Rd and the Great Eastern Hwy, mapped as ESA. This area adjoins the eastern portion of the Woondowing Nature Reserve. Ck2 – identified in the LP Strategy as 'Priority Resource and Extraction Area" – future potential extractive activities should consider alternative locations and minimise impact on the remaining vegetation. R30393 is vested for the purposes of Zoological Garden and reserved Parks & Recreation in the LPS. Subject to vegetation condition assessment, it is recommended that conservation of threatened vegetation is added to the reserve purpose. Ck1 & Ck4 are within the Landscape Protection SCA in LPS 6. Due to the fragmented nature of remnants representative of Coolakin vegetation complex, it will not be possible to contribute the 1073ha, the missing share from the Shire to the regional protection of Coolakin. Every opportunity to improve the protection status of this vegetation complex in the Shire should be explored.	In Ck1: Coolakin - Ck 259.77ha In Bi1: Coolakin - Ck 63.49 ha In Ck2: Coolakin - Ck 42.51 ha In Ck3: Coolakin - Ck 14.17 ha In Ck4: Coolakin - Ck 46.97 ha In Ck5: Coolakin - Ck 155.95ha In Ck6: Coolakin – Ck 85.50ha InCk7: Coolakin - Ck 31.84ha In Ck8: Coolakin - Ck 25.78ha Total in Ck1-Ck8 &Bi1: 726ha **Area required to achieve adequate local protection:** 1073ha
Michibin – Mi Open woodland of *Eucalyptus wandoo* over *Acacia acuminata* with some *Eucalyptus loxophleba* on valley slopes, with low	30ha in R28043, R44700, R30393 and R293 recommended for purpose to include conservation. TA Mi1 includes 3 properties registered with LFW. Retention and protection of vegetation within Mi1 and Mi2 is important to maintaining connectivity within Wheatbelt High Priority connectivity zone, and between conservation reserves Warranine Nature Reserve, Clackline Nature Reserve and freehold land managed by DPAW (registered with	In Ck1: Michibin – Mi 104.62ha In Bi1: Michibin - Mi 19.84 ha In Bi4: Michibin - Mi 20.37 ha In Mi1: Michibin – Mi 373.78 ha In Mi2: Michibin - Mi 46.51 ha In Mi3:

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
woodland of *Allocasuarina huegeliana* on or near shallow granite outcrops in arid and peri-arid zones.	LFW and reserved Conservation of Flora and Fauna in the LPS). Mi4 – identified in the LP Strategy as 'Priority Resource and Extraction Area" In Mi5 includes properties zoned Rural Smallholdings with restrictions on further subdivision (RSH3, LPS 6). Support to landholders on properties adjoining the Clackline Nature Reserve will help with providing a buffer between the rural areas and the nature reserve. Mi6 – within SCA2 (Landscape protection – however LPS No 6 does not specify provisions) Mi6, Mi7 & Mi8 are within the Landscape Protection SCA.	Michibin - Mi 11.03 ha In Mi4: Michibin - Mi 101.00ha In Mi5: Michibin - Mi 106.69ha In Mi6: Michibin - Mi (b, c) 44.92 ha In Mi7: Michibin - Mi (b, c) 197.45 ha In Mi8: more than 230ha (1062 of vegetation within Mi8 mapped by Beard mostly as BVA 352 (Medium woodland; York gum) Total in TAs: at least 1256ha **Area required to achieve adequate local protection:** 948.52 ha
Murray 2 – My2 Open forest of *Eucalyptus marginata* subsp. *thalassica-Corymbia calophylla-Eucalyptus patens* and woodland of *Eucalyptus wandoo* with some *Eucalyptus accedens* on valley slopes to woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* on the valley floors in semi-arid and arid zones.	<2% protected locally, only 2.5ha in R33050 recommended for purpose to include conservation. My1 – includes part of R6203 (Reservoir/catchment, Water Corporation) and adjoins a DPAW freehold property. Includes the largest example of My2 within a large vegetated area that is being mapped as Conservation in the LP Strategy (no further development or subdivision assumed). Current zoning is Agriculture Local My2 – includes patches of vegetation registered with LFW. Most vegetation mapped as My2 outside the proposed TAs occurs in small patches on lands zoned Rural. If all the Murray 2 vegetation zoned in the LP Strategy as Conservation was formally reserved for Conservation, the local protection status of My2 would only increase to 6% of the pre-European extent. Therefore, further protection is dependent on conservation on private land. Due to the fragmented nature of the remaining vegetation representative of My2, it will not be	In My1 Murray 2 - My2 63.85ha In My2: Murray 2 - My2 89.74ha In My3: Murray 2 - My2 18.24 ha Total in TAs: 171.4ha **Area required to achieve adequate local protection:** 218ha

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
	possible to provide the proportionate share to the regional conservation status of this vegetation type.	
Swamp – S Mosaic of low open woodland of *Melaleuca preissiana-Banksia littoralis*, closed scrub of Myrtaceae spp., closed heath of Myrtaceae spp. and sedgelands of Baumea and Leptocarpus spp. on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones.	The only example of vegetation representative of Swamp vegetation complex is located within two properties zoned Agriculture-Local northeast of the Wundowie locality. Some extend onto adjoining properties zoned Rural Residential where long term retention of vegetation in good condition will not be viable. LP Strategy identifies this area as Future Rural Living Development (1-40ha), including a property held freehold by the Shire. The Shire's Land Rationalisation Strategy (2011) recommends that this property is to be subdivided and sold. Consideration of the introduction of a Rural conservation zone or creation of a local conservation reservation including the last remaining example of this locally rare vegetation type would provide more formal protection than subdivision conditions currently being used in other parts of the Shire.	In S1: Swamp - 10.9 ha **Area required to achieve adequate local protection:** 5ha
Williams – Wi Mixture of woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla,* low forest of *Casuarina obesa* and tall shrubland of Melaleuca spp. on major valley systems in arid and peri-arid zones	None of the remaining vegetation representative of Wi is protected in the Shire. Wi1 includes R32143 vested for Community purposes and containing 6.52ha of Wi. It might not be possible to formally reserve vegetation representative of Wi for conservation in the Shire due to the fragmented nature of the remaining vegetation. Opportunities exist to ensure informal protection of Wi through the provisions of the Landscape Protection zone (LP Strategy) and strengthening provisions for protection of vegetation along watercourses (e.g. extending the Avon & Mortlock River SCA provisions to other high priority areas as identified in the Local Biodiversity Strategy). Portions of Wi1, Wi2 and Mi8 are within the SCA Landscape Protection. While it might not be possible to formally protect 187ha of Williams vegetation complex in the Shire, every opportunity to improve the protection status of this regionally significant vegetation type should be investigated and supported.	In Mi1: Williams - Wi 3.91 ha In Wi1: Williams - Wi 115.71ha In Wi2: Williams - Wi 21.66 ha In Mi8 at least 9ha mapped but it is reasonable to assume that more would be mapped along Spencers Brook and its tributaries with the 1062 ha of vegetation within Mi8 mapped by Beard mostly as BVA 352 (Medium woodland; York gum) In BA6: at least 27.10ha Total in TAs: at least 150ha **Area required to achieve adequate local protection:** 187ha

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
Yallanbee – Y5 Mixture of open forest of *Eucalyptus marginata* subsp. *thalassica-Corymbia calophylla* and woodland of *Eucalyptus wandoo* on lateritic uplands in semiarid to peri-arid zones.	91.8ha is in R11619 and R25225 recommended for purpose to include conservation. There is 1434.7ha in R6230 reserved for Reservoirs/catchments and managed by the Water Corporation. Significant portions of Ck5 and My1 are being mapped in the LP Strategy as Conservation. If protection of vegetation within these areas was formalized, the Shire would achieve the minimal target for formal conservation of Y5.	In Ck3: Yalanbee - Y5 36.20 ha In Ck5: Yalanbee - Y5 38.52 ha In My1: Yalanbee - Y5 405.13 ha Total in TA: 479.7ha **Area required to achieve adequate local protection:** 198ha
Yallanbee – Y6 Woodland of *Eucalyptus wandoo-Eucalyptus accedens,* less consistently open forest of *Eucalyptus marginata* subsp. *thalassica-Corymbia calophylla* on lateritic uplands and breakaway landscapes in arid and peri-arid zones.	Ck1 includes R40986 (Water Supply) Yalanbee - Y6 Portion of Y1 is within the Landscape Protection SCA (LPS 6). There are many good opportunities to increase the formal protection status of Y6 in the Shire and meet the minimal contribution to the regional protection of this vegetation type (286ha). However, Y6 is the most widespread vegetation type in the Jarrah Forest portion of the Shire and thus plays an important role in connecting the landscape.	In Ck1: Yalanbee - Y6 52.78 ha In Bi1: Yalanbee - Y6 281.73 ha In Bi2: Yalanbee - Y6 11.89 ha In Ck3: Yalanbee - Y6 33.76 ha In Ck4: Yalanbee - Y6 68.61 ha In Ck5: Yalanbee - Y6 172.88 ha In Y1: Yalanbee - Y6 288.81 ha Total in TAs: 910.42 **Area required to achieve adequate local protection:** 285.63ha
BVA 352 Medium woodland; York gum	BVA 352 was and remains the most widespread vegetation type in the Wheatbelt portion of the Shire. Due to historical broadscale clearing, it has been overcleared and it is not possible to contribute with an adequate proportion from the Shire towards adequate protection at the regional level. The proposed TAs identify examples of BVA 352 with good opportunities to formalize protection	In Mi8: Katanning(AVW02) : 352 - 1034.23 ha Northern Jarrah Forest(JAF01) : 352 - 6.50 ha In BA 1: Katanning(AVW02) : 352 - 48.62 ha In BA3:

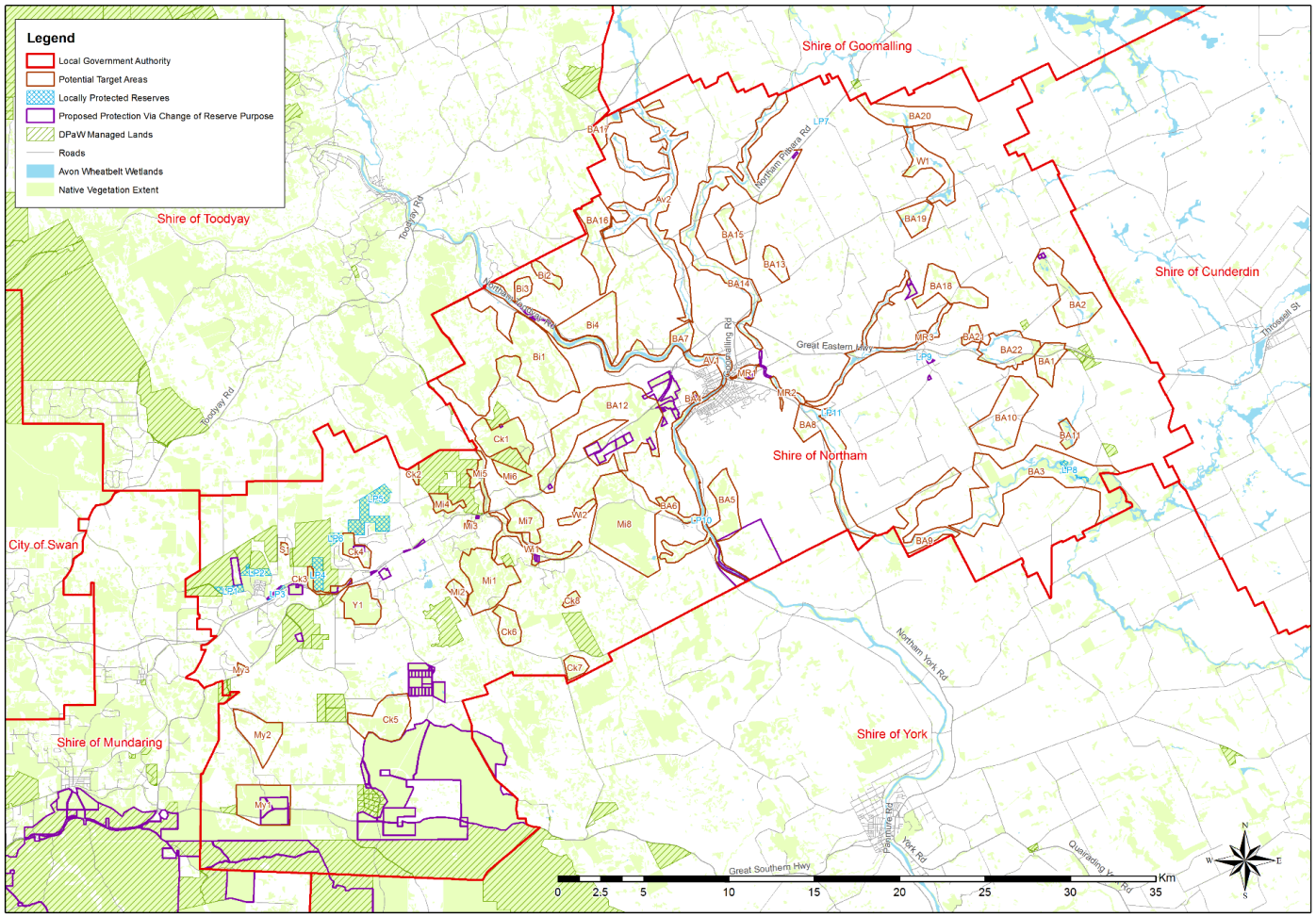
Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
	levels for portions of remaining vegetation in good condition.	Katanning(AVW02) : 352 - 371.02 ha In BA4: Katanning(AVW02) : 352 - 5.42 ha In BA5: Katanning(AVW02) : 352 - 239.58 ha In BA6: 352 – 365.26 ha In BA7: Katanning(AVW02) : 352 - 167.98 ha In BA8: Katanning(AVW02) : 352 - 99.44 ha In BA10: Katanning(AVW02) : 352 - 166.63 ha In BA11: Katanning(AVW02) : 352 - 46.58 ha In BA12: Katanning(AVW02) : 352 - 122.11 ha Northern Jarrah Forest(JAF01) : 352 - 8.21 ha In BA14: Katanning(AVW02) : 352 - 233.10 ha In BA15: Katanning(AVW02) : 352 - 71.70 ha In BA16: Katanning(AVW02) : 352 - 198.20 ha In BA17: Katanning(AVW02) : 352 - 57.91 ha In BA18: Katanning(AVW02) : 352 - 149.08 ha In BA20: Katanning(AVW02) : 352 - 8.37 ha Total in TAs: 3398ha **Area required to achieve adequate local protection:**

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
		10052ha – unachievable only 7540.66ha remains
BVA 511 Medium woodland; salmon gum & morrel	The only two larger patches of the remaining extent of this locally rare vegetation type are in BA13 and BA14. In BA13 – in the LP Strategy land with one of the larger remaining examples of BVA 511 is identified as "Priority Resource and Extraction Area". Any future proposal for extraction should completely avoid the remnant vegetation. The only reserved area of salmon gum is reported in the Throssell Nature Reserve (R7220), DPAW land (1987)	In BA13: Katanning(AVW02) : 511 - 41.85 ha In BA14: Katanning(AVW02) : 511 - 17.14 ha Total in TAs: 58.9ha **Area required to achieve adequate local protection:** 163ha unachievable only 67.13 ha remains
BVA 694 Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	BA1 & BA2 are relatively close to the Meenaar Nature Reserve. Protection of the largest patches in good condition, through conservation covenants, creation of reserves and restoration of degraded areas, would improve the connectivity between the nature reserves and other patches of vegetation in this highly fragmented part of the landscape.	In BA 1: Katanning(AVW02) : 694 - 33.00 ha In BA2: Katanning(AVW02) : 694 - 158.64 ha In BA18: Katanning(AVW02) : 694 - 7.49 ha Total in TAs: 199ha **Area required to achieve adequate local protection:** 574ha unachievable only 414.61 ha remains
BVA 946 Medium woodland; wandoo	All the remaining extent of vegetation mapped as BVA 946 occurs on one property on the boundary with the Shire of Toodyay and is mapped within several patches smaller than 3ha. More detailed mapping will need to be undertaken to determine the real extent of BVA 946 in this area before seeking formal protection. Due to the fragmented character of the remaining vegetation it is unlikely formal protection can be achieved within the Shire. Better opportunities might exist in the adjoining areas within the Shire of Toodyay.	In BA17: Katanning(AVW02) : 946 - 3.76 ha All remaining should be retained.

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
	Informal protection through existing land use provisions should ensure retention of this locally rare vegetation association.	
BVA 1048 Mosaic: Shrublands; melaleuca patchy scrub / Succulent steppe; samphire	Formal protection of all vegetation in good condition within BA3 will not only allow to meet the minimal proposed protection target but also secure one of the largest areas of remnant vegetation in the eastern part of the Shire on which future initiatives to improve connectivity can be built.	In BA3: Katanning(AVW02) : 1048 - 363.97 ha **Area required to achieve adequate local protection:**106.5ha
BVA 1049 Medium woodland; wandoo, York gum, salmon gum, morrel & gimlet	BA2 & BA19 – contain the 2 largest patches of BVA1049 remaining in the Shire BA2 includes R6305 reserved for water purpose. These large patches are relatively isolated (connectivity measures at average values) but with strategic restoration could be re-connected to other protected areas.	In BA2: Katanning(AVW02) : 1049 - 70.31 ha In BA14: Katanning(AVW02) : 1049 - 80.74 ha In BA19: Katanning(AVW02) : 1049 - 65.88 ha In BA20: Katanning(AVW02) : 1049 - 92.70 ha Total in TAs: 309.6ha **Area required to achieve adequate local protection:** 2550ha unachievable only 851.56 ha remains
Target Areas focusing on waterways		
AV1	Portion of Avon River within the Townsite Classified as Conservation in the LPS	
AV2	Mostly covered by the Special Control Area (SCA) Avon River and Mortlock River provisions	
MR1	Includes 3 reserves proposed to change purpose to include conservation; classified Parks and Recreation in LPS No 6.	
MR2	Extend the SCA Avon-Mortlock Rivers to include this section	
MR3	Extend the SCA Avon-Mortlock Rivers to include this section	
W1	Protection of mapped wetlands is a high priorty, by fencing, revegetation within buffers.	Katanning (AVW02) 1049 - 44ha

Vegetation complexes and Beard vegetation associations	Notes/Comments LPS 6 – Local Planning Scheme LP Strategy – Local Planning Strategy (July 2013) TA – Potential Target Areas LFW – Land for Wildlife	Area of vegetation within Target Areas (TA) (Bi1 – TA labeling used on mapping in the Environmental Planning Tool)
	Wetlands and the remaining vegetation provide opportunity to consolidate connectivity between large patches of priority vegetation within BA19 and BA20	Katanning (AVW02) 694 – 2.4ha

Appendix J: Proposed Target Areas and Crown reserves proposed for extension or change of reserve purpose to conservation (Local Biodiversity Program, 2014)



Target Areas are areas that highlight areas where good opportunities exist to improve the protection status of under-represented vegetation complexes in the Shire. Six Target Areas focus on buffers of important waterways. Target Area boundaries are designed to be indicative only and include already cleared areas or even portions of areas where development has been approved. Target Areas are not to be interpreted as areas where development is prohibited. They should be used to identify areas where any remaining vegetation and other natural areas are of conservation significance and their retention and protection should be a priority when deciding on future land use planning.

APPENDIX K: How to use the on-line Environmental Planning Tool

The Environmental Planning Tool (EPT) is an on-line application designed to facilitate access to environmental information relevant to land use planning and support strategic natural resource management.

It was developed through the Western Australian Local Government Association's Local Biodiversity Program.

All the mapping developed for the Shire of Northam Local Biodiversity Strategy is available through a special login version of this Environmnetal Planning Tool. This section outlines how to access the mapping and lists datasets most relevant to this document.

It is recommended that readers use the EPT when reading the Local Biodiversity Strategy as the zoom in functions and other supporting data available through the EPT allow review of the mapping in the context of numerous other relevant datasets.

Before you start

System Requirements

To use the Environmental Planning Tool (EPT) or the Regional Framework Mapping Viewer you will need a computer with internet access with at least 1GB of RAM. This should include any computer made in the last 8-10 years running Windows XP or later, Mac OSX 11.5 or later, or Linux.

The GeoICE map viewer requires Java 6 or newer for your computer. You will be prompted to install Java if your computer does not already have it. Java is available for Windows, Mac OSX, Linux and other popular operating systems. Java applets are not currently supported on iOS or Android so you will not be able to use this application on a smartphone or tablet.

To access the EPT go to:

http://lbp.asn.au/index_ept.html

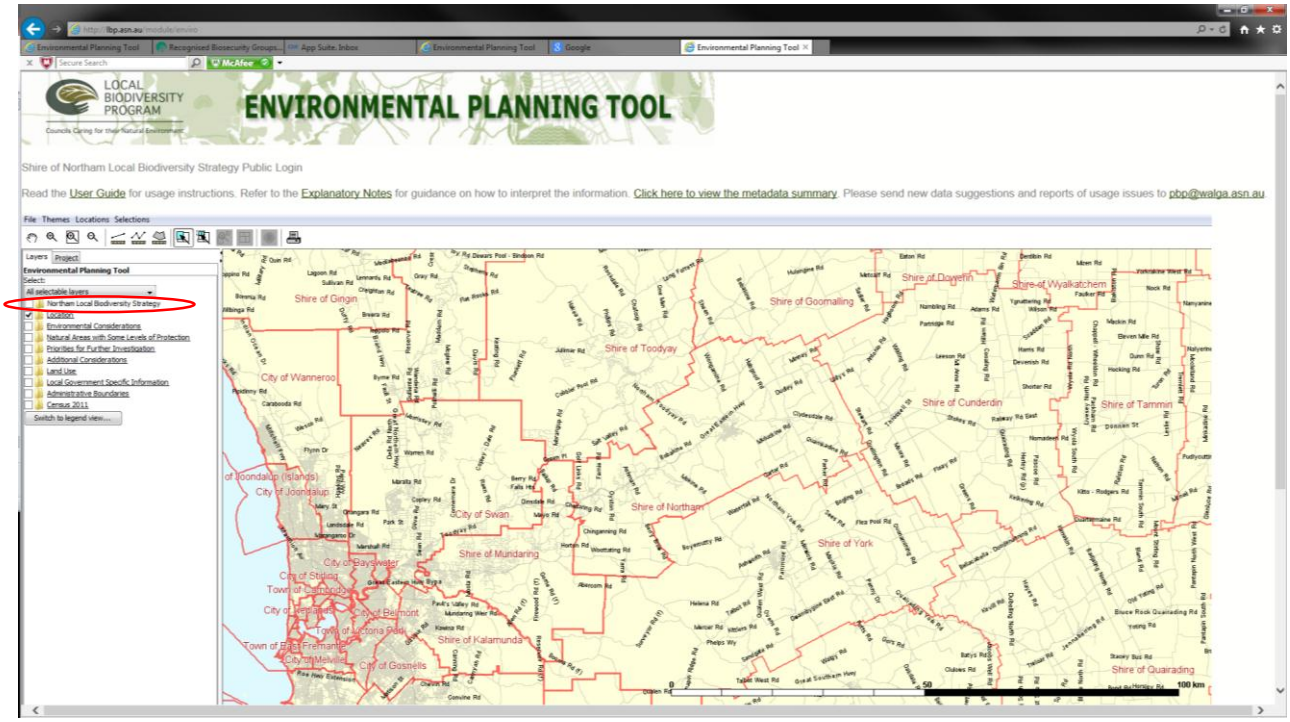
Read **Terms and Conditions**, **Tips for beginners** and enter your supplied user name and password details and press the login button to enter the main Environmental Planning Tool (EPT) page.

Login details for this project:

User name: northamLBSP

Password: floribunda

When you log in you should see the following screen:



In the Legend window, you should see the following heading: *Northam Local Biodiversity Strategy.*

Using your computer mouse or the function buttons on top of the map window, zoom into the Shire of Northam and open the list of layers under the Northam Local Biodiversity Strategy heading.

Brief description of the most relevant datasets is provided below. Before you start, it is recommended that you read the **User Guide** that can be downloaded through a link above the map Legend window. The User Guide describes the function buttons and how to use them most effectively to interrogate the datasets. For example, the EPT allow you to create reports on available data for a selected area which can be based on a cadastral boundary, native vegetation patch, 'Target Area' or you can define your own area using the drawing tools under the 'Project' heading (see top of the Legend window).

You can highlight as many mapping layers as feasible to view. A scroll bar under most of the layers allows controlling the transparency of those layers, allowing the viewing of multiply overlapping datasets.

All underlined text is linked to the **Explanatory Notes** which relevant background to the datasets. **Metadata Summary** lists all the datasets, and includes information in data currency and contact details for relevant data custodians.

Description of Spatial Layers displayed in the Environmental Planning Tool

Layer category	Layer title	Brief description (LBP = Local Biodiversity Program)
NorthamLocal Biodiversity Strategy	Unallocated Crown Land	This data layer highlights properties classified as V CROWN in the cadastral data layer available through Landgate (2013).
	Regional Centre Growth Plan	Areas identified in the Shire of Northam's Growth Plan as potential areas for future expansion. Data layer created by the LBP based on hard copy plans provided by the Shire.
	Potential Target Areas	Potential Target Areas represent areas where good opportunities exist to improve the protection status of underrepresented vegetation complexes in the Shire. The lines are designed to include significant patches of remnant vegetation representative of vegetation complexes that have been identified as not being adequately represented in the regional conservation estate (considering reserve and off-reserve protection mechanisms). However, it is not intended that all vegetation mapped within these Potential Target Areas will be formally protected. Potential Target Areas can include freehold land and lands reserved for various purposes (other than conservation). Priority was given to areas where good opportunities exist to protect vegetation considering the existing land use provisions, land tenure (Unallocated Crown Land) or presence of initiatives supporting land conservation (Land For Wildlife). Remnant vegetation outside the Potential Target Areas See Appendix D for details of an area of each vegetation complex occurring within each Potential Target Area and notes on mechanism to examine to secure protection of the most significant portions of this vegetation.
	Locally Protected Areas	Lands within reserves with vesting purpose conservation of flora, fauna, landscape protection or foreshore protection and lands reserved in the Local Planning Scheme No 6 as Conservation of Flora and Fauna.

	Proposed Protection via Reserve Purpose	This layer identifies reserves where a change or extension of reserve purpose to conservation will contribute to the improved protection status of underrepresented vegetation complexes Six reserves vested in other agencies were also included as they include relatively large examples of conservation priority vegetation complexes on Crown land. Vegetation condition on these sites will need to be examined before pursuing formal conservation. See Appendix H for the list of Potential Conservation Reserves, their current vesting purpose, area of remnant vegetation and vegetation complex and other conservation assets.
	Prioritisation criteria	Number of prioritisation criteria met by any portion of remnant vegetation provides a mechanism for comparison of relative conservation significance of remnant vegetation in the Shire. 20 criteria describing the representation status of vegetation, its rarity, presence of important ecosystem features to maintain ecological functions were used. The higher the number of criteria met, the greater the relative conservation significance. It is important to note that some areas with lower count of criteria might contain rare flora, fauna or ecological communities and thus will require special consideration. In addition, absence of threatened flora, fauna and ecological communities' records does not mean they cannot be present, the reason can be a lack of surveys. See Appendix F for the description of the criteria used. Data layer developed by the LBP using the 2013 remnant vegetation extent mapping and other datasets including surrogates.
	Patch size	A patch of remnant vegetation is defined as a discrete polygon of vegetation separated from another polygon by 10m. Remnant vegetation patched are categorized according to their size to assist with identification patches that could potentially support a range of fauna or where specific land use provisions could be applied. It is important to note that the patch size analysis does not consider the diversity of or suitability of habitat within a patch. Thus while the patch size might

		indicate sufficient habitat size for a certain species, the quality of the habitat within this patch might not be adequate. Therefore this data layer should not be used in isolation. Data layer developed by the LBP using the 2013 remnant vegetation extent mapping. Patch size categories informed by fauna minimal habitat size information provided by DPaW and LPS provisions.
	Wheatbelt NRM Corridor Plan Connectivity Zones	The Wheatbelt Corridor Plan is a landscape scale connectivity study which identified high, medium and low 'connectivity zones' considering the number of patches of 'functional vegetation"[19], their area and configuration. The Shire of Northam falls within two connectivity zones, the portion west of the Northam townsite is within a high connectivity zone (HC West) and the portion east of the townsite is within a medium connectivity zone (MC North). High connectivity zones include patches that are considered already well connected. Maintenance and improvement of connectivity at local scales should be a priority in these areas. Medium connectivity zones identify areas where achievement of landscape connectivity will require significant investment. However, improvement of connectivity within the medium connectivity zone North (labelled as Central in the WNRM report) will connect the rangelands to the jarrah forest, facilitating climate change response by connectivity across the climatic gradient (Richardson *et al,* 2013).
Connectivity Three connectivity metrics have been developed by the LBP to describe the level of connectivity between patches of	Fragmentation	Fragmentation, a scaleless and dimensionless measure which describes the shape and local arrangement of patches in the study area. It measures a degree to which any remnant patch is diverting from the 'ideal circle' shape. A high vegetation fragmentation index indicates large, compact or locally well connected patches; a low

[19] Richardson *et al* (2013) defines "functional vegetation" as remnant patches outside the high risk salinity zone, greater than 30ha and are within a nominal distance (500m or 1km) of another patch or are greater than 200ha.

remnant vegetation, defined as a discrete patch of vegetation separated from another patch buy at least 10, as mapped in the 2013 remnant vegetation extent dataset (DAFWA). The metrics do not consider the inner patch diversity of habitats. More detailed description of the model used will be available in the report.		index indicates small, isolated or poorly shaped patches. 2013 remnant vegetation extent mapping was used as a basis for this analysis.
	Connectivity Reach	Connectivity Reach, describes the size of the connective network a patch belongs to but does not consider how sparse or dense that network is.
	Regional Connectivity	Regional Connectivity, a scaleless and dimensionless measure of how well a patch contributes to a network of patches in the wider landscape. A high regional connectivity index indicates large patches or patches that are part of a large, dense regional network; and a low index indicates small, fragmented or isolated patches.
Additional layers recommended to be the selected when viewing the layers created specifically for Local Biodiversity Strategy or where further baseline information used in the prioritization analysis can be found		
Administrative boundaries	DPAW managed lands	Dataset identifying all lands managed by the Department of Parks and Wildlife for various purposes such as conservation, state forest or other (status 2013)
	IBRA 7.1 sub-regions	Datasets identifying portions of the Shire within the Jarrah Forest and Avon Wheatbelt biogeographic regions.
Location/Topographical features	Property boundaries	2013 Landgate data
	Hydrograpgy lines	Used in the Prioritisation criteria to model riparian vegetation
	Aerial photography (SLIP)	Recommended – most up to date than Google.
Environmental Considerations	Threatened and priority flora, fauna and ecological communities	Used in the Prioritisation criteria. However, please note 2014 data was used in the prioritization and this will be made available in the EPT at the end of August.
	Vegetation/Native vegetation extent/Beard association and Vegetation complexes	When viewing, only one of the two vegetation mappings can be highlighted at one time, however the Environmental Consideration Report generated for any area of interest will list vegetation extent by both vegetation mapping datasets where they overlap. Based on 2013 vegetation extent mapping (DAFWA).

	Wetlands/Avon (Wheatbelt) wetland mapping stage 1	Used in the Prioritisation criteria
Land Use	Local Scheme zones	Please note this layer is based on January 2013 data provided by the Department of Planning. This will be updated soon to show the LPS 6 land uses. However, in the notes on current land use provisions described in the Notes on the Proposed Target Areas for vegetation, the current LPS 6 and the Local Planning Strategy were used.
	Crown reserves	Landgate dataset identifying Reserve number, purpose, vesting agency and agency with management responsibility.