Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia

Department of Agriculture
Department of Conservation and Land Management
Department of Environment
Department of Fisheries

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"Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision."

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Executive Summary

There are many important natural resource assets across Western Australia. However, not all require investment in management systems to protect them against natural resource threats. With the broadening of NRM in recent years to cover all natural resource issues from the marine environment, across the coasts and into the inland areas and the requirements for accredited regional NRM strategies to guide investments, there is a clear need for the State to integrate and explain its NRM priorities.

A clear statement of State NRM priorities is also useful for Regional NRM groups in developing their priorities and will provide an indication as to the priorities that the State will be considering when determining its position on regional strategies presented for accreditation.

This report describes the State ('Whole of Government') Preliminary Priority Natural Resource Assets. The State's NRM agencies have been through a process of identifying and categorising the State's natural resource assets. The intent is that the results, once finalised, will provide:

- A guide for the current annual investment of state funds, and the prospective annual investment Commonwealth and State funds, particularly through the Natural Heritage Trust and National Action Plan.
- A guide and direct State agency activities in NRM.
- Provide clear directions to regional groups in developing regional strategic plans.

The processes described within this report help separate important assets that are at threat, from those assets that are not at threat. The results are not a final list of where resources should be invested but the first step towards identifying statewide priorities for investment in threat management against our biophysical assets. To develop investment priorities information on the feasibility of management options is required. This is the next step in the process and has not been undertaken as part of this assessment. The rankings presented are works in progress and have been brought together at this time to assist everyone involved in natural resource management or natural resource management funding decisions to compare and contrast their proposal with the priorities put forward by the agencies in the relevant NRM area of interest.

The processes used to identify important assets within the biophysical asset classes of biodiversity, water resources and fisheries is based on the approach developed by the Salinity Investment Framework (SIF). All threatening processes were considered by a modified version of the 'value versus threat matrix' to assess assets across Western Australia. Customised value-threat assessments were developed to assess the unique nature of each asset class. Four distinct assets classes were used with each of the key NRM agencies responsible for undertaking the analysis on their asset class.

- Water resources
- Fisheries
- Biodiversity
- Agricultural land

This report describes the assets assessed at a State scale and there will be some similarities between these results and regional priorities. However it is not expected that both priorities will completely align because of the significant differences in scale in which the assessments were undertaken. To help Regional groups appreciate where their State assets fit in a Western Australian context the results have been partitioned by region.

A higher concentration of assets at threat has been identified within the southwest area of the State, from Kalbarri to Esperance. Obviously this is to be expected given that this area of the state has been subject to higher levels of human interference. Higher levels of urbanisation, industrial activity and agricultural production all contributing to disproportionately higher threats to this region's natural resources. The report has also highlighted that a lack of natural resource information in areas outside of the southwest may have skewed this outcome. Gathering further information on assets and threats in the rangeland may provide a future priority for the State.

The Senior Officers Group acknowledges that both the processes used and the results described in this report require a higher level of stakeholder consultation. The results presented by this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision being made.

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Value, threat and feasibility

The SIF is centred on an appreciation of the biophysical and socio-economic assets that are present in an area and which may be impacted to various degrees by a threat. The term 'asset' indicates an item of value. 'Threat' indicates the predicted severity and urgency of the impact of salinity (in this report's case threat is considered across a greater spectrum of issues, eg eutrophication, wind erosion, weed invasion, habitat fragmentation etc) on the asset, resulting in a loss of asset value. Discussion about an asset item's value also leads to a better understanding of what is most important at a local community, regional or State scale. When an understanding of value is combined with an understanding of future threats to an asset, it becomes easier to identify specific goals with realistic aspirations for the future. This leads logically to addressing questions including:

- What are we prepared to spend to recover, maintain or adapt that value?
- What is required to attain a goal for an asset?
- Is that option technically and socially feasible?

A modified version of the 'value versus threat matrix', developed by the SIF, was employed to assess the unique nature of each asset class. The value – threat matrix helped identify the relative importance of each asset. Three tiers of assets are defined within the value-threat matrix (Table 2.1):

1st Tier (Highest importance): Includes assets or groups of assets of high value and at high threat.

2nd Tier (Medium importance): Includes assets or groups of assets of high value at medium threat, assets of medium value at high threat and assets of medium value at medium threat.

3rd Tier (Low importance): Those remaining assets or groups of assets that include: High value low threat; Medium value low threat; Low value low threat; Low value medium threat, and Low value high threat.

The value of an asset is what makes the asset important. Determining the relative value of an asset needs to acknowledge that there are firm quantitative measures for economic values, but less so for social and environmental values.

Threat identifies the timing and/or extent of potential impact from, for example, salinity, eutrophication and erosion (or any other threat) and the urgency required for any action to recover, contain or adapt to the threat. The key question is 'How much of the asset's value will be impacted on and when will this impact occur if it has not already?

Feasibility information is an important ingredient in determining investment priorities. Assigning an NRM management option to an asset item requires a number of important aspects to be considered. This step has not been attempted as part of this report.

The value – threat matrix helps to identify high importance groups or tiers of assets for further feasibility investigations. Three tiers of assets are defined within the value-threat matrix (Table 2.1) below. Each tier will require varying levels of investigations.

Value versus threat matrix and the three asset tiers

Assets		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	**1st Tier**		
	Medium Intermediate time and/or not that greater extent 2020-2075		**2nd Tier**	
	Low Long term >2075 Or already impacted significantly			**3rd Tier**

Each agency used a combination of "expert panels" and published information to undertake their assessments of assets.

Water Resources

Water resources were grouped into two subclasses that reflect the difference between protection and management for water supply and protection and management of the system. The two sub-classes were:

1. Water supply
2. Waterscapes (wetland, waterway and estuary ecosystems)

Most water resource assets have numerous values associated with them. It was important to acknowledge and score these multiple values. These multiple values were grouped into three broad categories:

- Economic - Industry, drinking water, aquaculture.
- Social - Recreation: fishing, swimming, bird watching, boating and other pursuits; Spirituality and culture:
- Environmental - biodiversity, uniqueness, aesthetics, ecological functions (flood mitigation, natural land drainage).

Threats considered included; erosion, sedimentation, eutrophication, salinity, feral animals, weed infestations, pollution from point sources, ecosystem fragmentation, land development: residential and rural residential, land development: intensive agriculture, land development - broad acre farming, land development – pastoral, water development - aquaculture and boating facilities, recreation, commercial fishing, industrial discharge, water abstraction agricultural drainage (eg coastal plain and saline land drainage). Using the following scale the threats to assets were scored:

Aquatic Assets and Fish Resources

Fish resources were grouped into two subclasses that reflect the different fisheries environments within the State. The two sub-classes were:

1. Freshwater environments
2. Marine environments

Most fisheries assets have numerous values associated with them. It is important to acknowledge and score these multiple values. Values were grouped into three broad categories economic, social and environmental:

- Economic, The commercial fisheries
- Social Values: Recreational fishing
- Environmental Values: Biodiversity, uniqueness

Threats considered included fishing by Australian and foreign fleets, eutrophication, introduced marine pests, pollution from point sources, ecosystem fragmentation, coastal development including the development of petroleum products, land development: intensive agriculture, water development, aquaculture and boating facilities, recreation, and commercial fishing.

Agriculture productivity threats

The Department of Agriculture's process is based on a combination of expert knowledge and the inherent physical qualities of the land resource to determine threat. Value is based on the average value of agricultural land ($/ha) determined from year 2000 Bank West data.

Information on threat and asset value were obtained and put into an 'NRM issues database'. The NRM issues database provides information on the significance of NRM issues related to geographic areas of southwestern Australia.

The spatial framework for the assessments of value and threat is the *soil-landscape zone* as defined by the Natural Resources Assessment Group of the Department of Agriculture. These zones delineate broad terrain types based on geomorphological criteria and are useful for gaining a regional perspective of landscape related issues. There are 31 zones described for southwestern Australia (Figure 5.1). Grouping of more detailed underpinning soil-landscape mapping creates the boundaries of the zones.

Five key NRM issues relevant to agriculture and related to soil and land were identified by a Department of Agriculture expert panel. Biodiversity, plant or animal specific issues were not considered, and NRM issues of minor extent in WA (for example mass movement) are not included.

For each combination of NRM issue and soil-landscape zone, an estimate of the threat to the asset caused by the issue/process and the value of the asset being threatened was made. The threat - value matrix was then used to determine the priority of the asset/issue within a zone.

First tier issues are of highest importance, second tier of moderate importance and third tier of low importance.

In addition, for each zone a summary table was prepared looking at the average threat to the land resource based on the five threatening processes. For example, if a particular zone had two issues of High threat, one issue of Moderate threat and two issues of Low threat, the average threat was determined as Moderate. This process, although subjective, gives an indication of which zones are most at risk.

Biodiversity assets

For the purpose of this exercise the biodiversity asset class has been allocated into four primary sub-categories. These categories are of the highest order of importance and provide an overarching framework for lower order conservation strategies and actions aimed at biodiversity. The sub-categories are:

Bio-subgroup 1: Biodiversity inventory and establishment of a Comprehensive, Adequate and Representative (CAR) terrestrial conservation reserve system and marine conservation reserve system.

Bio-subgroup 2: Effective management and protection of conservation reserves and other recognised special conservation value areas.

Bio-subgroup 3: Recovery of threatened species and threatened ecological communities other significant species and areas of exceptional diversity or endemism.

Bio-subgroup 4: Conservation of landscape/seascape scale ecological systems and processes (integrating reserve and off-reserve conservation).

Bio sub-category 1: Biodiversity inventory and establishment of a comprehensive, adequate and representative (CAR) terrestrial conservation reserve system and marine conservation reserve system

Under existing national protocols and agreements the basic requirements of a CAR reserve system have been defined to include 15% of the landscape of an ecoregion being legislatively protected and managed specifically as conservation reserves. The 15% is a basic figure and must be considered in relation to the ecological functions of the ecosystems to be conserved. In some instances there may be a requirement for a higher proportion of the ecoregion to be conserved in order to protect particularly sensitive ecosystems.

The higher the 'value' the further the sub-bioregion/bioregion is from achieving a CAR reserve system, and hence a higher priority for action and investment.

Bio sub-category 2: Effective management of and protection conservation reserves and other recognised special conservation value areas.

Across the State there are around 1600 conservation reserves managed by the Department of Conservation and Land Management, 11 Ramsar sites, two Biosphere reserves and one World Heritage Area. The above biodiversity assets are designated for their high biodiversity conservation value, and are all considered a priority for investment.

The value assessment is based on the area of an IBRA sub-region covered by conservation reserves. Assessment describes the importance of IBRA sub-bioregions based on the area of conservation reserve and the stress class relevant to that subregion and shows the relative threat and value of the 6 declared marine parks and marine nature reserve.

Bio sub-category 3: Recovery of threatened species and ecological communities that are listed under relevant national and State legislation, other significant species and areas of exceptional diversity or endemism.

Threatened species or ecological communities are those living organisms or ecosystems that are at risk from extinction in the wild. Threatening processes operate to cause and accelerate species extinctions. At global, national and State scales extinctions are irreversible and have evolutionary consequences. Avoiding extinction then becomes an important strategy to avoiding biodiversity loss. Hence, the focus and priority on the recovery of species and ecological communities threatened by extinction.

Bio sub-category 4: Conservation of landscape/seascape scale ecological systems (integrating reserve and off-reserve conservation).

Landscape/seascape scale ecological systems comprise a set of protected areas and sites and off reserve areas, some of which are required to be actively managed for conservation in order to ensure ongoing biodiversity conservation.

Location and scale of priority management actions will vary between landscapes/seascapes, and be related to the impact of threatening processes upon natural resources, degree of landscape fragmentation/intactness, extent of protected area network and number of threatened species and ecological communities.

Summary of outputs

The report documents the processes used to establish potential priorities within the biophysical asset classes of biodiversity, water resources and fisheries and the agricultural productivity threats. The process was completed at a whole of State scale, and considered all threatening processes. The findings in this report represent the first step towards identifying statewide investment priorities in natural resource management.

The following table summarises for each asset class their importance in a Western Australian context. It is critical to note that the term 'importance' is used to describe the requirement for further investigations to determine specific goals for assets, management options to achieve these goals, and then their likelihood of achieving success for each asset or class of asset.

Summary of asset classes and their level of importance[1] (Based on value and threat) in Western Australia.

Asset Class	*Sub-class*	*Tier 1- (high importance)*	*Tier 2 (medium importance)*	*Tier 3 (low importance)*
Biodiversity	i) Establishment of reserves	**6** IBRA sub bioregions **6** marine conservation reserve regions	**13** IBRA sub bioregions **26** marine conservation reserve regions	**33** IBRA sub bioregions **20** marine conservation reserve regions
	ii) Management of reserves	**2** terrestrial IBRA subregions **7** marine conservation reserves	**23** terrestrial IBRA subregions	**27** terrestrial IBRA subregions
	iii) TEC[2], DRF[3], Priority flora and fauna	**343** flora (terrestrial) **58** fauna (terrestrial) **54** TECs (terrestrial) **5** marine fauna	**188** flora (terrestrial) **175** fauna (terrestrial) **35** TECs (terrestrial) **16** marine fauna	**1334** Flora (terrestrial) **299** Fauna (terrestrial) **25** TECs (terrestrial) **5** marine fauna
	iv) Target landscapes and Diversity recovery catchments	**24** proposed and existing natural diversity recovery catchments **7** target landscapes **13** IBRA provinces with species hotspots	**38** target landscapes	**51** target landscapes
Water Resources	Water supplies (includes PDWSA[4] and RIWIA[5] areas)	**62**	**182**	**47**
	Waterscapes (includes wetlands and waterways)	**34**	**105**	**118**
Aquatic assets and fish resources		**5**	**24**	**42**
Agricultural land	Productive land	**1** soil - landscape zone	**17** soil - landscape zones	**13** soil - landscape zones

** Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.*

Comparing the results

The more specific asset assessments for biodiversity and water resources provide an extensive description of important resources at a State scale. At both a State and Regional scale they identify specific points in the landscape that might require management action.

Combined, some results support the importance of assets in other classes. For example, the specific assets identified through the water resources, fisheries and Bio-subgroup 3 (DRF, TECs and Priority species) assessments provide potential points in the landscape for establishment of conservation reserves to help meet requirements of Bio-subgroup 1 (Comprehensive and Adequate Reserve Systems). Similarly, the broad assessment of estuaries by the Department of Fisheries is backed up by the more specific assessment of these assets by the water resources assessment.

Multiple values and Spatial analysis

Any process that explores the pros and cons of an investment should also assess for all potential benefits. Apart from the Department of Agriculture's broad scale overview of the threats to the agricultural land resource, the other agency's processes have assessed individual asset items for their value and threat. The Department of Agriculture has however undertaken a detailed examination of the numerous issues or processes threatening, or deriving from, agricultural land uses, and this information is available from the NRM issues and strategies documents prepared for each region. An importantpoint to consider is the failure of each process to consider the relationship between asset items from different asset classes, especially where these asset items occur in close proximity within the landscape.

[1] *Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

[2] Threatened ecological communities

[3] Declared rare flora and fauna

[4] Public drinking water source area

[5] Areas proclaimed under the *Rights in Water and Irrigation Act 1914*

For example, across the Western Australian landscape there are many areas of remnant vegetation located in close proximity to infrastructure assets such as towns or even water supplies. Assessed individually, in many cases, these assets may only achieve a moderate ranking. However, should their combined values be assessed the cluster of assets may achieve a higher level of importance. There is also a possibility that one management option will result in much larger and more diverse returns on investment.

The SIF is currently investigating an approach to consider this situation. Spatial analysis (otherwise known as 'pizza approach') may provide one method for completing this assessment. This approach should form an important component of any feasibility study for an asset.

To complete spatial assessments and to allow for a better comprehension of assets and their importance across the State there is a need for the information in this report to be presented spatially.

Gaps and Fissures

The initial value and threat assessments described above have been completed by each of the NRM agencies using relevant data sets and expert opinion. These assessments represent a 'State Agency' view on what natural resource assets are considered important in the face of NRM threats. Wider consultation is required to ensure that these assessments are appropriate for this scale. Furthermore, it should be acknowledged that although there will be some similarities the final list of high importance assets identified at the region scale will be different to that of the State.

The assessment of asset classes within this report has been quite detailed. However, there are a number of gaps or 'under-done classes' that need to be addressed. Investigations into identifying important assets within these underdone classes may well form a priority for future investigations by the State. The following list identifies the classes of assets not covered by this assessment:

- European and Indigenous cultural assets: This includes all biophysical assets such as indigenous significant sites (eg Caroline's Gap, Gnammas (watering hole), granite outcrops) and European heritage sites (eg, Toapin Weir- Quairading).
- Unique land management issues on Indigenous land holdings: Section 3.16 of WA Bilateral.
- Coastal ecosystems: fisheries, biodiversity and water resources have assessed estuaries and near shore assets and environments. The terrestrial component of coastal systems has not been assessed adequately. This includes all dune and rocky coastal systems.
- Infrastructure: this includes roads, rail, and towns.
- Agricultural land: The assessment in this document is very broad. Further, more detailed, assessments should examine individual soil and land types within regions as assets. This information is available within the Department of Agriculture, but was considered too detailed for this overview assessment. An assessment of the off-site effects on public and private assets from agricultural land uses is not covered in this document. To discuss the asset at threat without examining the cause is a limitation of the document.
- Wetlands: Although the Water resource process has assessed some significant wetlands within ANCA and Ramsar classifications, not all have been individually assessed. In some cases groups of wetlands (eg. conservation category wetlands on the Swan Coastal Plain and other important wetlands identified in WRC and other publications) have been assessed as one asset. These assets should be considered individually.
- Rangeland natural resource information (condition, value, and threat) is generally limited.

Refining the priorities

At write up an approach or methodology for identifying a final list of priority assets for investment had not been developed. However, the second phase of the SIF was investigating a methodology for determining a final ranking.

Although the SIF focuses on salinity threat, the investment decision process will most likely be easily modified to consider other threats. Any further work to determine investment priorities, using the information presented in this report, should consider and incorporate any decision-making process developed by the SIF project. The final process developed by the SIF will determine the amount and nature of information required for decision making.

Commenting

Senior Officers Group recognises that there has been insufficient consultation in developing the lists within this report and that Regional NRM Groups are highly focused on developing their regional strategies. The consequence is that the findings in this report are open to further discussion and amendment and will not be finalised without sufficient consultation and review. Feasibility assessments are critical to developing a final list of investment priorities for Western Australia.

1.0 Introduction

1.1 The situation in Natural Resource Management

One of Australia's greatest challenges is the way we manage our natural resources, which include our soil, water and biodiversity (native plants and animals, ecological communities, ecological processes and ecosystem services). Ensuring the ecologically sustainable management of Australia's natural resources is a critical issue we are to maintain the health of our environment, conservation of our biodiversity, and the long-term prosperity of our agricultural production and export and urban environments.

To protect the environment and the future of this State's natural resources the full range of stakeholders (Government, Industry and the Community to which they belong) must work together. By collectively tackling major issues such as salinity, declining water quality and biodiversity loss Australia will reap not only environmental but major social and economic rewards.

There are many threats to our natural resources, which include eutrophication, acidification, over clearing, introduced plants and animals, habitat fragmentation, inappropriate fire regimes competing land uses, salinity, weed invasion and wind and water erosion. In Western Australia current estimates on the extent of salinity alone are that approximately 1.8 million ha of land in the Southwest Agricultural Zone are currently affected. It has been calculated that this saline affected area will increase to over 6 million ha (some 30% of the landscape) without intervention by the time a new hydrological equilibrium is reached. Even with the most optimistic intervention options using perennial vegetation and engineering about 4 million ha of land will be affected, and for most catchments changes in land use will not have any significant impact for at least 20 years (Government of WA, 2000).

For Western Australia's biodiversity the impacts from salinity will be great, with most or all of the existing wetland, dampland and woodland communities in the lower parts of catchments, within the south west of Australia, being lost or affected without massive intervention. As well, there will be a much increased flood risk with flood peaks and flows two to four times higher than at present for the same amount of rainfall. Just as importantly, profitable farming systems that control salinity are generally not available on the scale needed. Without proven systems that are both effective for managing salinity, and profitable, farmers will not willingly change their current ways of farming.

The clear conclusion is that both public and private investment into natural resource management will need to be increased above current levels for a significant period of time, and be much better targeted into actions that generate maximum returns to investment. It then follows that a rigorous and transparent process is needed to determine priorities for the allocation of the limited funds that will become available over time.

Over the past 12 months the Salinity Investment Framework project (SIF) has been working towards developing a process to allocate public funds to protect assets of high public value. Although this project is not fully completed it has produced a methodology for identifying assets of high importance. High importance assets are those assets that have both a high value and high threat. Important assets do not represent a final priority listing for investment of resources, but represent a starting point for further investigations and discussions on a final investment decision.

In parallel with the SIF the various Natural Resource Management (NRM) groups across Western Australia have been working towards developing their Regional Plans which identify NRM priorities. This is an essential task in meeting Federal accreditation requirements. The NRM groups in Western Australia are at various stages of developing their regional NRM strategies.

Strategic planning and priority setting for investments is the fundamental basis from which the State, Commonwealth, Regional NRM groups, local communities, industry, commercial organisations and individuals will choose to address natural resource management into the future. Under the Bilateral Agreements between the State and the Commonwealth for delivery of the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality publicly funded investments must be targeted to those areas of greatest need and where they will deliver the best outcomes for public assets.

Together, State agencies invest over $200 million of public funds annually in natural resource management programs. As the State Government is a major investor in Natural Resource Management and a major contributor to public programs through its various agencies, it has a long history of establishing NRM investment priorities. These priorities are traditionally based on the need to protect key public assets and are well understood within the agencies. In relation to salinity, priorities have been well documented in the Salinity Action Plan and Salinity Strategy and in the various agencies reports and documentation.

With the broadening of NRM in recent years to cover all natural resource issues from the marine environment, across the coasts and into the inland areas and the requirements for accredited regional NRM strategies to guide investments, there is a clear need for the State to integrate and explain its NRM priorities.

A clear statement of State NRM priorities will also be useful for Regional NRM groups in developing their priorities and will provide an indication as to the priorities that the State will be considering when determining its position on regional strategies presented for accreditation.

The State's NRM agencies have been through an internal process of identifying and categorising the State's natural resource assets in terms of their ongoing programs and priorities. The processes used to complete this have evolved from the methodology developed by the SIF. Using the 'value versus threat matrix' each agency has compiled a list of assets within their NRM areas of expertise. These assets have then been ranked on the basis of threats and values.

These rankings are works in progress and have been brought together at this time to assist everyone involved in natural resource management or natural resource management funding decisions to compare and contrast their proposal with the priorities put forward by the agencies in the relevant NRM area of interest.

The rankings do not provide an easy means for comparison across NRM areas. More work is required before such comparisons can be made in a reasonable and repeatable manner. Work is progressing on techniques to assist decision making in that regard.

The results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision being made.

1.2 The Project

At the Senior Officers Group workshop (*State Priorities for NRM*) it was agreed that as a matter of urgency a set of State ('Whole of Government') Priority Natural Resource Assets, should be identified. The purpose for this task was threefold –

- To provide guidance for the current annual investment of state funds, and the prospective annual investment Commonwealth and State funds, particularly through the Natural Heritage Trust and National Action Plan;
- To guide and direct state agency activities in NRM, and
- To provide leadership to regional groups in developing regional strategic plans.

The aim of the work is summarised as follows:

> *To develop a statement of NRM issues and priorities in Western Australia and, where possible, to present these at a regional scale.*

The Workshop agreed to use the 'threat - value matrix' (Table 2.1) to help determine the relative importance of each asset or asset type in Western Australia. This approach follows the general approach being used in the SIF. It was also determined that the set of principles developed for the SIF process should apply:

Eight SIF Principles

1) **The top priority public investments are those which generate the greatest public benefits per dollar of public investment.**
2) **Direct financial assistance to landholders to undertake NRM action should be strategic and should not exceed the public benefits that result.**
3) **Where the priority is high and the net public benefits are sufficient, Government should be prepared to take strong action to ensure protection of the asset.**
4) **Where the public priority is low but there are extensive private assets at risk, public investment should be aimed at industry development.**
5) **Inevitably, a targeted investment strategy in NRM will result in unequal distribution of investment across the State.**
6) **Government must fulfil its statutory obligations for natural resources and functions (such as research) when it sets its priorities for investment in action.**
7) **The process required for priority setting will involve ongoing learning, adaptive management and need constant feedback.**
8) **Setting priorities must proceed even when there is only limited or imperfect information on prevailing environmental, social and economic circumstances.**

The Senior Officers Group assigned the responsibilities for developing rules for identifying important assets for each asset class to the responsible Natural Resource Agency:

- **Biodiversity:** Department of Conservation and Land Management (Section 3). *Western Australia's Biodiversity Conservation Priorities* (Claymore K and Wyre, G, in progress 2003).
- **Water Resources:** Department of Environment (Section 4). *Identifying High Importance Water Resource Assets* (Klemm & McAlinden, in progress 2003).
- **Agricultural production and infrastructure:** Department of Agriculture (Section 5). *Key natural resource management issues in Western Australia – an agricultural perspective* (Schoknecht, in progress 2003).
- **Fisheries Resources:** The Department of Fisheries (Section 6). *Identifying High Importance Aquatic assets and Fish Resources* (Chalmers, in progress 2003).

The project to produce this report was managed by a joint team lead by Verity Klemm of the Department of Environment. Other team members included:

- Keith Claymore, Gordon Wyre (Department of Conservation and Land Management)
- Eve Bunbury and Rob Tregonning (Department of Fisheries)
- Noel Schoknecht, Brendan Nicholas, Ian Watson (Department of Agriculture)
- Damien McAlinden (Department of Environment)

1.3 This report

Section 2 Outlines the principles for identifying investment attractiveness as developed by the Salinity Investment Framework and describes the overall process for identifying high importance assets.
Section 3 Presents the process and outputs for identifying important biodiversity assets
Section 4 Presents the process and outputs for identifying important water resource assets
Section 5 Presents the process and outputs for identifying important aquatic assets and fish resources
Section 6 Presents the process and outputs for identifying and ranking threats to the agricultural asset
Section 7 Provides an overall discussion of the results high-lighting any similarities and discrepancies
Section 8 Identifies further work required

The **Attachments** contain supporting material, and present and rank assets in a regional context according to their importance.

Attachment 1 – Additional Biodiversity information
Attachment 2 – Rangelands Assets
Attachment 3 – Northern Agriculture Assets
Attachment 4 – Avon Basin
Attachment 5 – Swan Assets
Attachment 6 – South West Assets
Attachment 7 – South Coast Assets

2.0 Setting priorities for investment in NRM – the Salinity Investment Framework approach

As discussed above the Senior Officers Group decided to adopt the value versus threat approach to help identify priorities in NRM. Below is a summary of the logic behind this process as described by the SIF. The approach has been adapted for use at a Statewide scale and considers all NRM threats which include eutrophication, acidification, over clearing, introduced plants and animals, habitat fragmentation, inappropriate fire regimes competing land uses, salinity, weed invasion and wind and water erosion.

2.1 Value, threat and feasibility

The Salinity Investment Framework is centred on an appreciation of the biophysical and socio-economic assets that are present in an area and which may be impacted to various degrees by a threat. The term 'asset' indicates an item of value. 'Threat' indicates the predicted severity and urgency of the impact of salinity (in this report's case threat is considered across a greater spectrum of issues, eg eutrophication, wind erosion, weed invasion, habitat fragmentation etc) on the asset, resulting in a loss of asset value. Discussion about an asset item's value also leads to a better understanding of what is most important at a local community, regional or State scale. When an understanding of value is combined with an understanding of future threats to an asset, it becomes easier to identify specific goals with realistic aspirations for the future. This leads logically to addressing questions including:

- What are we prepared to spend to recover, maintain, adapt that value?
- What is required to attain a goal for an asset?
- Is that option technically and socially feasible?

For any given asset item, the process of setting priorities based on the asset's *value*, combined with an understanding of the threat or threats to that value, and the known ability to influence that scenario through intervention – the *feasibility* (or likelihood of success), will assist in deciding whether action should be aimed at recovery, containment or adaptation. The feasibility simply means the ability to meet the desired goal for an asset, which requires consideration of management options, costs, social capacity and political will.

Figure 2.1 illustrates how consideration of these three criteria (value, threat and feasibility) can lead to identification of asset priorities. Asset items (for example - a discrete wetland) can be ranked on one axis for their value in achieving set goals, and on the second axis for the degree of threat measured by the extent and timing of the impact. On the third axis, the feasibility – the ability to address the threat, can be ranked.

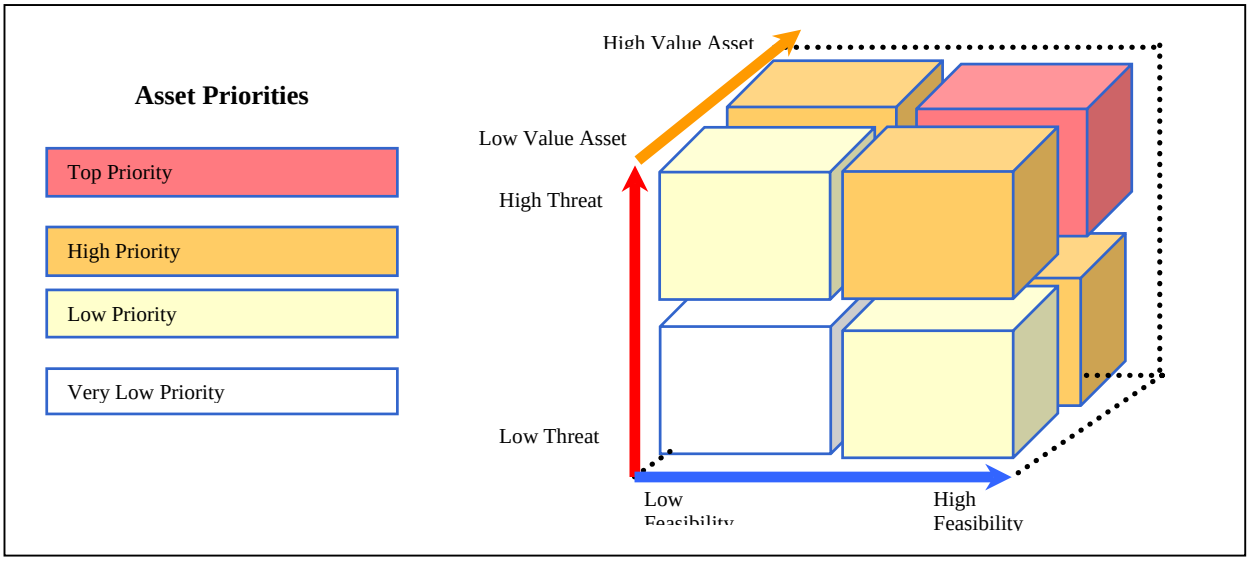


Figure 2.1 Graphic representation of asset priorities according to their value, threat and feasibility[6].

Generally those assets with the highest value that are the most threatened, but where the threat can be successfully managed (cost effective, technically feasible and socially acceptable) will be the highest priority for action – in particular public investment. In some circumstances, however, an asset under high threat may not be the highest option once feasibility is considered, and hence a high value asset with a lower threat may be a better option for public investment in the longer term. Those assets of low value, that are facing low threat and where the ability to do something about the threat is low will be the lowest priority for public investment.

[6] Adapted from '*Supporting Environmental Investment Decisions* (2003)', a presentation by Stefan Hajkowicz from CSIRO's Resource Governance Group, Sustainable Ecosystems.

2.2 Collecting the information

2.2.1 Measuring Asset Value

Assets are valued because they assist people to achieve goals. For example, rare flora has high value because they contribute to the goal of conserving biodiversity. In a different example, rural town infrastructure has value for the public and private services it supports. The value of an asset is what makes the asset important. Determining the relative value of an asset needs to acknowledge that there are firm quantitative measures for economic values, but less so for social and environmental values.

Choosing a method of expressing values depends on the goal for the asset class. If the asset can be valued in economic terms, as for example in the case of road infrastructure and agricultural productivity, then values should be assessed in financial terms. If the asset value can be expressed in other quantity and quality terms, as for example in the conservation of biodiversity, values should be expressed in the most suitable quantity terms (eg. environment- number of species, area of vegetation type, or combination of both). Developing a consistent description for asset value across the various classes (social, environment, and economic) is not possible beyond categorisation into 'high', 'medium' and 'low' value as shown in Table 2.1 and demonstrated by the SIF. In this report unique vales have been defined for each of the asset classes (refer to sections 3 to 6).

An asset item's value should not only be considered in isolation but should also be considered in combination with assets in close proximity (multiple values). The importance of multiple values associated with clusters of assets from various classes is discussed in Section 7.5.

2.2.2 Measuring Threat

Threat identifies the timing and/or extent of potential impact from, for example, salinity, eutrophication and erosion (or any other threat) and the urgency required for any action to recover, contain or adapt to the threat. The key question is 'How much of the asset's value will be impacted on and when will this impact occur if it has not already? To illustrate the difference between the spatial and temporal impacts of a threat the salinity example is used. There is evidence that some wheatbelt valley floors will be totally impacted by salinity, but the impact may not occur for over 50. Conversely, a relatively small section of the township of Morawa is currently being affected by saline water from hillside seepage, but the extent of impact will not increase over time. The threat to this town might be considered to be low.

The left-hand column of Table 2.1 below separates assets into three groups depending on their threat (high, medium or low). The SIF project has determined that it is important for threat assessments to be somewhat similar across the asset classes to ensure that a suitable comparison can be made between asset classes. Sections 3 to 6 describe the methods for measuring the various threats to assets within each core classes described for this report.

2.2.3 Feasibility

Feasibility information is an important ingredient in determining investment priorities. Assigning an NRM management option to an asset item requires a number of important aspects to be considered.

1. How much will the management option cost?
2. How will this cost change over time if action is not taken now?
3. Is it technically feasible?
4. Will the option achieve the goal?
5. How long will it take for the goal to be achieved?
6. Will the option be implemented or be supported by surrounding land managers?
7. What is the magnitude of the combined threats to the assets (weed invasion, eutrophication, erosion etc)?

The SIF determined that collecting this information for all assets would require an inhibitive amount of resources in terms of money, time and investigations. The proposed method developed by the SIF employs a filter that focuses assessment of feasibility on those assets that have a higher level of importance. This importance is determined from their value and threat information. Relative to threat and value data, information on feasibility is far more challenging to obtain.

2.2.4 Value – Threat Matrix

Using the value and threat information, asset items can be arranged into the 'value - threat matrix'. The value – threat matrix helps to identify high importance groups or tiers of assets for further feasibility investigations. Three tiers of assets are defined within the value-threat matrix (Table 2.1) below. Each tier will require varying levels of investigations.

Table 2.1 Value versus threat matrix and the three asset tiers

Assets		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	**1st Tier**		
	Medium Intermediate time and/or not that greater extent 2020-2075		**2nd Tier**	
	Low Long term >2075 Or already impacted significantly			**3rd Tier**

The value – threat matrix defines three tiers of assets that can be applied generally in most, but not all, situations. The tiers are described as follows:

1st Tier: Includes assets or groups of assets of high value and at high threat.

2nd Tier: Includes assets or groups of assets of: high value at medium threat; medium value at high threat; and medium value and medium threat.

3rd Tier: Those remaining assets or groups of assets that include: High value low threat; Medium value low threat; Low value low threat; Low value medium threat, and Low value high threat.

Identifying an asset's value and threat should involve stakeholder participation at all scales of application (State, region or local). The initial value and threat assessments described in following sections have been completed by each of the NRM agencies using available data sets and expert opinion. These assessments represent a 'State Agency' view on what assets are important in the face of a threat at a State scale. To ensure that this State-scale assessment is correct wider stakeholder consultation is required. Furthermore, it should be acknowledged that although there will be some similarities the final lists of high importance assets at the Regional scales will be different.

Should an asset's allocation within any of the tiers be contested, 'reprocessing' the asset, through the matrix or spatial analysis can prove or disprove this contention. Reprocessing an asset item should acknowledge any new information that is made available.

In summary, the value-threat matrix as defined by the SIF project helps complete the first step towards identifying investment priorities in NRM. It is most useful where a single identifiable threat category is being considered but can also be used as the basis for considering priorities in the case of multiple assets and multiple threats:

- Provides a simple and transparent approach to identify a group of high importance assets for further assessment on feasibility.
- Reduces the workload by ensuring that detailed studies for feasibility are completed on assets with high public value or of highest priority.
- Allows identification of assets and then priority groups of assets can be considered.
- Can be applied at State, Region and local scales (employing the relevant goals).
- Can incorporate multi-agency information in identifying priority groups of assets.

3.0 Water Resources[7]

3.1 Introduction

The DoE has a statewide responsibility for advising on water resource management issues. Water resource issues may relate to wetlands, waterways and water supply protection and management including the restoration of degraded environments. The broad nature of these responsibilities required that two broad goals be developed for the water resource asset class:

- Protect, manage and restore present and future water supplies from the impacts of land use activities.
- Protect, conserve and restore significant waterscapes (wetland and waterway ecosystems) from the impacts of land and water use activities.

To acknowledge these vastly different goals and their related values the assets have been grouped into two sub-classes:

1. Water supply
2. Waterscapes (wetland, waterway).

3.2 The Process

At the outset of this process the DoE had already completed extensive work on prioritising water resource assets through the:

- *State Waterways Needs Assessment* (WRC, 2002)
- Process for prioritising water resource assets for the Salinity Investment Framework (in progress, 2003)

The *State Waterway's Needs Assessment* (2002) value, condition, pressure and response results were re-arranged to generate threat value results as a priority for this investigation. These data covered all waterways at a broad level (all tributaries assessed as part of the larger waterway system) within Western Australia. Unfortunately the value and threat data did not extend to:

- public drinking water supplies
- proclaimed groundwater areas
- wetlands not associated with waterways

Further information for these water resource categories was required. The method employed to measure value and threat for water resources assets in the SIF was modified to measure all threats including salinity.

A guided expert panel approach was used to assess each asset for a number of criteria. The expert panel was given access to published and spatial data when scoring criteria. The expert panel comprised of DoE head office staff. Regional staff were given opportunity to review all results. Their comments were incorporated.

Given the short time frame required for completion of this process it required a centralised approach. The intention was to compile a draft list of assets and to assess them in head office prior to referring the assets to DoE regions for confirmation of value and threat assessments.

Unavoidably some water resource assets were assessed more than once. In most cases this was a result of comparing SIF information with assessments compiled by Resource Management staff of DoE. Where a double assessment occurred three rules were used to determine the most appropriate scores:

- The assessment with the highest value or threat score was retained.
- When value threat scores were opposite, the asset with the highest value score was kept.
- When scores were equal SWANA results were retained.

3.2.1 Measuring Value

Most water resource assets have numerous values associated with them. It is important to acknowledge and score these multiple values. Values were grouped into three broad categories economic, social and environmental:

Economic: Industries throughout Western Australia (eg. agricultural, aquaculture, mining, fisheries, tourism etc.) derive a multitude of economic benefits from water resources. For example, direct benefits would include the provision of water to enable agricultural production and mineral processing. Similarly provision of fresh water

[7] This section is adapted from the Department of Environment's '*Identifying High Importance Water Resource Assets*' (Klemm & McAlinden, in progress 2003).

for drinking is another direct benefit. Indirect benefits derived from water resources (specifically waterways) would include:

- Improved water quality due to a healthy riparian ecosystem.
- Decreased algal blooms and eutrophication due to the flushing effect of flooding.
- Increases in biological/fauna health through a reduction in heat or cold stress due to windbreaks and shelter provided by riparian vegetation.
- An increase in the capital value of land due to the potential for diversification into areas such as eco-tourism.

Social Values:

Recreation: Water resources such as water supplies and waterscapes can provide pleasant surroundings that are popular for various recreational pursuits. Rivers and the riparian zone are an important recreational resource for fishing, swimming, bird watching, boating and other pursuits.

Spirituality and culture: Wetlands, rivers and foreshores are often places of spiritual and cultural significance. Traditional landowners may have strong spiritual attachments to watercourses. Wetlands, rivers and foreshores are also places of spiritual significance for non-indigenous communities.

Environmental Values:

Biodiversity: Biodiversity refers to the variety of genes, species and ecosystems, and is essential to human wellbeing in many ways. It underpins ecological processes that are vital to human health and survival and the continued evolution of life on Earth.

Uniqueness: Some habitats and ecosystems are representative of environmental systems that are no longer widespread and are therefore considered unique.

Aesthetics: The river and riparian zone or a vegetated public drinking water catchment or groundwater area tend to dominate the local landscape and may also contribute significantly to the regional landscape and so are important to the aesthetic value of an area.

Ecological function: ability of a watercourse to mitigate floods, increase water quality, cool the land, provide habitat for organisms.

Using the following scale, water resource assets were scored for their economic, social and environmental values described above:

1 = None, the attribute does not contribute to the value of the asset
2 = Minor, the attribute contributes to the asset at a local level
3 = Moderate, the attribute contributes to the value of the asset at a local and regional scale
4 = Important, the attribute contributes to the value of the asset at local, regional and state scale
5 = Significant, attribute contributes to the value of the asset at a local, regional, state and national level
Unknown, unable to answer

An overall score for value was obtained by adding the environment, social and economic scores. A total score of 15 could be obtained. A fourth value score was taken for assets assessed by the Salinity Investment Framework process for water resource assets. The value score from the SIF assessment was modified to disregard the extra value score and only consider environmental, social and economic scores.

The High Medium and Low value score bands were as follows:
High = 10 – 15
Medium = 5 - 9
Low = 1 - 4

3.2.2 Measuring Threats

Threats considered included; erosion, sedimentation, eutrophication, salinity, feral animals, weed infestations, pollution from point sources, ecosystem fragmentation, land development: residential and rural residential, land development: intensive agriculture, land development - broad acre farming, land development – pastoral, water development - aquaculture and boating facilities, recreation, commercial fishing, industrial discharge, water abstraction agricultural drainage (eg coastal plain and saline land drainage). Using the following scale the threats to assets were scored:

1 = No other threats of significance
2 = Minor, impacts will occur in 75 years or more or significant impacts have already occurred and not expected to get any worse and or the threat affects less then 20% of the asset.
3 = Moderate, impacts will occur in 20 to 75 years and or the threat affects 20-50% of the asset.
4 = Severe, impacts will occur over next 20 years and or the threat affects 50-80% of the asset.
5 = Extreme, impacts will occur in a few years and impacts will be significant and or the threat affects more than 80% of the asset.
Unknown = unable to answer question.

The high medium and low threat bands were defined as follows:
High = 4 – 5
Medium = 3
Low = 1 – 2

3.3 The outputs

Table 3.1 Waterscape assets in Western Australia and their importance (State scale) as defined by the value-threat matrix.

State Waterscape Assets		Value				
		High		**Medium**		**Low**
Threat	**High** Existing and/or near and substantial <2020	Avon River (Dale to Mortlock Rivers) Bremer River Broadwater Brockman River Conservation category wetlands Dale River Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 Fitzgerald River and estuary Fitzroy River Fortescue River Gingilup-Jasper Wetland Sys (ANCA) Gingin Brook Harding River downstream of Dam Hardy Inlet Hill River Estuary Hutt River important wetlands specifically identified in reports commissioned by WRC	Irwin River Estuary Leschenault estuary Lower Blackwood Estuary (ANCA) Lower Moore / Gingin Bk Moore River Estuary Munni Munni Creek to Yule River Murchison River Estuary Oldfield River Ord River Downstream of Dam Oyster Harbour Peel-Harvey Estuarine system Preston River Princess Royal Harbour Scott Lower Vasse-Wonnerup Warren river Wilson Inlet	Avon River (Beverley upstream) Avon River Lower Avon River Middle Beaufort Inlet Chapman River Chapman River Estuary Chittering Lakes (ANCA) Coyrecup Lake (ANCA) Johnston River Kalgan River King River Lake Gore Lake Grace System (ANCA) Lake Logue/Indoon System (ANCA) Lake Toolibin (proposed RAMSAR) Leeuwin Ridge streams	Lockhart Catch/River Marbellup main drain Moore Catch/River Murray River Pallinup River Robinson Drain Serpentine River Thompsons Lake (RAMSAR) Torbay Inlet Torbay main drain Wooroloo Brook Yakamia Creek Yealering Lakes System (ANCA) Yenyening Lakes System Yilgarn Catch/River	Bitter Water Creek Cape Arid to Coomalbidgup Gairdner River Geographe Bay Streams Gordon River Hunter River Irwin River Lake Moore Lake Pinjarrega Mills Lake Wetland system Mongers Lakes PARRY INLET Yarra Yarra Lakes
	Medium Intermediate time and/or not that greater extent 2020-2075	Bandy Creek Cape Leeuwin System (ANCA) Caramup Creek Chamberlain River Coobidge Creek Coomalbidgup Creek Dalyup River Denmark River Directory of Important wetlands Doggerup Creek Doonabup Creek Durack River Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 - South west Environmental Protection (Swan Coastal Plain Lakes) Policy 1992- Mid West Environmental Protection (Swan Coastal Plain Lakes) Policy 1992- Swan Forrest River Frankland River Greenough River Estuary Hamersley River	Jerdacuttup River and Lakes (LR) Kateup Creek King Edward River King River Lake Warden System Maitland (Munni Munni) Meerup River Mitchell River (MR) Oldfield Estuary Ord River Dam upstream Pentecost River Ramsar Wetlands Robe River Salmond River Sherlock River Stokes inlet Walpole-Nornalup Inlet Wellstead Inlet	Balicup Lake System (ANCA) Benger Swamp (Wellesley) (ANCA) Blackwood lower Bowe River Bowes Estuary Brunswick River Carson River Corackerup Creek Culham Inlet East Mortlock River Gascoyne River Greenough River Harvey River Irwin inlet Karri and Cordubup Creeks Kent River Lake Bryde Catchment Lake McLeod Lennard River	Margaret River May River McCarleys Swamp (Ludlow) (ANCA) Meda River Minor streams between Moore and Arrowsmith Rivers Morgan River Mortijinup Lake System (ANCA) Munglinup River Murchison River Owingup Swamp System (ANCA) Peenebup Creek Taylor Inlet Toby Inlet Vasse Catch/River Wagin Lakes Wannamal Lake System (ANCA) Yellilup Yate Swamp Sys (ANCA) Yule River	Bowes River Buller River Collu Collu Creek Cowenup Brook Cuppup drain, Munster, Robinson, Torbay DeGrey River Devil Creek Eneabba Creek Gordon Inlet Hutt Estuary Jam Creek Lake Shaster Needilup River North Mortlock River Oakagee River Peniup Creek Pinjalup Creek Slab Hut Gully SLEEMAN RIVER Torradup River Towerlup River Uannup Brook Wadjekanup River Yallabup Brook
	Low Long term >2075 Or already impacted significantly	Alexander river Berkeley River Big Creek Black Cat Creek – Moates Lake Bluff River Broke Inlet Calder River Charnley River Collie River Copper Mine Creek Cordinup River Deep River Dempster Inlet Dempster River DonnellyRiver Drysdale River Drysdale, King George and Berkeley Rivers Eyre River Forth River Gardener River Glenelg River	Goodga River – Moates Lake Hammersley Inlet Harding River Dam upstream Hunter River Inlet River Isdell River King Creek King George River King George Sound Moran River Mullocullup Creek Prince Regent River Princess Royal Harbour Fitzgerald Biosphere Roe River Sale River Shannon River Thomas River Walpole River Waychinicup River Willyun Creek Wonderup Creek	Blackboy Creek Blackwood River Boyup upstream Cambridge Gulf Cane River Coramup Creek Duke River Dumbleyung Lake (ANCA) Fern Creek Fitzgerald Inlet (ANCA) Gentle Creek Jenamullup Creek JERDACUTTUP LAKES Lake Muir (ANCA) Lakes of Bee Keeper Management Area and other coastal lakes (MR) Lort River	Lyndon River to Minilya River Margaret River Mouth Muir-Unicup (proposed RAMSAR) Mungliginup Creek Neridup Creek Phillips River Steer River Sussetta River Towerinning Lake Weamerjungup Creek West River Yorkrakine Rock Pools (ANCA) Young River Hay River	Ashburton River CHEYNE INLET Jackitup Creek Martaquin Creek Moolyall Creek Six Mile Creek Warperup Creek Wellesley River Wooramel Basin Yarra Monger Trib

Table 3.2 Water supply assets in Western Australia and their importance (State scale) as defined by the value-threat matrix.

State Water Supply Assets		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Albany (RIWIA) Allanooka WR Dongara-Denison WR (PDWSA) Armstrong spring & weir (PDWSA) Badgarning (6km W of Wagin) (PDWSA) Balingup (see Padbury and Greenbushes) CA (PDWSA) Bickley Brook CA (PDWSA) Bindoon / Chittering WR (PDWSA) Blackwood (RIWIA) Bridgetown CA (Hester Dam) (PDWSA) Broome (RIWIA) Broome WR (PDWSA) Bunbury (RIWIA) Bunbury WR (PDWSA) Busselton WR (PDWSA) Busselton-Capel (RIWIA) Carnarvon (RIWIA) Cockburn (RIWIA) Collie (RIWIA) Derby (RIWIA) Derby WR (PDWSA) Donnybrook WR (PDWSA) Dunsborough/ Yallingup WR (PDWSA) Esperance (RIWIA) Esperance WR (PDWSA) Gascoyne River WR (PDWSA) Gingin WR (PDWSA) Gingin (RIWIA) Gnangara (RIWIA) Grass Patch CA (70km N of Esperance) (PDWSA) Greenbushes Dams (see Padbury Reservoir) CA (PDWSA) Harding Dam CA (PDWSA) Jandakot (RIWIA) Jandakot UWPCA (PDWSA) Jurien (RIWIA) Kojonup dam (PDWSA) Lake King CA (70km NW of Ravensthorpe) (PDWSA) Leeuwin Spring Dam (PDWSA) Lefroy Brook CA (see Pemberton) (PDWSA) Manjimup Dam CA - Phillips Creek & Scabby Gully (PDWSA) Marbelup Bk WR (PDWSA) Millstream CA (PDWSA) Mirrabooka (RIWIA) Mirrabooka UWPCA (PDWSA) Mullalyup WR & Mullalyup Dam CA (20km SE of Donnybrook) (PDWSA) Pemberton - Lefroy Brook, Big Brook Dam CA (PDWSA) Perth (including Gwelup) (RIWIA) Preston Beach WR (PDWSA) Quickup River Dam CA (PDWSA) Quinninup Dam CA (PDWSA) Ravensthorpe CA (PDWSA) Rockingham (RIWIA) Rottnest (RIWIA) Salmon Gums CA (100km n of Esperance) (PDWSA) SW Coastal (RIWIA) Swan (RIWIA) Wanneroo (RIWIA) Wanneroo UWPCA (PDWSA) Waroona CA (PDWSA) Warren River WR (PDWSA) Wellington Dam CA (PDWSA) Wicherina CA (40km east of Geraldton) (PDWSA) Yanchep (RIWIA)	Aboriginal communities (NW) (Health Act) Aboriginal communities (SGA) (Health Act) Aboriginal communities (SW) (Health Act) Arrowsmith WR (Perenjori) (PDWSA) Binningup Beach WR (PDWSA) Bolgart WR (PDWSA) Brookton - Happy Valley WR (PDWSA) Brookton Dam CA (PDWSA) Calingiri WR (40km SW of Wongan Hills) (PDWSA) Cowaramup - soak WR (PDWSA) Cue WR (PDWSA) Dandalup River System (RIWIA) Dathagnoorara WR (21km SW of Carnamah) (PDWSA) Dookanooka WR (16km west of 3 Springs) (PDWSA) Eaton WR (PDWSA) Eneabba WR (PDWSA) Finucane Island WR (PDWSA) Fitzroy Crossing WR (PDWSA) Gascoyne Junction WR (PDWSA) Gibson WR (25km N of Esperance) (PDWSA) Guilderton WR (PDWSA) Gwelup UWPCA (PDWSA) Halls Creek WR (PDWSA) Harvey Irrigation District (RIWIA) Jane Brook (PDWSA) Jurien WR (PDWSA) Karnup Dandalup UWPCA & WR (PDWSA) Kirup Dam CA (16km SE of Donnybrook) (PDWSA) Lake Seppings CA (Albany) (PDWSA) Lancelin WR (PDWSA) Laverton WR (PDWSA) Ledge Point WR (PDWSA) Leinster (Goldfields) WR (PDWSA) Leonora WR (PDWSA) Lower Helena Pipehead Dam CA (PDWSA) Lower Serpentine (Goorolong) CA (PDWSA) Marble Bar WR (PDWSA) Meekatharra WR (PDWSA) Menzies WR (PDWSA)	Miling WR (35km NE of Moora) (PDWSA) Mingenew WR (54km W of Dongara) (PDWSA) Mungalup Dam on Collie R (PDWSA) Myalup WR (20km W of Harvey) (PDWSA) Nabawa WR (35km NE of Geraldton) (PDWSA) New Norcia WR (PDWSA) Northampton WR (PDWSA) Nullagine WR (PDWSA) Nyabing Dam on Blackwood R (60km NE of Katanning) (PDWSA) Padbury reservoir CA (PDWSA) Perenjori WR (PDWSA) Perth Coastal UWPCA (PDWSA) Perup River PHS (Future Dam site PDWSA) Pinjarra CA (PDWSA) Pinwernying Dam (5km NW of Katannning) (PDWSA) Private drinking sources (Health Act) Private drinking sources (Health Act) Private drinking sources (Health Act) Private drinking sources e.g Carey Bk on Donnelly R, East Bk, Smith Bk, Treen Bk, & Wilgarup R on Warren R, Fly Bk on Donnelly R (Health Act) Private drinking sources -e.g. Dirk Bk Private drinking sources eg Ferguson R. (Health Act) Private sources for landscape and recreation irrig'n (RIWIA) SW Private stock & irrig'n sources (RIWIA) KP Sandstone WR (PDWSA) Seabird WR (PDWSA) Seaview Park (new see WC) WR (PDWSA) Sovereign Hill (new see WC) WR (PDWSA) Three Springs WR (PDWSA) Varley WR (42 km N of Lake King) (PDWSA) Warmun (Turkey Creek) WR (PDWSA) Watheroo WR (40km N of Moora) (PDWSA) Wiluna WR (PDWSA) Woodridge WR (PDWSA) Yalgoo WR (PDWSA) Yerecoin WR (20km NE of New Norcia) (PDWSA) Yerina Spring WR (PDWSA) Yuna WR (35km E of Northhampton) (PDWSA) Yunderup (Mandurah) WR (PDWSA)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Angove Creek CA (PDWSA) Arrowsmith (RIWIA) Bancell Brook CA (PDWSA) Boddington Dam CA (PDWSA) Bolganup Creek CA (PDWSA) Brunswick Water Supply (Beela Dam) CA (PDWSA) Cane River WR (PDWSA) Canning River CA (Kangaroo Gully wz, Araluen?) (PDWSA) Capel River (RIWIA) Churchman Brook CA (PDWSA) Conjurunup Creek Pipehead Dam CA (PDWSA) De Grey River WR (PDWSA) Denmark River CA (PDWSA) Dumbleyung CA (39km E of Wagin) (PDWSA) Dumpling Gully on Blackwood R (PDWSA) Dwellingup WR (PDWSA) Gnangara UWPCA (PDWSA) Gnowangerup CA (PDWSA) Goldfields (RIWIA) Harris River Dam (PDWSA) Harvey Dam CA (PDWSA) Irrigation schemes - Lake Argyle (RIWIA) Kent River CA (PDWSA) King River Pools WR (PDWSA) Kununurra WR (PDWSA) Limeburners Creek CA (PDWSA) Lower Bickley Re CA (PDWSA) Margaret River/ Ten Mile Brook CA (PDWSA) Millstream (West Pilbara) WR (PDWSA) Moochalabra Dam CA (PDWSA) Mundaring Weir CA (PDWSA) Murray (RIWIA) Nannup - Tanjanerup Dam CA (PDWSA) Newman WR (PDWSA) North Dandalup Pipehead Dam CA (PDWSA) Panawonica WR (PDWSA) Paraburdoo WR (PDWSA) Pilbara (RIWIA) Preston Valley Irrigation (RIWIA) Rocky Gully on Frankland R (PDWSA) Roebourne WR (PDWSA) Samson Bk CA (Dam and pipehead) (PDWSA) SC WR (PDWSA) Scotsdale Brook CA (PDWSA) Serpentine (RIWIA) Serpentine Dam CA (PDWSA) South Dandalup Dam CA (PDWSA) Stirling Dam CA (PDWSA) SW Yarragadee WR (PDWSA) Tambellup Dams on Frankland R (49km S of Katanning) (PDWSA) Tom Price WR (PDWSA) Turner River WR (PDWSA) Victoria CA (PDWSA) Walpole CA-Butlers Creek (PDWSA) Warren R DS55 (Future Dam site PDWSA) Wokalup (Wellesley River) CA Yule River WR (PDWSA)	Arrino Bores WR (PDWSA) Badgingarra WR (60km NW of Moora) (PDWSA) Barlee Bk- Donnelly River (PDWSA) Bremer Bay (RIWIA) Bremer Bay WR (PDWSA) Brunswick River WR (PDWSA) Camballin WR (PDWSA) Canning-Kimberley (RIWIA) Carnarvon WR (PDWSA) Cervantes WR (PDWSA) Condingup WR (65km E of Esperance) (PDWSA) Coomberdale WR (20km N of Moora) (PDWSA) Dandaragan WR (PDWSA) Deep River CA (PDWSA) Denham WR D7 - 2 artesian bore desalinated (PDWSA) Donnelly River WR (PDWSA) East Murchison (RIWIA) Exmouth WR (PDWSA) Farm Irrigation schemes-Drakesbrook, Waroona, Logue Bk & Glen Mervyn reservoirs (RIWIA) Felix Bk on Blackwood R (PDWSA) Frankland WR (PDWSA) Gascoyne (RIWIA) Green Head WR (PDWSA) Hopetoun (RIWIA)	Hopetoun WR (PDWSA) Horrocks Beach WR (PDWSA) Jerramungup Dams Jurien - Turquoise Coast WR (PDWSA) Kalbarri WR (PDWSA) Kukerin catchment & reservoir (40km W of Lake Grace) (PDWSA) Leeman WR 30km Sw of Eneabba (Midway bore) (PDWSA) Moora WR (PDWSA) Mount Peron WR (20 km NE of Jurien) (PDWSA) Munglinup WR (80km E of Ravensthorpe) (PDWSA) Northcliffe WR (PDWSA) Port Gregory WR (PDWSA) Private sources for industry & commerce (RIWIA) Private sources for industry & commerce (RIWIA) Private stock & irrig'n sources (RIWIA) MW Private stock & irrig'n sources (RIWIA) NW Private stock & irrig'n sources (RIWIA) SC Private stock & irrig'n sources (RIWIA) SGA Private stock & irrig'n sources (RIWIA) SW Puntapin Rock (PDWSA) Record Bk on Donnelly R (PDWSA) Serpentine PH CA (PDWSA) South Dandalup PH C A (PDWSA) Wilgarup R DS (Future Dam site PDWSA)	Davies Bk on Murray River (PDWSA)
	Low Long term >2075 Or already impacted	Private sources for industry & commerce (RIWIA) Private sources for industry & commerce e.g Oakley Bk dam (RIWIA) Wungong CA (PDWSA)	Abba R DS (Future Dam site PDWSA) Big Brook Weir (Future Dam site PDWSA) Big Easter Bk (Future Dam site PDWSA) Big Hill Bk DS (Future Dam site PDWSA) Boyinup Brook Dam (TWS) (Future Dam site PDWSA) Carey Bk DS4 (Future Dam site PDWSA) Dalgarup Bk DS1.5 (Future Dam site PDWSA) Dombakup BK DS (Future Dam site PDWSA) Hester Dam (Bridgtn TWS) (PDWSA) Lower South Dandalup (& pipehead dam?) CA (PDWSA) **McAtee Bk DS (Future Dam site PDWSA)** New Norcia (RIWIA) Norilup Bk DS1.5 (Future Dam site PDWSA)	Phillips Dam CA (PDWSA) Private sources for industry & commerce (RIWIA) Private sources for industry & commerce (RIWIA) Private sources for landscape and recreation irrig'n (RIWIA) KP Private sources for landscape and recreation irrig'n (RIWIA) MW Private sources for landscape and recreation irrig'n (RIWIA) NW Private sources for landscape and recreation irrig'n (RIWIA) SC Private sources for landscape and recreation irrig'n (RIWIA) SGA Red Swamp Brook (Future Dam site PDWSA) Scabby Gully Dam (ManjTWS) (PDWSA) St John Bk (Future Dam site PDWSA) Tanjannerup Dam (Nannup TWS) (PDWSA) Tinkers Bk PHS (Future Dam site PDWSA)	Adelaide Bk (Future Dam site PDWSA) Bolgart East (RIWIA) Condingup (RIWIA) Depot Springs WR (80km E of Sandstone) deproclaim? (PDWSA) Dwellingup (RIWIA) Gibson (RIWIA) Happy Valley (RIWIA) Kondinin-Ravensthorpe (RIWIA) Long Gully DS2 (Future Dam site PDWSA) Milyeannup Bk DS (Future Dam site PDWSA) Nannup Bk DS6 (Future Dam site PDWSA) Quickup River Red Gully (Future Dam site PDWSA) Rosa Bk DS (Future Dam site PDWSA) Westonia (RIWIA) Yenart (RIWIA) Yerecoin (RIWIA)

4.0 Aquatic Assets and Fish Resources [8]

4.1 Introduction

The DoF has a statewide responsibility for managing and allocating fish resources and the protection of its aquatic environment. Fisheries management responsibilities extend out to 200 nautical mile Exclusive Economic Zone (EEZ). The two broad responsibilities are:

- Protect fish and their habitats; and
- Ensure that commercial and recreational fishing activities are undertaken in an ecologically sustainable manner.

To acknowledge these responsibilities and their related values the assets have been grouped into two sub-classes:

1. Freshwater environments
2. Marine environments.

4.2 The process

At the outset of this process, the DoF had already completed extensive work on prioritising the management of fish resources and preparation of:

- Commercial Fisheries Management Plans
- Recreational Fisheries Management Plans
- Aquaculture Plans
- Fisheries Environmental Management Plans (at a bioregional scale)
- Annual State of the Fisheries Report

All of these publications and resources were combined with expert opinion to complete the following value-threat assessment of aquatic assets and fish resources.

4.2.1 Measuring Value

Most fisheries assets have numerous values associated with them. It is important to acknowledge and score these multiple values. Values were grouped into three broad categories economic, social and environmental:

Economic: The commercial fisheries of WA generate returns of approximately $600 million/year. Recreational fishing is one of the State's most popular leisure activities and the fishing industry is a major employer in some rural areas.

Social Values:

Recreational fishing is one of the State's most popular leisure activities.

Environmental Values:

Biodiversity: Biodiversity refers to the variety of genes, species and ecosystems, and is essential to human wellbeing in many ways. It underpins ecological processes that are vital to human health and survival and the continued evolution of life on Earth.

Uniqueness: Some habitats and ecosystems are representative of environmental systems that do not occur outside of WA.

Using the following scale, fish resource assets were scored for their economic, social and environmental values described above:

1 = None, the attribute does not contribute to the value of the asset
2 = Minor, the attribute contributes to the asset at a local level
3 = Moderate, the attribute contributes to the value of the asset at a local and regional scale
4 = Important, the attribute contributes to the value of the asset at local, regional and state scale
5 = Significant, attribute contributes to the value of the asset at a local, regional, state and national level
Unknown, unable to answer

An overall score for value was obtained by adding the environment, social and economic scores. A total score of 15 could be obtained.

[8] This section is adapted from the Department of Fisheries' '*Identifying High Importance Aquatic assets and Fish Resources* (Chalmers, in progress 2003).

The High Medium and Low value scores were as follows:
High = 10 – 15
Medium = 5 - 9
Low = 1 - 4

4.2.2 Measuring Threats

Threats considered included:

- Fishing by Australian and foreign fleets
- Eutrophication
- Introduced Marine Pests
- Pollution from point sources
- Ecosystem fragmentation
- Coastal development including the development of petroleum products
- Land development: intensive agriculture
- Water development: aquaculture and boating facilities
- Direct loss of fish habitat (reclamation and dredging)
- Commercial fishing

Using the following scale the threats to assets were scored:

1 = No other threats of significance
2 = Minor, impacts will occur in 75 years or more or significant impacts have already occurred and not expected to get any worse.
3 = Moderate, impacts will occur in 20 to 75 years
4 = Severe, impacts will occur over next 20 years
5 = Extreme, impacts will occur in a few years and impacts will be significant.
Unknown = unable to answer question

The high medium and low threat bands were defined as follows:
High = 4 – 5
Medium = 3
Low = 1 - 2

4.3 The outputs

Table 4.1 Department of Fisheries - Threat Matrix identifying aquatic asset in terms of value and threat level

Fisheries assets		Value		
		High	**Medium**	**Low**
Threat	**High**	Freshwater fish (SC,SW,NA) Margaret River Marron stocks(SW) Inshore reefs (Urban)SW, Swan Estuaries(SW, Swan, NA) Marron stocks (NA, Swan, SW)	Cockburn Sound (Swan) Inshore reefs (Swan)	Ports (small)(all regions) Ports (large)(all regions) North Coast Shark (combined JANSF & WANCSF) (R)
	Medium	Marine fish stocks(all regions) Estuaries (remote) Coastal waters (offshore 3 nm) Inshore Kimberley waters Estuaries (R) Pink Snapper (R) Recreational Marron (NA, SW, SC, Swan) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) Minor Scallops Abrolhos Island and Mid West Trawl (NA) Minor Scallops South Coast Trawl (SC) West Coast Demersal Scalefish (NA, Swan, SW) Shark Bay Snapper (R) Onslow Prawn (R) Broome Prawn (R) Kimberley Prawn (R) Pilbara Demersal Finfish (R) Spanish Mackerel (R) Demersal Gillnet and Demersal Longline (DGDLF) (SC) Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	Minor Scallops South West Trawl (SW) Lower West Coast Beach and Embayment Cockburn Sound Finfish (Swan) Nickol Bay Prawn (R) Barramundi Farming (R) Ornamental Fish Farming (Swan, NA, SW, SC)
	Low	Abrolhos Islands (NA) Corals and benthic (R, NA, Swan, SW) Inshore reefs (R, NA, SC, SW) West Coast Rock Lobster (SW, Swan, NA, R) Shark Bay Prawn (R) Exmouth Gulf Prawn (R) Shark Bay Scallop (R) Greenlip and Brownlip Abalone (SC) Roe's Abalone (SC) Pearl Oyster (R) Recreational - Kimberley and Pilbara Regions (R) Recreational - South Coast (SC) Rock Lobster (R; NA; Swan; SW)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) West Coast Blue Swimmer Crab (SW; Swan; NA, R) West Coast Deep-sea Crab (SW; Swan; NA; R) West Coast Estuarine (SW, Swan) West Coast Purse Seine (Swan) Mussel Farming (SC, Swan) Northern Demersal Scalefish (R) South Coast Rock Lobster (SC) Black Snapper (R) Recreational - Northern Inland (R) Freshwater Angling (All Regions)	Lower West Coast Beach and Embayment West Coast Beach Bait (Fish Net) (NA, Swan, SW, SC) Shark Bay Beach Seine and Mesh Net (R) Kimberley Gillne and Barramundi (R) Lake Argyle Freshwater Catfish (R) South Coast Estuarine (SC) Western Australian Salmon (SC) Australian Herring (SC) South Coast Purse Seine (SC) Coastal aquaculture: pearl and pearl oysters + others (NA, SC) Trout Farming (SC, SW)

SC= South Coast Region
SW= South West Region
NA= Northern Agriculture Region
R= Rangeland Region
Swan = Swan Region

5.0 NRM Issues Database - Department of Agriculture, Western Australia[9]

5.1 Introduction

Numerous processes occur on agricultural land that not only threaten the land asset itself, but also off-site assets such as water quality, freshwater and estuarine ecosystems and biodiversity. This overview however only deals with the processes that directly threaten the agricultural land asset and influence the ability of the land to sustain agricultural land uses into the future. More comprehensive coverage of the NRM issues facing agriculture is included in the "NRM issues and strategies" documents prepared for individual regions.

5.2 The process

The Department of Agriculture's process is based on a combination of expert knowledge and the inherent physical qualities of the land resource to determine threat. Value is based on the average value of agricultural land ($/ha) determined from year 2000 Bank West data.

Information on threat and asset value were obtained and put into an 'NRM issues database'. The NRM issues database provides information on the significance of NRM issues related to geographic areas of southwestern Australia.

The spatial framework for the assessments of value and threat is the *soil-landscape zone* as defined by the Natural Resources Assessment Group of the Department of Agriculture. These zones delineate broad terrain types based on geomorphological criteria and are useful for gaining a regional perspective of landscape related issues. There are 31 zones described for southwestern Australia (Figure 5.1). Grouping of more detailed underpinning soil-landscape mapping creates the boundaries of the zones.

Five key NRM issues relevant to agriculture and related to soil and land were identified by a Department of Agriculture expert panel. Biodiversity, plant or animal specific issues were not considered, and NRM issues of minor extent in WA (for example mass movement) are not included.

The issues and their definitions are provided in Table 5.1.

Table 5.1 Key NRM issues related to the agricultural land asset

Key NRM issues facing agricultural land	
Land salinisation	Risk of land salinisation considering the inherent susceptibility of the land to salinisation and land management practices.
Soil acidification	Risk of subsurface or subsoil acidification considering the inherent susceptibility of the land to acidification and land management practices.
Wind erosion	Risk of wind erosion considering the inherent susceptibility of the land to wind erosion and land management practices.
Water erosion	Risk of water erosion considering the inherent susceptibility of the land to water erosion and land management practices.
Soil structure decline/compaction	Risk of soil compaction/structure decline considering the susceptibility of the soil to compaction (texture/structure/organic matter/sodicity) and land management practices.

The NRM database at the Department of Agriculture provides more information on the definition, processes and impacts of the issues. It also includes several other issues that influence the long-term sustainability of agricultural industries in Western Australia but have not been included in this assessment, as they do not directly threaten the agricultural land resource.

For each combination of NRM issue and soil-landscape zone, an estimate of the threat to the asset caused by the issue/process and the value of the asset being threatened was made. The threat - value matrix was then used to determine the priority of the asset/issue within a zone.

First tier issues are of highest importance, second tier of moderate importance and third tier of low importance.

[9] This section is adapted from the Department of Agriculture's 'Key natural resource management issues in Western Australia – an agricultural perspective (Schoknecht, in progress 2003)'.

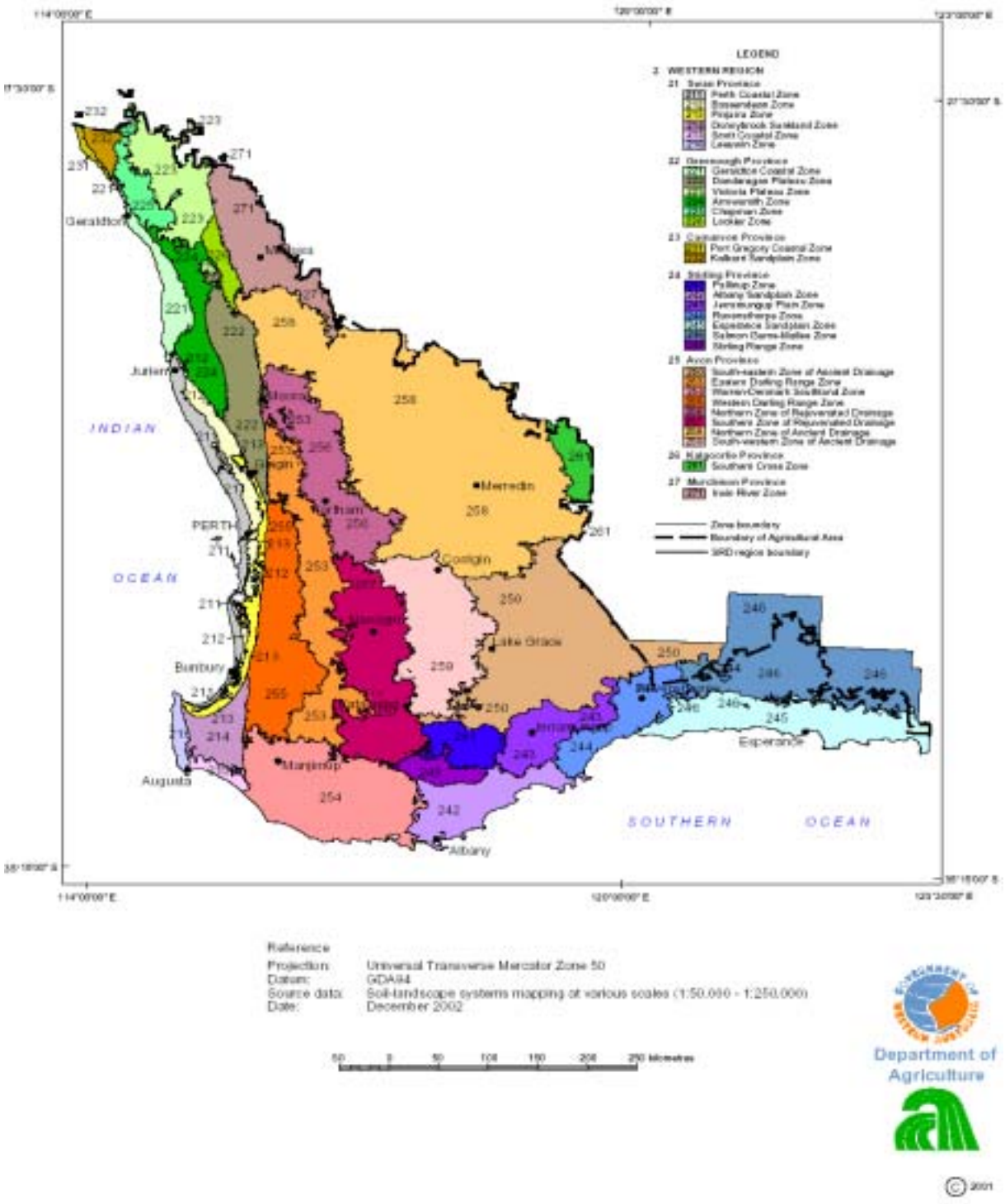


Figure 5.1 Soil-landscape zones for southwestern Australia

In addition, for each zone a summary table was prepared looking at the average threat to the land resource based on the five threatening processes. For example, if a particular zone had two issues of High threat, one issue of Moderate threat and two issues of Low threat, the average threat was determined as Moderate. This process, although subjective, gives an indication of which zones are most at risk.

5.2.1 Measuring value

Value is the average value of agricultural land ($/ha) per shire of land in year 2000 based on data from Bank West. The shire value data was then proportionally allocated to the soil-landscape zones based on the area of each shire in each zone. For the purposes of this exercise the agricultural land values have been allocated to three categories – High (H), Moderate (M) and Low (L). High value land average value of >$3000/ha, Moderate $750 – 3000/ha and Low <$750/ha. Average agricultural land value is strongly correlated with rainfall (higher rainfall areas tend to have higher land values) and proximity to urban centres.

5.2.2 Measuring threat

The level of threat is based on an assessment of the timing of a significant impact from the process/issue – ie when will the issue occur, and how big will the impact be. The threat categories were described as follows:

- **High**: Current/imminent risk of high impact
- **Moderate**: Current/imminent risk of moderate impact, or
  Medium-term risk of high impact
- **Low**: Current/imminent risk of low impact
  Medium-term risk of low-moderate impact
  Long-term risk of low-high impact

The terms used to describe these threat categories are defined as:

- **Current/imminent:** significant impact realised within 0 20 years
- **Medium-term:** significant impact within 20-75 years
- **Long-term:** significant impact greater than 75 years

- **High impact:** majority of asset at risk
- **Moderate impact:** some of the asset at risk
- **Low impact:** minority of asset at risk

For *salinity-related issues*, information already collected as part of the SIF and results from project work on the rural towns project were used to determine threat levels. For the *soil-related issues*, information held in the soil-landscape database of the Department of Agriculture was used to determine the size and nature of the threat based on the current extent of the land degradation issue and the inherent susceptibility of the land.

5.2.3 Assigning priorities to regions

The spatial unit of assessment is the Soil-landscape Zone. Each zone falls within one or more NRM regions. Table 5.3.7 gives the percentage of each soil-landscape zone within each NRM region enabling an assessment of priority issues by region to be determined.

5.3 The outputs

Table 5.3.1 Agricultural land asset - Average of land-related threats

Threat to agricultural land resource asset based on an average of all threats
(wind erosion, water erosion, land salinisation, soil structure decline/compaction, soil acidification)

Agricultural land (all threats)		**Value of land ($/ha)**		
		H	**M**	**L**
Threat	**High**	• Northern Zone of Rejuvenated Drainage	• Dandaragan Plateau Zone • Northern Zone of Ancient Drainage • Pallinup Zone	• Jerramungup Zone • South-eastern Zone of Ancient Drainage
	Medium	• Bassendean Zone • Eastern Darling Range Zone • Perth Coastal Zone • Pinjarra Zone • Scott Coastal Zone • Warren-Denmark Southland Zone • Western Darling Range Zone	• Albany Sandplain Zone • Chapman Zone • Kalbarri Sandplain Zone • Port Gregory Coastal Zone • Southern Zone of Rejuvenated Drainage • Stirling Range Zone • Esperance Sandplain Zone	• Lockier Zone • Ravensthorpe Zone • South-western Zone of Ancient Drainage • Victoria Plateau Zone
	Low	• Donnybrook Sunkland Zone • Leeuwin Zone	• Arrowsmith Zone	• Geraldton Coastal Zone • Irwin River Zone • Salmon Gums-Mallee Zone • Southern Cross Zone

Threat to agricultural land resource asset based on wind erosion threat

Agricultural land (wind erosion)		**Value of land ($/ha)**		
		H	**M**	**L**
Threat	**High**	• Bassendean Zone • Perth Coastal Zone • Scott Coastal Zone	• Pallinup Zone • Arrowsmith Zone • Dandaragan Plateau Zone • Kalbarri Sandplain Zone • Albany Sandplain Zone • Northern Zone of Ancient Drainage • Port Gregory Coastal Zone • Esperance Sandplain Zone	• Geraldton Coastal Zone • Jerramungup Zone • Ravensthorpe Zone • South-eastern Zone of Ancient Drainage
	Medium	• Warren-Denmark Southland Zone • Eastern Darling Range Zone • Northern Zone of Rejuvenated Drainage • Western Darling Range Zone	• Chapman Zone • Stirling Range Zone • Southern Zone of Rejuvenated Drainage	• South-western Zone of Ancient Drainage • Victoria Plateau Zone • Irwin River Zone • Lockier Zone • Salmon Gums-Mallee Zone • Southern Cross Zone
	Low	• Pinjarra Zone • Leeuwin Zone • Donnybrook Sunkland Zone		

Table 5.3.3 Agricultural land asset - Threat class – water erosion
Threat to agricultural land resource asset based on water erosion threat

Agricultural land (water erosion)		Value of land ($/ha)		
		H	**M**	**L**
Threat	**High**	• Warren-Denmark Southland Zone • Eastern Darling Range Zone • Western Darling Range Zone • Northern Zone of Rejuvenated Drainage • Southern Zone of Rejuvenated Drainage	• Chapman Zone • Port Gregory Coastal Zone	• Lockier Zone • Ravensthorpe Zone • Victoria Plateau Zone
	Medium	• Perth Coastal Zone • Leeuwin Zone • Donnybrook Sunkland Zone	• Kalbarri Sandplain Zone • Stirling Range Zone • Dandaragan Plateau Zone • Pallinup Zone	
	Low	• Scott Coastal Zone • Pinjarra Zone • Bassendean Zone • Geraldton Coastal Zone	• Arrowsmith Zone • Albany Sandplain Zone • Northern Zone of Ancient Drainage • Esperance Sandplain Zone	• Jerramungup Zone • Irwin River Zone • Salmon Gums-Mallee Zone • South-eastern Zone of Ancient Drainage • South-western Zone of Ancient Drainage • Southern Cross Zone

Table 5.3.4 Agricultural land asset - Threat class – land salinisation
Threat to agricultural land resource asset based on land salinisation threat

Agricultural land (land salinisation)		Value of land ($/ha)		
		H	**M**	**L**
Threat	**High**	• Eastern Darling Range Zone • Northern Zone of Rejuvenated Drainage • Pinjarra Zone • Warren-Denmark Southland Zone • Western Darling Range Zone	• Chapman Zone • Dandaragan Plateau Zone • Northern Zone of Ancient Drainage • Pallinup Zone • Southern Zone of Rejuvenated Drainage • Stirling Range Zone • Esperance Sandplain Zone	• Jerramungup Zone • South-eastern Zone of Ancient Drainage • South-western Zone of Ancient Drainage
	Medium	• Bassendean Zone • Perth Coastal Zone	• Albany Sandplain Zone	• Lockier Zone • Ravensthorpe Zone • Victoria Plateau Zone
	Low	• Donnybrook Sunkland Zone • Leeuwin Zone • Scott Coastal Zone	• Arrowsmith Zone • Kalbarri Sandplain Zone • Port Gregory Coastal Zone	• Geraldton Coastal Zone • Irwin River Zone • Salmon Gums-Mallee Zone • Southern Cross Zone

Table 5.3.5 Agricultural land asset - Threat class – soil structure decline/compaction
Threat to agricultural land resource asset based on threat of soil structure decline and/or compaction

Agricultural land (soil structure decline/ compaction)		**Value of land ($/ha)**		
		H	**M**	**L**
Threat	**High**	• Pinjarra Zone	• Pallinup Zone	
	Medium	• Eastern Darling Range Zone • Northern Zone of Rejuvenated Drainage • Southern Zone of Rejuvenated Drainage • Warren-Denmark Southland Zone	• Albany Sandplain Zone • Chapman Zone • Dandaragan Plateau Zone • Kalbarri Sandplain Zone	• Jerramungup Zone • Lockier Zone • Northern Zone of Ancient Drainage • Ravensthorpe Zone • Salmon Gums-Mallee Zone • South-western Zone of Ancient Drainage • Victoria Plateau Zone
	Low	• Bassendean Zone • Donnybrook Sunkland Zone • Leeuwin Zone • Perth Coastal Zone • Scott Coastal Zone • Western Darling Range Zone	• Arrowsmith Zone • Port Gregory Coastal Zone • Stirling Zone • Esperance Sandplain Zone	• Geraldton Coastal Zone • Irwin River Zone • South-eastern Zone of Ancient Drainage • Southern Cross Zone

Table 5.3.6 Agricultural land asset - Threat class – Soil acidification
Threat to agricultural land resource asset based on soil acidification threat

Agricultural land (soil acidification)		Value of land ($/ha)		
		H	**M**	**L**
Threat	**High**	• Bassendean Zone • Northern Zone of Rejuvenated Drainage • Scott Coastal Zone	• Albany Sandplain Zone • Dandaragan Plateau Zone • Kalbarri Sandplain Zone • Northern Zone of Ancient Drainage • Southern Zone of Rejuvenated Drainage	• Esperance Sandplain Zone • Jerramungup Zone • Lockier Zone • South-eastern Zone of Ancient Drainage • South-western Zone of Ancient Drainage • Victoria Plateau Zone
	Medium	• Eastern Darling Range Zone • Perth Coastal Zone • Warren-Denmark Southland Zone	• Chapman Zone • Pallinup Zone • Port Gregory Coastal Zone • Stirling Zone	• Ravensthorpe Zone • Southern Cross Zone
	Low	• Donnybrook Sunkland Zone • Leeuwin Zone • Pinjarra Zone • Western Darling Range Zone		• Irwin River Zone • Salmon Gums-Mallee Zone

Table 5.3.7 Distribution of soil-landscape zones by % within NRM regions

Soil-landscape zone	*NRM Region*					
	Avon	**Northern**	**South Coast**	**South West**	**Swan**	**Other areas (Rangelands)**
Perth Coastal Zone	0	26	0	20	54	0
Bassendean Zone	0	28	0	22	50	0
Pinjarra Zone	0	0	0	73	27	0
Donnybrook Sunkland Zone	0	0	0	100	0	0
Scott Coastal Zone	0	0	0	100	0	0
Leeuwin Zone	0	0	0	100	0	0
Geraldton Coastal Zone	0	100	0	0	0	0
Dandaragan Plateau Zone	0	80	0	0	20	0
Victoria Plateau Zone	0	100	0	0	0	0
Arrowsmith Zone	0	100	0	0	0	0
Chapman Zone	0	100	0	0	0	0
Lockier Zone	0	100	0	0	0	0
Port Gregory Coastal Zone	0	100	0	0	0	0
Kalbarri Sandplain Zone	0	100	0	0	0	0
Pallinup Zone	0	0	98	2	0	0
Albany Sandplain Zone	0	0	100	0	0	0
Jerramungup Zone	0	0	100	0	0	0
Ravensthorpe Zone	0	0	100	0	0	0
Esperance Sandplain Zone	0	0	95	0	0	5
Salmon Gums-Mallee Zone	0	0	52	0	0	48
Stirling Range Zone	0	0	100	0	0	0
South-eastern Zone of Ancient	81	0	8	5	0	6
Eastern Darling Range Zone	18	0	0	52	30	0
Warren-Denmark Southland Zone	0	0	44	56	0	0
Western Darling Range Zone	0	0	0	81	19	0
Northern Zone of Rejuvenated	73	17	0	0	10	0
Southern Zone of Rejuvenated	12	0	17	70	0	0
Northern Zone of Ancient Drainage	77	23	0	0	0	0
South-western Zone of Ancient	54	0	0	46	0	0
Southern Cross Zone	100	0	0	0	0	0
Irwin River Zone	0	100	0	0	0	0

6.0 Biodiversity assets[10]

6.1 Introduction

Biodiversity (biological diversity) is a simple concept, with an underlying complexity that necessitates an intricate and multi-scaled approach to its conservation, often requiring involvement of a wide range of key stakeholders or interest groups and applying across all land/wildlife uses. Consequently biodiversity management and conservation is a challenging issue to implement in NRM processes.

The overall objective is to maintain functioning land and seascapes that adequately provide for their full range of biodiversity and at all organisational levels (genes, species, populations, communities and ecosystems). In some instances this will require recovery of key elements of biodiversity such as threatened species or threatened ecological communities.

With limited resources available for conservation a targeted approach is vital. In such an approach specific strategy must be pursued to maximise maintenance of existing biodiversity components (genes, species, ecosystems), patterns and processes at various spatial and temporal scales, and also to recover those elements of biodiversity that are threatened.

For the purpose of this exercise the biodiversity asset class has been necessarily allocated into four primary sub-categories. These categories are of the highest order of importance and provide an overarching framework for lower order conservation strategies and actions aimed at biodiversity conservation. The sub-categories are:

Bio-subgroup 1: Biodiversity inventory and establishment of a Comprehensive, Adequate and Representative (CAR) terrestrial conservation reserve system and marine conservation reserve system.

Bio-subgroup 2: Effective management and protection of conservation reserves and other recognised special conservation value areas.

Bio-subgroup 3: Recovery of threatened species and threatened ecological communities other significant species and areas of exceptional diversity or endemism.

Bio-subgroup 4: Conservation of landscape/seascape scale ecological systems and processes (integrating reserve and off-reserve conservation).

The priority areas are based on applying conservation biology principles, coupled with supportive institutional mechanisms, to conserve the various organisational levels (genes, species, populations, communities and ecosystems), and ecosystem function. Collectively, these priorities aim to achieve a balance between landscape/seascape conservation management, and management of rare or geographically restricted high value biodiversity assets often under threat.

Collectively the four priority groups encompass the breadth of actions identified in "The National Strategy for the Conservation of Australia's Biological Diversity" (1996), as signed by the Premier and Prime Minister.

Where relevant, the Interim Biogeographic Regionalisation of Australia (IBRA) and Interim Marine and Coastal Regionalisation of Australia (IMCRA) boundaries have been used as the basis for identifying and presenting spatial priorities, along with information from the recent national biodiversity assessment under the National Land and Water Resources Audit. Appendix 1a and 1b describes the IBRA and IMCRA regions in relation to NRM boundaries.

The following identification of Western Australia's biological diversity conservation priorities has been prepared using a combination of existing data sets, and expert opinion from within the Department of Conservation and Land Management, as well as using opinion from a number of expert independent advisory bodies.

[10] This section is adapted from the Department of Conservation and Land Management's '*Western Australia's Biodiversity Conservation Priorities*' (Claymore K & Wyre G, in progress, 2003).

6.2 The process and outputs

6.2.1 Bio sub-category 1: Biodiversity inventory and establishment[11] of a comprehensive, adequate and representative (CAR) terrestrial conservation reserve system and marine conservation reserve system

This sub-category represents one of the key planks of biodiversity conservation. The overall goal is for formal protection of a viable sample of each major biome (to maintain biodiversity) through provision of appropriate long-term security and management protocols. This may entail establishment of nature reserves national parks, conservation parks, or other formal reserves with management practices in accordance with the objectives outlined under IUCN protected area categories I - IV.

Reserves form a basis for conservation benchmarking, the nucleus for species and ecological community protection and recolonisation and wildlife corridors/stepping stones for species dispersal and survival. Traditionally reserves have also provided places where areas of high biodiversity, and the potential valuable chemicals and processes contained or provided for can be searched and tested through bioprospecting.

Increasingly, the economic values of reserves in protecting biodiversity are being understood. Studies and investigations undertaken around the world have shown that it costs between 10 and 100 times more to recover degraded areas than to conserve them. In many cases degraded areas cannot be recovered completely because key species are no longer available for recolonisation and translocation. In these instances reserve creation will at least partly be too late.

Establishment of a comprehensive, adequate and representative terrestrial reserve system follows the principles as agreed between the State and Commonwealth under the Interim Bioregionalisation of Australia (IBRA) and Interim Marine and Coastal Regionalisation for Australia (IMCRA).

- Comprehensive refers to the inclusion of the full range of ecosystems recognised within and across each bioregion.
- Adequate means ensuring that sufficient proportions of each ecosystem should be included within a conservation reserve network in order to maintain ecological viability and integrity of populations, species and communities.
- Representative means that the reserves need to cover the breadth of the biotic diversity of the ecosystems they are seeking to conserve.

Under existing national protocols and agreements the basic requirements of a CAR reserve system have been defined to include 15% of the landscape of an ecoregion being legislatively protected and managed specifically as conservation reserves. The 15% is a basic figure and must be considered in relation to the ecological functions of the ecosystems to be conserved. In some instances there may be a requirement for a higher proportion of the ecoregion to be conserved in order to protect particularly sensitive ecosystems.

Priorities in this group are best represented in four categories. Appendix 1c and 1d show the current status (extent) of the terrestrial and marine conservation reserve system for each IBRA sub-bioregion and IMCRA bioregion respectively. The higher the 'value' the further the sub-bioregion/bioregion is from achieving a CAR reserve system, and hence a higher priority for action and investment. Tables 6.1 and 6.2 outline the relative value (reservation status) of existing reserves against threat. . It should be noted, however, the ability to protect healthy ecosystems, that is with high ecological integrity, is of primary importance to establishing a conservation reserve system. Hence, sub-bioregions with high biodiversity value (i.e currently having low status) with medium-low threat may be of higher importance to focus on areas where the threat is higher.

There is a basic requirement for the State to have a good understanding of its biodiversity, its spatial representation and the functional relationships of ecosystem processes, in order to implement a network of reserves and associated off-reserve conservation initiatives to conserve that biodiversity.

Increased understanding of biodiversity, particularly patterns and components, through systematic biological assessment provides a basis for conservation planning. For the ongoing development of the terrestrial conservation reserve system current high priorities include the completion of the agricultural zone biological survey over the coming year and continued implementation of the State's biological survey program over the Pilbara Bioregion over the period 2003 to 2007. There is an urgent need for reserve creation across much of the pastoral areas of the State. Although considerable progress has been made in purchasing leasehold areas for the reserve system in the

[11] Establishment covers the identification of key areas for protection through scientific-based research and other investigative work on biodiversity (that is components, patterns and processes), the acquisition of land/waters for the conservation reserves system, and use of legislative mechanisms to protect ecosystems

Gascoyne-Murchison Strategy area over the past few areas, these need to be converted into formal reserves and further reserves need to be identified and established in other pastoral areas (see attachment 1). The Government is also committed to using the expiry of all pastoral leases in 2015 to provide for exclusions for conservation purposes which will help with progress towards the CAR reserve targets in pastoral areas.

Marine biological survey priorities include assessment of the Kimberley and Eucla bioregions; Beagle and Abrolhos Islands; and proposed extension to the Shoalwater Marine Park. In addition, a further priority is the development of rapid marine biodiversity mapping with particular focus on deeper (>20 M) and turbid waters. Priorities for establishment of new marine conservation reserves have been identified as Jurien, the Montebello Islands/Barrow Island, Dampier Archipelago/Cape Preston, Geographe Bay to Hardy Inlet, and Walpole-Nornalup Estuaries.

Table 6.1 - Relative value (reservation status) of existing conservation reserves systems within IBRA subregions against threat (continental stress class).

Bio-subgroup 1 Terrestrial		Biodiversity Value		
		High	**Medium**	**Low (towards CAR)**
Threat	**High**	Avon Wheatbelt 1 Avon Wheatbelt 2 Dampierland 1 Dampierland 2 Central Kimberley 2 Ord Victoria Plain 2	Mallee 2 Swan Coastal Plain 1 Central Kimberley 1 Central Kimberley 3	Swan Coastal Plain 2 North Kimberley 1 North Kimberley 2 Geraldton Sandplain 2 Jarrah Forest 2
	Medium	Pilbara 2 Murchison 2 Carnarvon 1 Gascoyne 1	Pilbara 4 Pilbara 1 Carnarvon 2 Murchison 1 Victoria Bonaparte 1**r**	Ord Victoria Plain 1 Geraldton Sandplains 3 Esperance 1 Coolgardie 2 Jarrah Forest 1 Yalgoo 1 Warren Gascoyne 3 Mallee 1 Gibson Desert 1
	Low	Great Sandy Desert 2 Great Sandy Desert 1 Gibson Desert 2 Nullarbor 2 Coolgardie 3 Little Sandy Desert 2 Central Ranges	Gascoyne 2 Great Victoria Desert 3 Great Victoria Desert 2 Great Victoria Desert 1	Gibson Desert 1 Hampton Coolgardie 2 Esperance 2 Little Sandy Desert 1 Nullarbor 1 Pilbara 3

Table 6.2 - Relative value (reservation status) of existing marine conservation reserves systems within IMCRA regions against threat

Bio-subgroup 1 Marine		Relative Conservation Value			
		High	**Medium**		**Low**
Threat	**High**	*Dampier Archipelago* *Montebello Islands* *Barrow Island* *Exmouth Gulf* *Roebuck Bay* Houtman Abrolhos	Peel Harvey Inlet Geographe – Cape Leeuwin King George Sound/Princess Royal Harbour Nth SIMP Leschenault Inlet Hardy Inlet *Muiron Islands*		
	Medium	Walpole-Nornalup Inlets Recherche Archipelago *Eighty Mile*	*Cape Preston* *Sourrier Islands* *Robe* Jurien Bernier, Dorre & Dirk Hartog Islds **Oceanic coral banks and Cambridge Gulf islands Buccaneer Archipelago**	Broke Inlet *Lagrange Bay* Donnelly & Gardner Inlets West Cape Howe Stokes Inlet William Bay Port Gregory Kalbarri	
	Low	**Prince Fredrick Harbour** Fitzgerald	*Pender bay-Cape Borda* *Depuch and Cowrie C*ree Cape Vancouver- Bald Islands Red Bluff to Pt. Quobba Sth. Ningaloo MP **Admiralty Gulf** **Vansittart Bay** **St. Georges Basin** **Montgomery Islands**	**Walcott Inlet/Secure Bay, Londonderry** *Keraudren* *Lacepede Islands* Black Point Warren Beach * Twilight	Beagles Seven Mile Beach

Key: Kimberley, *Pilbara*, West Coast, South Coast

Priorities were established via a Marine Parks and Reserves Authority workshop in 1998 involving all key stakeholders using a framework developed by the Department of Conservation and Land Management. (Simpson, C.J. and Bancroft, K.P. (1998). A framework for prioritising the establishment of marine conservation reserves in Western Australia. A Position paper prepared for the Marine Parks and Reserves Authority. August 1998. Marine Conservation Branch, Department of Conservation and Land Management)
*Only 1 MPA candidate area has been identified for the Eucla Bioregion due to insufficient data available at publication of the Marine Parks and Reserves Selection Working
Group report (CALM, 1994). Further biodiversity assessment will be required for this region to identify further candidate areas.

6.2.2 Bio sub-category 2: Effective management and protection conservation reserves and other recognised special conservation value areas.

This subcategory includes formal conservation reserves and other areas comprising areas of land and water that are either set aside or specifically recognised under statutory mechanisms for biodiversity conservation values. The State's terrestrial and marine conservation reserve system, Ramsar sites (internationally recognised wetlands of importance), biosphere reserves and World Heritage Properties can all be included under this category. Those areas that are formally specially protected under legislation under this category can be referred to as protected areas and collectively as the protected area network.

Across the State there are around 1600 conservation reserves managed by the Department of Conservation and Land Management, 11 Ramsar sites, 2 Biosphere reserves and 1 World Heritage Area (Shark Bay - part of which is protected in formal reserves or in areas purchased for conservation management). Note that the categories are not mutually exclusive. Rather there are areas that have been recognised and specially protected for a range of values within the formal reserve system.

The above biodiversity assets are designated for their high biodiversity conservation value, and are all considered a high priority for investment. It is imperative that priority conservation reserves are adequately managed to protect the values they were created to conserve.

The assessment of value and threat for this subcategory is based on IBRA bio-subregions. The continental landscape stress class for the IBRA sub-bioregions has been used as a surrogate for (appendix 1e). It is important to note that the levels and types of threat faced by individual reserves in these regions will vary between each reserve/area.

The value assessment is based on the area of an IBRA sub-region covered by conservation reserves. Appendix 1f illustrates IBRA sub-bioregions and the proportion of land covered by the protected area network. The greater the percentage area coverage the higher the overall value a protected area network has on a sub-regional basis. Table 6.3 shows the relative importance of IBRA sub-bioregions based on the proportion of protected area and the stress class relevant to that subregion. It is important to note, however, that this table does not necessarily infer that a protected area within a sub-region with a high value and high threat is of higher priority for investment than a sub-region where there is relatively low coverage of protected areas and low threats. As noted above, all protected areas have a high nature and biodiversity conservation value due to either contributing towards a comprehensive, adequate and representative conservation reserve system or containing other unique conservation values for which they were declared. When the various individual areas of protected areas are combined to give a percentage coverage at a sub-regional scale, as in this analysis, individual protected area values are invariably not indicated.

Management priorities include the following generic strategies:

- development and implementation of an appropriate *administrative framework* (ie. the essential policy, legal, financial, operational requirements for effective management);
- *active management intervention* (both pro-active and reactive[12]);
- *monitoring and evaluation*;
- gaining knowledge through targeted *scientific research* (ecological and social) and other investigative work;
- *public participation; education and interpretation; and*
- *surveillance and enforcement.*

[12] This includes abatement of threatening processes, spatially strategic and targeted native habitat recovery and rehabilitation; landscape focused strategic revegetation to increase connectivity and viability, and maintenance of key natural processes and patterns at various scales.

•

Table 6.3 Terrestrial conservation reserves by IBRA bio-subregion versus threat

Bio-subgroup 2 Terrestrial		**Value** (proportion of IBRA sub-bioregion protected)		
		High >19%	**Medium** 4-18%	**Low** 0-3%
Threat – continental landscape stress class	**High** (1-2)	Swan Coastal Plain 2 Jarrah Forest 2	Geraldton Sandplain 2 Mallee 2 Central Kimberley 3 Central Kimberley 1 North Kimberley 1 North Kimberley 2	Avon Wheatbelt 1 Avon Wheatbelt 2 Dampierland 1 Dampierland 2 Ord Victoria Plain 2 Central Kimberley 2 Victoria Bonaparte 1
	Medium (3-4)	Warren Jarrah Forest 1 Geraldton Sandplains 1 Esperance plains 1 Mallee 1 Coolgardie 2	Swan Coastal Plain 1 Geraldton Sandplains 3 Carnarvon 2 Yalgoo 1 Murchison 1 Murchison 2 Gascoyne 3 Carnarvon 1 Pilbara 1 Pilbara 4 Ord Victoria Plain 1	Gascoyne 1 Pilbara 2
	Low (5-6)	Esperance Sandplain 2 Coolgardie 1 Coolgardie 3 Hampton Nullarbor 2 Nullarbor 1 Little Sandy Desert 1	Great Victoria Desert 3 Great Victoria Desert 2 Great Victoria Desert 1 Gibson Desert 1 Gascoyne 2 Pilbara 3 Little Sandy Desert 2 Great Sandy Desert 2	Great Sandy Desert 1 Gibson Desert 2 Central Ranges

Table 6.4 Marine parks and marine nature reserve value vs threat matrix

Bio-subgroup 2 Marine		**Value**		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Shoalwater Marine Park Ningaloo Marine Park Marmion Marine Park Shark Bay Marine Park Swan Estuary Marine Park Rowley Shoals Marine Park Hamelin Pool Marine Nature Reserve		
	Medium Intermediate time and/or not that greater extent 2020-2075			
	Low Long term >2075 Or already impacted significantly			

6.2.3 Bio sub-category 3: Recovery of threatened species and ecological communities that are listed under relevant national and state legislation, other significant species and areas of exceptional diversity or endemism

Threatened species or ecological communities are those living organisms or ecosystems that are at risk from extinction in the wild. Threatening processes operates to both cause and accelerate species extinctions. At global, national and State scales extinctions are irreversible and have evolutionary consequences. Avoiding extinction then becomes an important strategy to avoiding biodiversity loss. Hence, the focus and priority on the recovery of species and ecological communities threatened by extinction.

Under accepted International (IUCN) criteria species and ecological communities are assigned a threat category, which denotes its conservation status in relation to its risk of becoming extinct. The conservation status categories, including critically endangered, endangered, vulnerable, and near threatened (conservation dependent and lower risk categories), as well as the presumed extinct (or for communities, presumed destroyed) categories. In Western Australia, we also have additional categories of near threatened/possibly threatened species denoted as 'priority' species, which do not satisfy the criteria (including in some cases the detailed survey requirement), but which are worthy of special investigation on the basis they may be, or become in the near future, threatened. The priorities are ranked as P1 - P4.

It is possible to rank priorities across species and communities that are threatened, near threatened or possibly threatened using the rankings outline above. This has been done in the threat/value matrix (Table 6.5).

As indicated by the levels of risk from extinction, 'critically endangered' and 'endangered' are given the highest level of threat. Hence, species and ecological communities within these categories are priorities for management. Notwithstanding this assessment, species or ecological communities that are rare, or geographically restricted, but are not considered as being threatened, are also a priority in order to prevent them from becoming threatened.

Recovery refers to a range of urgent and priority actions (often listed in interim recovery plans or recovery plans), including scientific research, monitoring and evaluation, management, abatement of threatening processes and maintenance of key natural processes at various scales that will lead to enhancing the quality or contribute to the return of ecosystem function, or improvement in species/ecological community conservation status. The development and implementation of recovery plans or interim recovery plans is a priority for public investment.

Appendix 1g shows the number of threatened species and ecological communities within risk categories for each IBRA sub-bioregion. Figure 6.3 shows the cumulative value of the number of species/threatened ecological communities and priority species/ecological communities for each IBRA sub-region. The value of each threat category has been weighted according to its level of risk from extinction. The SW sub-bioregions, principally due to the high level of threatening processes and high level of endemism, are identified as threatened species and ecological community hotspots.

Increasingly worldwide biodiversity priority setting is focussing on centres of exceptional species diversity and/or endemism. These are often referred to as biodiversity hotspots. The SW sub-bioregions, principally due to the high level of threatening processes and high level of endemism, are identified as threatened species and ecological community hotspots. Further work is currently under way at the national level to identify and prioritise national biodiversity hotspots.

A threat analysis framework has provided the basis to prioritise marine fauna for conservation management. Table 6.6 shows the relative value of fauna and priority for management. At a State level, Green Turtle, Loggerhead Turtle, Dugong, Little Penguin and Flatback Turtle have been rated the highest priority fauna for management, with the Australian Sealion, Blue Whale, Humpback Whale, Southern Right Whale, Tern spp., Hawksbill Turtle and Whaleshark having similar value but under less threat.

Table 6.5 The relative value and threat across threatened species and ecological communities risk categories

Bio-subgroup 3 terrestrial		Value		
		High	**Medium**	**Low**
Threat	**High**	Critically endangered & Endangered	Vulnerable	Priority 1-3
	Med	Vulnerable	Vulnerable	Priority 1-3
	Low	Priority 4 and Conservation Dependant	Priority 1-3	Priority 1-3

Note: Appendix 1g shows the number of threatened species and ecological communities within risk categories for each IBRA sub-bioregion.

Table 6.6 Relative value and threat of significant marine fauna

Bio-subgroup 3 Marine		Value		
		High	**Medium**	**Low**
Threat	**High**	Green turtles Loggerhead turtles Dugong Little Penguin Flatback turtles	Bunbury/ Busselton Dolphins Monkey Mia Dolphins Migratory birds	
	Medium	Whalesharks Australian sea lion Blue whale Humpback whale Southern right whale Tern spp. Hawksbill turtles Whalesharks	Marine Raptors NZ fur seals Cormorants/ Pelicans Dolphin spp	
	Low	Sea snakes	Crocodiles Manta Rays Leatherback turtles	Sting Rays

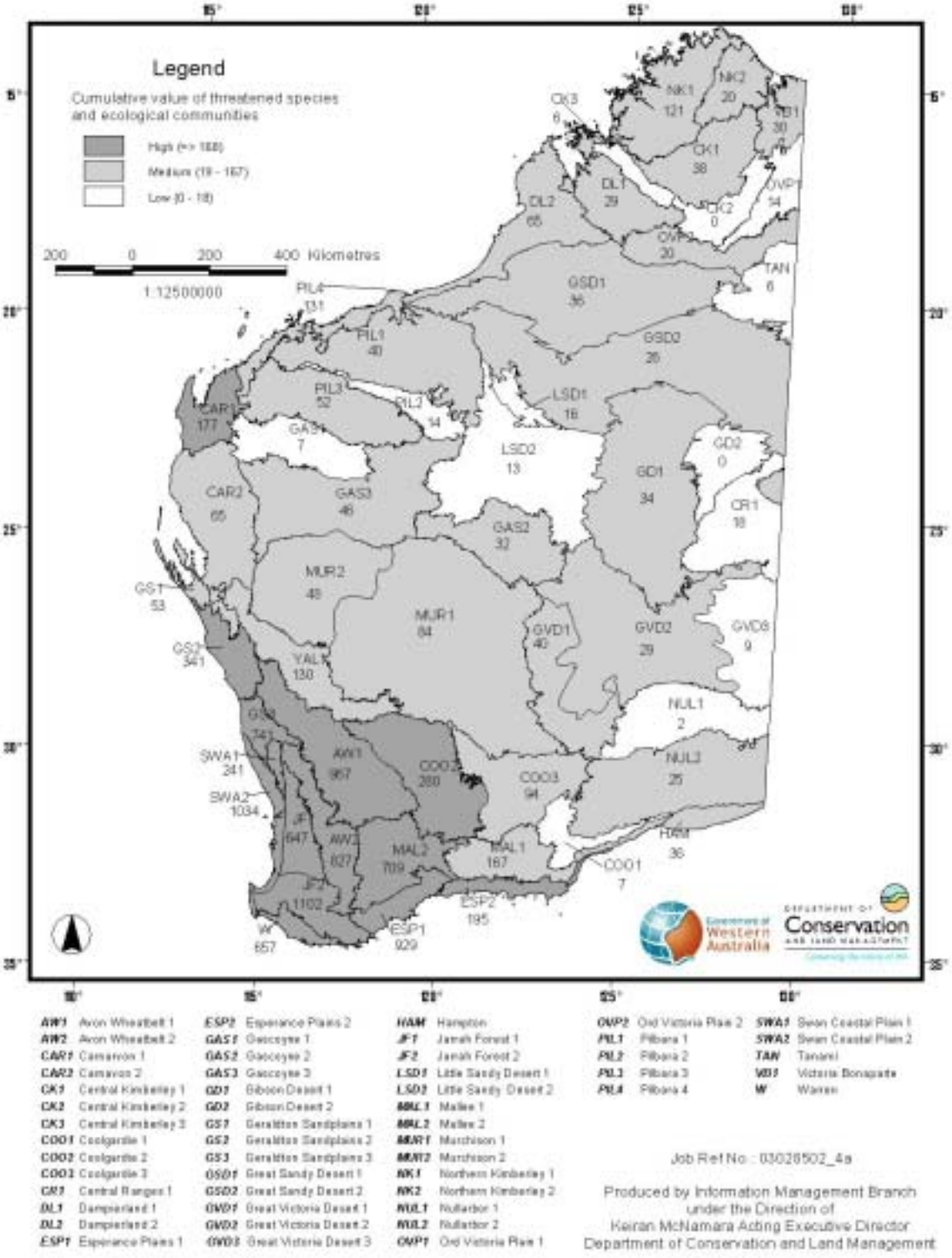


Figure 6.3 Cumulative value of threatened species/ecological communities and priority species/ecological communities for each IBRA sub-bioregion.

6.2.4 Bio sub-category 4: Conservation of landscape/seascape scale ecological systems (integrating reserve and off-reserve conservation)

Landscape/seascape scale ecological systems comprise a set of protected areas and sites and off reserve areas, some of which are required to be actively managed for conservation in order to ensure ongoing biodiversity conservation. A functional ecological area maintains its species through maintenance of ecological processes and the natural resources they depend on, including air, water, soils, minerals etc. Central to achieving a functional landscape/seascape are addressing priorities 1-3 above, and addressing landscape threatening processes. Each priority is interrelated, and reliant upon being dealt with in an integrated fashion within the context of landscape/seascape priorities, although primary management responsibility may change between priorities. Hence, priorities for the establishment of a conservation reserve system, management of a protected area network and recovery of threatened species and ecological communities (and other significant species/ecological communities) are nested priorities within achieving overall functional landscapes/seascapes. The major addition in this category is to ensure that ecological processes and components are conserved across both reserves and other lands and waters.

Location and scale of priority management actions will vary between landscapes/seascapes, and be related to the impact of threatening processes upon natural resources, degree of landscape fragmentation/intactness, extent of protected area network and number of threatened species and ecological communities. Hence, functional landscapes may comprise a matrix of public and private lands and waters and the management thereof to abate threatening processes and bring about recovery and return of ecosystem function.

In the marine area, the concept is similar, but the execution different, as there is no private seascape areas. Marine areas that are not targeted for extractive use or for intensive shipping or port developments etc. may be considered to be similar to off-reserve conservation areas, provided threats such as pollution, introduced species etc, are managed.

There is a need for considerably more work to be done in identifying priority target landscapes across the State, within which the various off-reserve conservation systems and landscape rebuilding or commercial use of wildlife approaches should be promoted and/or assisted most actively.

Spatial priorities for establishing functional landscapes in the Wheatbelt include identification and recovery of natural diversity recovery catchments, as defined under the State's Salinity Strategy and 'target landscapes' (see Table 6.5). In addition, Statewide 'species hotspots'[13] (areas recognised for their high number of endemic species under threat) also serve to identify landscapes of high biodiversity value and threat that require special priority attention. Appendix 1h describes existing and potential natural diversity recovery catchments.

Broad priorities for management on private land and leasehold lands, within the context of providing complementary outcomes to other biodiversity conservation activities, include:

- management of regionally significant high biodiversity conservation areas under formal binding conservation covenants and conservation management agreements;
- provision of non-binding private land support (such as Land for Wildlife), to areas of high biodiversity conservation value;
- identification, protection and management (including rehabilitation) of regionally significant areas to increase landscape connectivity and functionality;
- development and establishment of native species based industries, and spatial integration of those activities with nature conservation activities to bring about increase in landscape functionality;
- development and implementation of formally accredited environmental management systems that will demonstrate industry sustainability at various scales;
- sustainable use of flora and fauna under approved management plans; and
- reconciliation of competing land uses.

[13] Note: These are currently being refined.

Table 6.5 Threat Vs value matrix for Natural diversity recovery catchments, potential natural diversity recovery catchments and target landscapes in the Wheatbelt.

Bio-subgroup 4 Southwest Ag zone		Biodiversity Value				
		High		Medium		Low
Salinity Threat	**High** Existing and/or near and substantial <2020	Lake Warden Kojonup – Beaufort – Carrolup Rivers Flats Buntine – Marchagee Muir – Unicup NE of Stirling Ranges (Anderson Lake to Corackerup Nature Reserve) Magenta Area Lake Bryde Dunn Rock/Lake King chain Moore River System Drummond Boyup Brook – SE Collie Area Yinniebatharra System and Hutt Lagoon Upper Lort River (possibly including Pyramid Lake) Headwaters of the Fitzgerald River	Kondinin Salt Marsh Tooliban Lake Chinocup System Coyrecup Nature Reserve Kent Road Braided Saline Drainage System Mollerin Lake System Darkin Swamp/Dobbaderry Swamp System 91 94 80 46 67 92 82	66 86 70 64 57 60 41 19 44 45	19 44 45 21 81 24 51 16 61	3 2 20 8 12 15 28 30 32 56 18 17 26 29
	Medium Intermediate time and/or not that greater extent 2020-2075	13 34 47 63 75 93 95		39 6 27 25 35 48 76 42 74 23 58 72		7 87 10 36 37 38 5 31
	Low Long term >2075 Or already impacted significantly	55 54 65 71 68 89 88		84 33 53 43 85 52 77 40 90	22 49 62 50 83 73 59 69	1 4 9 14 11

Note: This table has been adapted from the Department of Conservation and Land Management's involvement in the Salinity Investment Framework. The numeric values in this table represent target landscapes. Target landscapes are areas of landscape, about 30,000 ha or larger, that retain a significant proportion of their area in natural habitats (greater than 25% remnant vegetation cover).

7.0 Discussion and Conclusion

7.1 Summary of outputs

This report documents the processes used to establish potential priorities within the biophysical asset classes of biodiversity, water resources and fisheries. The process was completed at a whole of State scale, and considered all threatening processes. The findings in this report represent the first step towards identifying statewide investment priorities in natural resource management.

A modified version of the 'value versus threat matrix', developed by the SIF, was employed to assess the unique nature of each asset class. The value – threat matrix helped identify the relative importance of each asset. Three tiers of assets are defined within the value-threat matrix (Table 2.1):

1st Tier (Highest importance): Includes assets or groups of assets of high value and at high threat.

2nd Tier (Medium importance): Includes assets or groups of assets of high value at medium threat and assets of medium value at high threat.

3rd Tier (Low importance): Those remaining assets or groups of assets that include: High value low threat; Medium value low threat; Low value low threat; Low value medium threat, and Low value high threat.

Table 7.1 summarises for each asset class their importance in a Western Australian context. Appendices 2-7 provides the information presented on a State scale (above) in an NRM regional context.

It is critical to note that the term 'importance' is used to describe the requirement for further investigations to determine specific goals for assets, management options to achieve these goals, and then their likelihood of achieving success for each asset or class of asset. . In some instances, when manageability of threat is taken into account, high value assets with medium-low threat maybe the preferred priority. This is discussed further in section 7.3.

Table 7.1 Summary of asset classes and their level of importance (based on value and threat) in Western Australia.

Asset Class	*Sub-class*	*Tier 1- (high importance)*	*Tier 2 (medium importance)*	*Tier 3 (low importance)*
Biodiversity	i) Establishment of reserves	**6** IBRA sub bioregions **6** marine conservation reserve regions	**13** IBRA sub bioregions **26** marine conservation reserve regions	**33** IBRA sub bioregions **20** marine conservation reserve regions
	ii) Management of reserves	**2** terrestrial IBRA subregions **7** marine conservation reserves	**23** terrestrial IBRA subregions	**27** terrestrial IBRA subregions
	iii) TEC[14], DRF[15], Priority flora and fauna	**343** flora (terrestrial) **58** fauna (terrestrial) **54** TECs (terrestrial) **5** marine fauna	**188** flora (terrestrial) **175** fauna (terrestrial) **35** TECs (terrestrial) **16** marine fauna	**1334** Flora (terrestrial) **299** Fauna (terrestrial) **25** TECs (terrestrial) **5** marine fauna
	iv) Target landscapes and Diversity recovery catchments	**24** proposed and existing natural diversity recovery catchments **7** target landscapes **13** IBRA provinces with species hotspots	**38** target landscapes	**51** target landscapes
Water Resources	Water supplies (includes PDWSA[16] and RIWIA[17] areas)	**62**	**182**	**47**
	Waterscapes (includes wetlands and waterways)	**34**	**105**	**118**
Aquatic assets and fish resources		**5**	**24**	**42**
Dept. of Agriculture	Productive land	**1** soil - landscape zone	**17** soil - landscape zones	**13** soil - landscape zones

[14] Threatened ecological communities

[15] Declared rare flora and fauna

[16] Public drinking water source area

[17] Areas proclaimed under the *Rights in Water and Irrigation Act 1914*

7.2 Where are the assets and threats

There are many important natural resource assets across Western Australia. However, not all are in need of investment in management to protect them against threats. This report helps separate important assets that are at threat, and potentially in need of additional investment, from those assets that are not at threat.

The DoA's investigations describe approximately 5 key NRM issues relevant to agriculture. DoA's data suggests that our understanding of these threats is far stronger in the Southwest Agricultural Zone, then it is in Rangeland areas.

The results describe a higher concentration of assets within the southwest area of the State, from Kalbarri to Esperance. Obviously this is to be expected given that this area of the state has been subject to higher levels of human interference and levels of assessment and investment. Higher levels of urbanisation, industrial activity and agricultural production all contributing to disproportionately higher threats to this region's natural resources. Table 7.2 broadly summarises for each asset class and tier classification their general locations across the Western Australian landscape.

Outside of the southwest zone assets at threat are observed to be located in the vicinity of population centres. For example, many of the water supply assets in Rangeland areas are located in close proximity to towns. High importance marine nature reserves in the Rangelands are subject to pressure from tourism and fishing, for example Ningaloo and Shark Bay Marine Parks. Tier one waterscape assets are located to areas of intensive agricultural development, for example, Ord and Fitzroy Rivers.

Table 7.2 Summary of assets and their distribution across the six Natural Resource Management Regions

Process	*Asset Class*	*General Asset location*		
		Tier 1	*Tier 2*	*Tier 3*
Dept. of Conservation and land Management	Biodiversity subcategory 1 Establishment of CAR reserves	**Terrestrial**: Across state **Marine:** RL (Pilbara)	**Terrestrial**: Across state **Marine:** Across state	**Terrestrial:** Across state **Marine:** Across state
	Biodiversity subcategory 2 Management of reserves	**Terrestrial:** Avon and SW **Marine:** Mostly in SW, NA, Swan, RL	**Terrestrial:** Avon, SC, SW, NA, some in RL **Marine:** All assets Tier 1	**Terrestrial** Mostly RL. **Marine:** All assets Tier 1
	Biodiversity subcategory 3 DRF, TECs Priority fauna	**Terrestrial:** Most in NA, Avon, Swan, SW, SC, **Marine:** Generally RL	**Terrestrial:** All over state **Marine:** Southern and Southwest oceans	**Terrestrial:** RL **Marine:** RL, SC, SW
	Biodiversity subcategory 4 Biodiversity recovery and target landscapes	NA, Avon, SW, SC	NA, Avon, SW, SC	NA, Avon, SW, SC
Dept. of Environment	Water supplies	Mostly in NA, Swan, Avon, SW, SC	Mostly in NA, Swan, Avon, SW, SC	Mostly in NA, Swan, Avon, SW, SC
	Water scapes	Across state	Large majority in SC, SW,	MW, SC, SW, RL
Dept. of Fisheries		SW, SC, Swan	State	State
Dept. of Agriculture	Ag land	• Data restricted to Southwest Agricultural zone • Avon has greatest number of Tier 1 threats • Tier 2 and 3 threats spread across Avon, Swan, NA, SC and SW.		

RL = Rangelands NRM Group, NA = Northern Agriculture NRM Group, SW = South West NRM Group, SC = South Coast NRM Group

7.3 Management feasibility studies

Using the three tiers identified above, generally the first tier will have the highest priority for collecting information on management feasibility, followed by assets in the second tier and then those in the third.

The term feasibility is used to describe the potential of a management option for an asset to achieve a specific goal. The success of a management option is dependent on a number of factors, which include:

- Specific goal for the asset (recover, maintain, or adapt)
- Social capacity and support
- Political will
- Technical feasibility
- Available resources. etc.

A methodology for collecting feasibility information for each asset class has not been developed at this stage. The second phase of the SIF project is currently investigating an approach for collecting this information. Table 7.3 describes a set of criteria that may guide compilation of feasibility information.

Assessment of feasibility may lead to some significant changes to the ranking determined by the threat-value matrix. For example High value, low threat assets (third tier in Table 2.1) may have a high level of feasibility and could attract a higher priority for investment. Some first tier asset items (high value high threat) may become low priority for investment, on the basis that the threat cannot be addressed within operational constraints (low feasibility). Completing the feasibility investigations on each asset item, and placing these items on the third axis in Figure 2.1, will help determine the priority to be given to the individual asset items.

Table 7.3 Indicative information requirements to help determine the success of any action for an asset[18].

Criteria (indicative points only)	*Points to consider (indicative points only)*
Acceptability	• Has the process identified the asset or assets as having a high level of importance? • Does the goal (recover, contain or adapt) for the asset have widespread community support? • Will the management option to achieve this goal have broader community and landholder's support? • Highlight local government and regional organisation involvement if any.
Dependability	• Considering both technical feasibility and social capacity what is the probability that the management option will achieve the goal for the asset?
Investment return	• What is the expected cost of implementing the management option? • Contributing partners and funding contributions (time, works undertaken by the land-holders etc) • Where investment will result in extensive private benefit, is there an appropriate balance between Government and Community resourcing? • For projects greater than $1 million dollars, does a cost effectiveness analysis indicate this program will be the most efficient approach to deliver the positive returns to investment? • Does the program address multiple issues and have complementary effects for other programs?
Precaution	• Is the program important to avoid serious or irreversible outcomes? • Are there likely to be thresholds where impacts rapidly increase? • How quickly do we need to act to avoid greater impacts? • Is there chance of unintended consequences causing negative impacts?
Timeliness	• Is the program necessary to addressing prerequisite issues? • Does this program require other actions to be taken before it can be successful? • Will this program prevent impacts from occurring or from increasing? • Will rates of change of impact severity increase over time? • How long will it take to successfully address the issue and deliver the outcomes?
Monitoring and Evaluation	• An appropriate evaluation and monitoring method should be developed that demonstrates achievement or non-achievement of goals for assets.

7.4 Comparing and contrasting the assessments

Although the four processes discussed in this report were established to assess assets in discrete classes (biodiversity, water resources, marine and fisheries and agricultural productivity) there has inevitably been overlap. Generally this overlap has been complimentary. Table 7.3 describes the common ground covered by each process and also describes the potential for applying these results at State and Regional scales.

Assessments of NRM issues and marine and fisheries resources present a broad summary of these assets and issues at a State scale. Whilst at a region scale they provide a reliable starting point for further discussion and debate on identifying NRM priorities.

The more specific asset assessments for biodiversity and water resources provide an extensive description of important resources at a State scale. At both a State and Regional scale they identify specific points in the landscape that might require management action.

Combined, some results support the importance of assets in other classes. For example, the specific assets identified through the water resources, fisheries and Bio-subgroup 3 (DRF, TECs and Priority species) assessments provide potential points in the landscape for establishment of conservation reserves to help meet requirements of Bio-subgroup 1 (Comprehensive and Adequate Reserve Systems). Similarly, the broad assessment of estuaries by the Department of Fisheries is backed up by the more specific assessment of these assets by the water resources assessment.

[18] Adapted from the SIF Report (DoE, in progress, 2003)

The general assessment of Bio-subgroup 2 (conservation reserve management priorities) emphasises for some of the specific assets, in the waterscape and Bio-subgroup 3 assessments, the potential for an upgrade in their management. However, this would be confirmed through the more detailed feasibility studies that would review the adequacy of management approaches for assets where they existed.

7.5 Multiple values and Spatial analysis

Any process that explores the pros and cons of an investment should also assess for all potential benefits Apart from the Department of Agriculture's broad scale overview of the threats to the agricultural land resource, the other agency's processes have assessed individual asset items for their value and threat. The Department of Agriculture has however undertaken a detailed examination of the numerous issues or processes threatening, or deriving from, agricultural land uses, and this information is available from the NRM issues and strategies documents prepared for each region. An important point to consider is the failure of each process to consider the relationship between asset items from different asset classes, especially where these asset items occur in close proximity within the landscape.

For example, across the Western Australian landscape there are many areas of remnant vegetation located in close proximity to infrastructure assets such as towns or even water supplies. Assessed individually, in many cases, these assets may only achieve a moderate ranking. However, should their combined values be assessed the cluster of assets may achieve a higher level of importance. There is also a possibility that one management option will result in much larger and more diverse returns on investment.

The SIF is currently investigating an approach to consider this situation. Spatial analysis (otherwise known as 'pizza approach') may provide one method for completing this assessment. This approach should form an important component of any feasibility study for an asset.

To complete spatial assessments and to allow for a better comprehension of assets and their importance across the state there is a need for the information in this report to be presented spatially.

Table 7.4 Comparison of agency processes and their outputs – application in a State and regional context.

Process	*Assets*	*Common ground*	*Application*	
			State	*Region*
Dept. of Conservation and land Management	Biodiversity subcategory 1	• Waterscape assets (with biodiversity value), Fisheries and Biodiversity subcategory 3 assets may provide impetus for establishment of conservation reserves.	Identifies targets (areas) in IBRA bio-subregions for establishment of conservation reserves across state	Within region identifies targets (areas) in IBRA bio-subregions for establishment of conservation reserves.
	Biodiversity subcategory 2	• Possibly also identifies importance and status of management of water resources and some fisheries assets. • Water resources have also assessed some wetland and waterway reserves already protected by reserves (eg ANCA, Ramsar)	Identifies priorities for better management	Identifies broad IBRA sub-bioregions that require better management of current reserve systems.
	Biodiversity subcategory 3	• This will provide value to both conservation reserve and water resources assets.	Identifies specific assets and provides defined points in landscape for potential action	Identifies specific assets and provides defined points in landscape for potential action
	Biodiversity subcategory 4	• Will cover some fisheries and water resources assets.	Identifies priority areas of the landscape to be targeted for potential management	Identifies priority areas of the landscape to be targeted for potential management
Dept. of Environment	Water supplies	Commonly correspond to reserves / State forest.	Identifies specific assets and provides defined points in landscape for potential action	Identifies specific assets and provides defined points in landscape for potential action
	Water scapes	• Biodiversity assessment of current conservation reserves and their management will cover some waterscapes. • Some marine assets including estuarine ecosystems and fresh water fisheries.	Identifies specific assets and provides defined points in landscape for potential action	Identifies specific assets and provides defined points in landscape for potential action
Dept. of Fisheries		• Has assessed estuarine ecosystems broadly. More specific assessments found in matching Waterscape assets and fresh water fisheries.	Summarises a broad group of assets and their importance at a States scale.	Provides starting point for discussion of fisheries assets at regional scale. Identifies some specific assets.
Dept. of Agriculture	Agricultural land.	• Agricultural land generally surrounds biodiversity and water resource assets in the Southwest Agricultural zone, and agricultural land use often influences NRM assets off-site.	Good description of threats and value of agricultural land at a Southwest agricultural zone scale.	Provides a starting point for more detailed sub-soil landscape zone assessment of threats and values. More information is available from the NRM issues and strategies papers prepared for each region.

7.6 Social and Socio-economic assets and NRM

Work completed by the SIF explored the concept of the social and socio-economic asset class in and NRM context. This work defined types and categories for the social and socio-economic assets, together with aspirational goals, rules for allocating priorities and data sources. Table 7.5 describes each of the subcategories of this asset class.

Table 7.5 Asset categories within the social and social-economic asset class as defined by the SIF in an NRM context[19].

Asset type	Category
Knowledge and skills	Knowledge and skills available
	Ability to grow knowledge and skills
	Robustness and availability
Values/ culture	NRM values
	Sense of place, cultural heritage
	Robustness, persistence, resilience and availability
Community well-being	Community health
	Cohesiveness
Networks/ organisations	NRM values
	Quality of social interaction
	Information flow
	Learning capacity
Economic resources	Investment available from businesses reliant on natural resources
	Investment available from sources not reliant on the natural resources
Governance capacity	Institutional arrangements for NRM

Generally the impact of environmental threats (such as wind erosion and salinity) against the social and socio-economic asset class are not significant. Forces that impact significantly on this asset stem from, for example:

- Declining terms of trade impacting on the economic health of country areas resulting in rural decline and loss of disposable income for use in NRM.
- Improved communications and the replacement of labour by technology, resulting in population decline.

The human or socio-economic asset is an important consideration in any NRM investment as in many circumstances these assets will contribute to the success of any action implemented to contend with a threat.

This report focuses primarily on biophysical or tangible assets. The report has not addressed the social and socio-economic asset class, as it is not directly at threat from natural resource issues. The NRM Council is currently developing a framework that will allocate funding to priority programs across the State. The programs recognised by this process include:

- Capacity building (social asset described above)
- Industry Development
- New technology
- Monitoring and evaluation
- And direct investment into biophysical assets.

7.7 Gaps and Fissures

The above discussion documents the processes used to establish potential NRM investment priorities within the biophysical asset classes of biodiversity, water resources and fisheries. It also provides an agricultural perspective of values and threats from all sectors across large landscape units. The process was completed at a whole of State scale, and considered all threatening processes.

The initial value and threat assessments described above have been completed by each of the NRM agencies using relevant data sets and expert opinion. These assessments represent a 'State Agency' view on what natural resource assets are considered important in the face of threat. Wider consultation is required to ensure that these assessments are appropriate for this scale. Furthermore, it should be acknowledged that although there will be some similarities the final list of high importance assets identified at the region scale will be different to that of the State.

Should an asset item's allocation within any of the tiers be contested, 'reprocessing' the asset, through the matrix or spatial analysis can prove or disprove this contention. Reprocessing an asset item should acknowledge any new information that is made available.

[19] Adapted from Burnside D, Rowley EE, and Hill-Tonkin (2003). '*Defining social assets for the Salinity Investment Framework*'. Unpublished Report for the State Salinity Investment Framework Steering Committee and Water and Rivers Commission.

The assessment of asset classes within this report has been quite detailed. However, there are a number of gaps or 'under-done classes' that need to be addressed. Investigations into identifying important assets within these underdone classes may well form a priority for future investigations by the State. The following list identifies the classes of assets not covered by this assessment:

- European and Indigenous cultural assets: This includes all biophysical assets such as indigenous significant sites (eg Caroline's Gap, Gnammas (watering hole), granite outcrops) and European heritage sites (eg, Toapin Weir- Quairading).
- Unique land management issues on Indigenous land holdings: Section 3.16 of WA Bilateral,
- Coastal ecosystems: fisheries, biodiversity and water resources have assessed estuaries and near shore assets and environments. The terrestrial component of coastal systems has not been assessed adequately. This includes all dune and rocky coastal systems.
- Infrastructure: this includes roads, rail, and towns.
- Agricultural land: The assessment in this document is very broad. Further, more detailed, assessments should examine individual soil and land types within regions as assets. This information is available within the Department of Agriculture, but was considered too detailed for this overview assessment. An assessment of the off-site effects on public and private assets from agricultural land uses is not covered in this document. To discuss the asset at threat without examining the cause is a limitation of the document.
- Wetlands: Although the Water resource process has assessed some significant wetlands within ANCA and Ramsar classifications, not all have been individually assessed. In some cases there are 1000's of individual wetlands within wetland groups (eg. conservation category wetlands on the Swan Coastal Plain and other important wetlands identified in WRC and other publications). To expedite the assessment of waterscape assets some groups of wetlands have been assessed as one asset. These assets should be considered individually.
- Rangeland natural resource information (condition, value, and threat) is generally limited.

7.8 Refining the priorities

At write up an approach or methodology for identifying a final list of priority assets for investment had not been developed. However, the second phase of the SIF is investigating a methodology for determining a final ranking.

Although the SIF focuses on salinity threat, the investment decision process will most likely be easily modified to consider other threats. The decision making approach will consider an asset's value, threat and feasibility information. Using the criteria outlined in Table 7.3, expert panels may be guided in collecting feasibility information. At a State and Regional scale the approach will almost certainly use reference group to finalise priorities for investment.

Any further work to determine investment priorities, using the information presented in this report, should consider any decision-making process developed by the SIF project. The final process will determine the amount and nature of information required for decision making.

8.0 Summary

There are many important natural resource assets across Western Australia. However, not all require investment in management systems to protect them against natural resource threats. With the broadening of NRM in recent years to cover all natural resource issues from the marine environment, across the coasts and into the inland areas and the requirements for accredited regional NRM strategies to guide investments, there is a clear need for the State to integrate and explain its NRM priorities.

A clear statement of State NRM priorities is also useful for Regional NRM groups in developing their priorities and will provide an indication as to the priorities that the State will be considering when determining its position on regional strategies presented for accreditation.

This report describes the State ('Whole of Government') Preliminary Priority Natural Resource Assets. The State's NRM agencies have been through a process of identifying and categorising the State's natural resource assets. The intent is that the results, once finalised, will provide:

- A guide for the current annual investment of state funds, and the prospective annual investment Commonwealth and State funds, particularly through the Natural Heritage Trust and National Action Plan.
- A guide and direct State agency activities in NRM.
- Provide clear directions to regional groups in developing regional strategic plans.

The processes described within this report help separate important assets that are at threat, from those assets that are not at threat. The results are not a final list of where resources should be invested but the first step towards identifying statewide priorities for investment in threat management against our biophysical assets. To develop investment priorities information on the feasibility of management options is required. This is the next step in the process and has not been undertaken as part of this assessment. The rankings presented are works in progress and have been brought together at this time to assist everyone involved in natural resource management or natural resource management funding decisions to compare and contrast their proposal with the priorities put forward by the agencies in the relevant NRM area of interest.

The processes used to identify important assets within the biophysical asset classes of biodiversity, water resources and fisheries is based on the approach developed by the Salinity Investment Framework (SIF). All threatening processes were considered by a modified version of the 'value versus threat matrix' to assess assets across Western Australia. Customised value-threat assessments were developed to assess the unique nature of each asset class. Four distinct assets classes were used with each of the key NRM agencies responsible for undertaking the analysis on their asset class.

- Water resources
- Fisheries
- Biodiversity
- Agricultural land

This report describes the assets assessed at a State scale and there will be some similarities between these results and regional priorities. However it is not expected that both priorities will completely align because of the significant differences in scale in which the assessments were undertaken. To help Regional groups appreciate where their State assets fit in a Western Australian context the results have been partitioned by region.

A higher concentration of assets at threat has been identified within the southwest area of the State, from Kalbarri to Esperance. Obviously this is to be expected given that this area of the state has been subject to higher levels of human interference. Higher levels of urbanisation, industrial activity and agricultural production all contributing to disproportionately higher threats to this region's natural resources. The report has also highlighted that a lack of natural resource information in areas outside of the southwest may have skewed this outcome. Gathering further information on assets and threats in the rangeland may provide a future priority for the State.

The Senior Officers Group acknowledges that both the processes used and the results described in this report require a higher level of stakeholder consultation. The results presented by this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision being made.

The results presented by this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision being made.

Value, threat and feasibility

The SIF is centred on an appreciation of the biophysical and socio-economic assets that are present in an area and which may be impacted to various degrees by a threat. The term 'asset' indicates an item of value. 'Threat' indicates the predicted severity and urgency of the impact of salinity (in this report's case threat is considered across a greater spectrum of issues, eg eutrophication, wind erosion, weed invasion, habitat fragmentation etc) on the asset, resulting in a loss of asset value. Discussion about an asset item's value also leads to a better understanding of what is most important at a local community, regional or State scale. When an understanding of value is combined with an understanding of future threats to an asset, it becomes easier to identify specific goals with realistic aspirations for the future. This leads logically to addressing questions including:

- What are we prepared to spend to recover, maintain or adapt that value?
- What is required to attain a goal for an asset?
- Is that option technically and socially feasible?

A modified version of the 'value versus threat matrix', developed by the SIF, was employed to assess the unique nature of each asset class. The value – threat matrix helped identify the relative importance of each asset. Three tiers of assets are defined within the value-threat matrix (Table 2.1):

1st Tier (Highest importance): Includes assets or groups of assets of high value and at high threat.

2nd Tier (Medium importance): Includes assets or groups of assets of high value at medium threat, assets of medium value at high threat and assets of medium value at medium threat.

3rd Tier (Low importance): Those remaining assets or groups of assets that include: High value low threat; Medium value low threat; Low value low threat; Low value medium threat, and Low value high threat.

The value of an asset is what makes the asset important. Determining the relative value of an asset needs to acknowledge that there are firm quantitative measures for economic values, but less so for social and environmental values.

Threat identifies the timing and/or extent of potential impact from, for example, salinity, eutrophication and erosion (or any other threat) and the urgency required for any action to recover, contain or adapt to the threat. The key question is 'How much of the asset's value will be impacted on and when will this impact occur if it has not already?

Feasibility information is an important ingredient in determining investment priorities. Assigning an NRM management option to an asset item requires a number of important aspects to be considered. This step has not been attempted as part of this report.

The value – threat matrix helps to identify high importance groups or tiers of assets for further feasibility investigations. Three tiers of assets are defined within the value-threat matrix (Table 2.1) below. Each tier will require varying levels of investigations.

Table 2.1 Value versus threat matrix and the three asset tiers

Assets		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	**1st Tier**		
	Medium Intermediate time and/or not that greater extent 2020-2075		**2nd Tier**	
	Low Long term >2075 Or already impacted significantly			**3rd Tier**

Each agency used a combination of "expert panels" and published information to undertake their assessments of assets.

Water Resources

Water resources were grouped into two subclasses that reflect the difference between protection and management for water supply and protection and management of the system. The two sub-classes were:

1. Water supply
2. Waterscapes (wetland, waterway and estuary ecosystems)

Most water resource assets have numerous values associated with them. It was important to acknowledge and score these multiple values. These multiple values were grouped into three broad categories:

- Economic - Industry, drinking water, aquaculture.
- Social - Recreation: fishing, swimming, bird watching, boating and other pursuits; Spirituality and culture:
- Environmental - biodiversity, uniqueness, aesthetics, ecological functions (flood mitigation, natural land drainage).

Threats considered included; erosion, sedimentation, eutrophication, salinity, feral animals, weed infestations, pollution from point sources, ecosystem fragmentation, land development: residential and rural residential, land development: intensive agriculture, land development - broad acre farming, land development – pastoral, water development - aquaculture and boating facilities, recreation, commercial fishing, industrial discharge, water abstraction agricultural drainage (eg coastal plain and saline land drainage). Using the following scale the threats to assets were scored:

Aquatic Assets and Fish Resources

Fish resources were grouped into two subclasses that reflect the different fisheries environments within the State. The two sub-classes were:

1. Freshwater environments
2. Marine environments

- Economic, The commercial fisheries
- Social Values: Recreational fishing
- Environmental Values: Biodiversity, uniqueness

Threats considered included fishing by Australian and foreign fleets, eutrophication, introduced marine pests, pollution from point sources, ecosystem fragmentation, coastal development including the development of petroleum products, land development: intensive agriculture, water development, aquaculture and boating facilities, recreation, and commercial fishing.

Agriculture productivity threats

The Department of Agriculture's process is based on a combination of expert knowledge and the inherent physical qualities of the land resource to determine threat. Value is based on the average value of agricultural land ($/ha) determined from year 2000 Bank West data.

Information on threat and asset value were obtained and put into an 'NRM issues database'. The NRM issues database provides information on the significance of NRM issues related to geographic areas of southwestern Australia.

The spatial framework for the assessments of value and threat is the *soil-landscape zone* as defined by the Natural Resources Assessment Group of the Department of Agriculture. These zones delineate broad terrain types based on geomorphological criteria and are useful for gaining a regional perspective of landscape related issues. There are 31 zones described for southwestern Australia (Figure 5.1). Grouping of more detailed underpinning soil-landscape mapping creates the boundaries of the zones.

Five key NRM issues relevant to agriculture and related to soil and land were identified by a Department of Agriculture expert panel. Biodiversity, plant or animal specific issues were not considered, and NRM issues of minor extent in WA (for example mass movement) are not included.

For each combination of NRM issue and soil-landscape zone, an estimate of the threat to the asset caused by the issue/process and the value of the asset being threatened was made. The threat - value matrix was then used to determine the priority of the asset/issue within a zone.

First tier issues are of highest importance, second tier of moderate importance and third tier of low importance.

In addition, for each zone a summary table was prepared looking at the average threat to the land resource based on the five threatening processes. For example, if a particular zone had two issues of High threat, one issue of Moderate threat and two issues of Low threat, the average threat was determined as Moderate. This process, although subjective, gives an indication of which zones are most at risk.

Biodiversity assets

For the purpose of this exercise the biodiversity asset class has been allocated into four primary sub-categories. These categories are of the highest order of importance and provide an overarching framework for lower order conservation strategies and actions aimed at biodiversity. The sub-categories are:

Bio-subgroup 1: Biodiversity inventory and establishment of a Comprehensive, Adequate and Representative (CAR) terrestrial conservation reserve system and marine conservation reserve system.

Bio-subgroup 2: Effective management and protection of conservation reserves and other recognised special conservation value areas.

Bio-subgroup 3: Recovery of threatened species and threatened ecological communities other significant species and areas of exceptional diversity or endemism.

Bio-subgroup 4: Conservation of landscape/seascape scale ecological systems and processes (integrating reserve and off-reserve conservation).

Bio sub-category 1: Biodiversity inventory and establishment of a comprehensive, adequate and representative (CAR) terrestrial conservation reserve system and marine conservation reserve system

Under existing national protocols and agreements the basic requirements of a CAR reserve system have been defined to include 15% of the landscape of an ecoregion being legislatively protected and managed specifically as conservation reserves. The 15% is a basic figure and must be considered in relation to the ecological functions of the ecosystems to be conserved. In some instances there may be a requirement for a higher proportion of the ecoregion to be conserved in order to protect particularly sensitive ecosystems.

The higher the 'value' the further the sub-bioregion/bioregion is from achieving a CAR reserve system, and hence a higher priority for action and investment.

Bio sub-category 2: Effective management of and protection conservation reserves and other recognised special conservation value areas.

Across the State there are around 1600 conservation reserves managed by the Department of Conservation and Land Management, 11 Ramsar sites, two Biosphere reserves and one World Heritage Area. The above biodiversity assets are designated for their high biodiversity conservation value, and are all considered a priority for investment.

The value assessment is based on the area of an IBRA sub-region covered by conservation reserves. Assessment describes the importance of IBRA sub-bioregions based on the area of conservation reserve and the stress class relevant to that subregion and shows the relative threat and value of the 6 declared marine parks and marine nature reserve.

Bio sub-category 3: Recovery of threatened species and ecological communities that are listed under relevant national and State legislation, other significant species and areas of exceptional diversity or endemism.

Threatened species or ecological communities are those living organisms or ecosystems that are at risk from extinction in the wild. Threatening processes operate to cause and accelerate species extinctions. At global, national and State scales extinctions are irreversible and have evolutionary consequences. Avoiding extinction then becomes an important strategy to avoiding biodiversity loss. Hence, the focus and priority on the recovery of species and ecological communities threatened by extinction.

Bio sub-category 4: Conservation of landscape/seascape scale ecological systems (integrating reserve and off-reserve conservation).

Landscape/seascape scale ecological systems comprise a set of protected areas and sites and off reserve areas, some of which are required to be actively managed for conservation in order to ensure ongoing biodiversity conservation.

Location and scale of priority management actions will vary between landscapes/seascapes, and be related to the impact of threatening processes upon natural resources, degree of landscape fragmentation/intactness, extent of protected area network and number of threatened species and ecological communities.

Summary of outputs

The report documents the processes used to establish potential priorities within the biophysical asset classes of biodiversity, water resources and fisheries. Need threat and Ag! The process was completed at a whole of State scale, and considered all threatening processes. The findings in this report represent the first step towards identifying statewide investment priorities in natural resource management.

The following table summarises for each asset class their importance in a Western Australian context. It is critical to note that the term 'importance' is used to describe the requirement for further investigations to determine specific goals for assets, management options to achieve these goals, and then their likelihood of achieving success for each asset or class of asset.

Summary of asset classes and their level of importance[20] (Based on value and threat) in Western Australia.

Asset Class	*Sub-class*	*Tier 1- (high importance)*	*Tier 2 (medium importance)*	*Tier 3 (low importance)*
Biodiversity	i) Establishment of reserves	**6** IBRA sub bioregions **6** marine conservation reserve regions	**13** IBRA sub bioregions **26** marine conservation reserve regions	**33** IBRA sub bioregions **20** marine conservation reserve regions
	ii) Management of reserves	**2** terrestrial IBRA subregions **7** marine conservation reserves	**23** terrestrial IBRA subregions	**27** terrestrial IBRA subregions
	iii) TEC[21], DRF[22], Priority flora and fauna	**343** flora (terrestrial) **58** fauna (terrestrial) **54** TECs (terrestrial) **5** marine fauna	**188** flora (terrestrial) **175** fauna (terrestrial) **35** TECs (terrestrial) **16** marine fauna	**1334** Flora (terrestrial) **299** Fauna (terrestrial) **25** TECs (terrestrial) **5** marine fauna
	iv) Target landscapes and Diversity recovery catchments	**24** proposed and existing natural diversity recovery catchments **7** target landscapes **13** IBRA provinces with species hotspots	**38** target landscapes	**51** target landscapes
Water Resources	Water supplies (includes PDWSA[23] and RIWIA[24] areas)	**62**	**182**	**47**
	Waterscapes (includes wetlands and waterways)	**34**	**105**	**118**
Aquatic assets and fish resources		**5**	**24**	**42**
Dept. of Agriculture	Productive land	**1** soil - landscape zone	**17** soil - landscape zones	**13** soil - landscape zones

** Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.*

Comparing the results

The more specific asset assessments for biodiversity and water resources provide an extensive description of important resources at a State scale. At both a State and Regional scale they identify specific points in the landscape that might require management action.

Combined, some results support the importance of assets in other classes. For example, the specific assets identified through the water resources, fisheries and Bio-subgroup 3 (DRF, TECs and Priority species) assessments provide potential points in the landscape for establishment of conservation reserves to help meet requirements of Bio-subgroup 1 (Comprehensive and Adequate Reserve Systems). Similarly, the broad assessment of estuaries by the Department of Fisheries is backed up by the more specific assessment of these assets by the water resources assessment.

Multiple values and Spatial analysis

Any process that explores the pros and cons of an investment should also assess for all potential benefits. Apart from the Department of Agriculture's broad scale overview of the threats to the agricultural land resource, the other agency's processes have assessed individual asset items for their value and threat. The Department of Agriculture has however undertaken a detailed examination of the numerous issues or processes threatening, or deriving from, agricultural land uses, and this information is available from the NRM issues and strategies documents prepared for

[20] *Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

[21] Threatened ecological communities

[22] Declared rare flora and fauna

[23] Public drinking water source area

[24] Areas proclaimed under the *Rights in Water and Irrigation Act 1914*

each region. An important point to consider is the failure of each process to consider the relationship between asset items from different asset classes, especially where these asset items occur in close proximity within the landscape.

For example, across the Western Australian landscape there are many areas of remnant vegetation located in close proximity to infrastructure assets such as towns or even water supplies. Assessed individually, in many cases, these assets may only achieve a moderate ranking. However, should their combined values be assessed the cluster of assets may achieve a higher level of importance. There is also a possibility that one management option will result in much larger and more diverse returns on investment.

The SIF is currently investigating an approach to consider this situation. Spatial analysis (otherwise known as 'pizza approach') may provide one method for completing this assessment. This approach should form an important component of any feasibility study for an asset.

To complete spatial assessments and to allow for a better comprehension of assets and their importance across the State there is a need for the information in this report to be presented spatially.

Gaps and Fissures

The initial value and threat assessments described above have been completed by each of the NRM agencies using relevant data sets and expert opinion. These assessments represent a 'State Agency' view on what natural resource assets are considered important in the face of NRM threats. Wider consultation is required to ensure that these assessments are appropriate for this scale. Furthermore, it should be acknowledged that although there will be some similarities the final list of high importance assets identified at the region scale will be different to that of the State.

The assessment of asset classes within this report has been quite detailed. However, there are a number of gaps or 'under-done classes' that need to be addressed. Investigations into identifying important assets within these underdone classes may well form a priority for future investigations by the State. The following list identifies the classes of assets not covered by this assessment:

- European and Indigenous cultural assets: This includes all biophysical assets such as indigenous significant sites (eg Caroline's Gap, Gnammas (watering hole), granite outcrops) and European heritage sites (eg, Toapin Weir- Quairading).
- Unique land management issues on Indigenous land holdings: Section 3.16 of WA Bilateral.
- Coastal ecosystems: fisheries, biodiversity and water resources have assessed estuaries and near shore assets and environments. The terrestrial component of coastal systems has not been assessed adequately. This includes all dune and rocky coastal systems.
- Infrastructure: this includes roads, rail, and towns.
- Agricultural land: The assessment in this document is very broad. Further, more detailed, assessments should examine individual soil and land types within regions as assets. This information is available within the Department of Agriculture, but was considered too detailed for this overview assessment. An assessment of the off-site effects on public and private assets from agricultural land uses is not covered in this document. To discuss the asset at threat without examining the cause is a limitation of the document.
- Wetlands: Although the Water resource process has assessed some significant wetlands within ANCA and Ramsar classifications, not all have been individually assessed. In some cases groups of wetlands (eg. conservation category wetlands on the Swan Coastal Plain and other important wetlands identified in WRC and other publications) have been assessed as one asset. These assets should be considered individually.
- Rangeland natural resource information (condition, value, and threat) is generally limited.

Refining the priorities

At write up an approach or methodology for identifying a final list of priority assets for investment had not been developed. However, the second phase of the SIF was investigating a methodology for determining a final ranking.

Although the SIF focuses on salinity threat, the investment decision process will most likely be easily modified to consider other threats. Any further work to determine investment priorities, using the information presented in this report, should consider and incorporate any decision-making process developed by the SIF project. The final process developed by the SIF will determine the amount and nature of information required for decision making.

Commenting

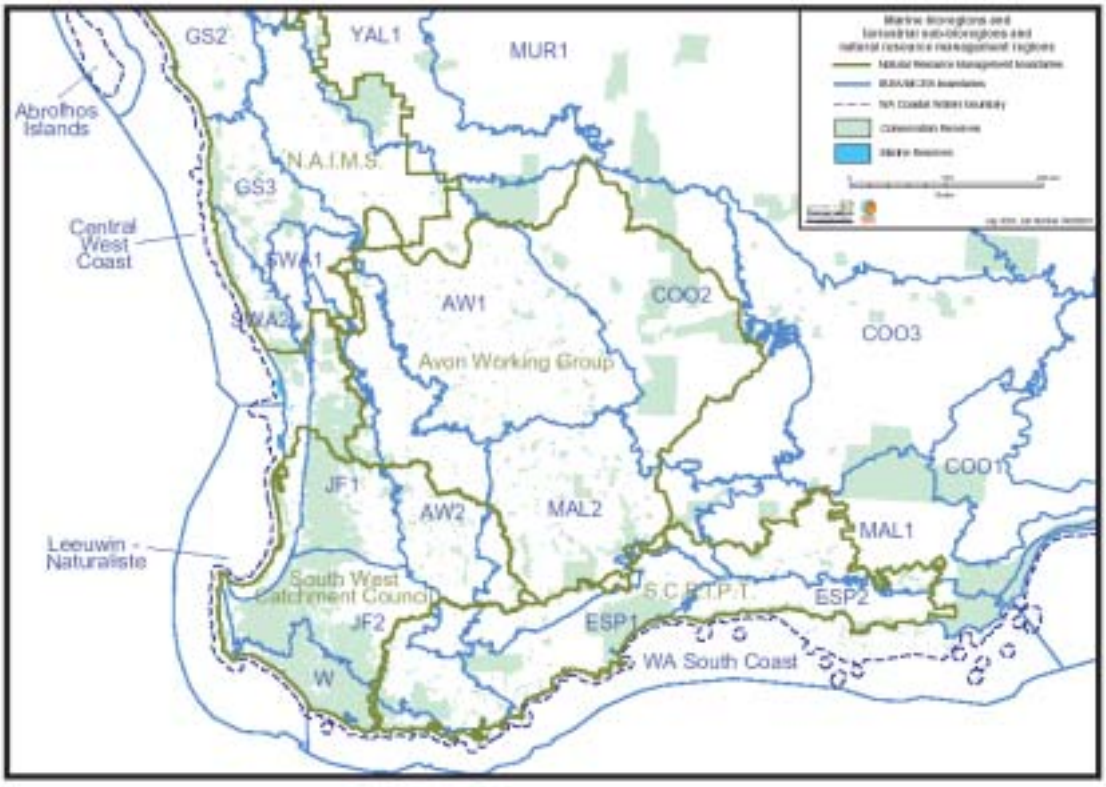
Senior Officers Group recognises that there has been insufficient consultation in developing the lists within this report and that Regional NRM Groups are highly focused on developing their regional strategies. The consequence is that the findings in this report are open to further discussion and amendment and will not be finalised without sufficient consultation and review. Feasibility assessments are critical to developing a final list of investment priorities for Western Australia.

Attachment 1 – Additional Biodiversity information

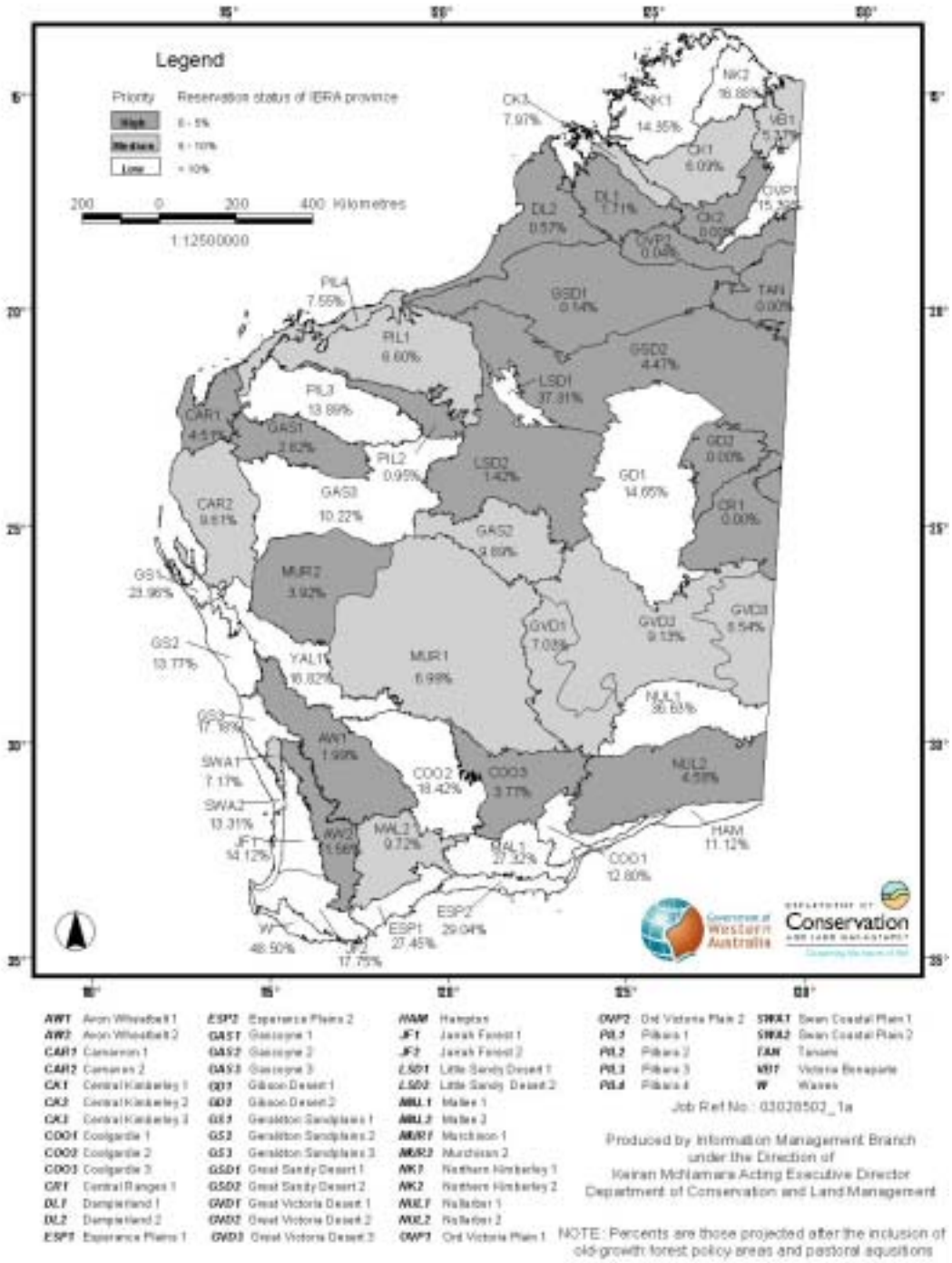
Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

<u>Attachment 1a</u> - Marine bioregions and terrestrial sub-bioregions and natural resource management regions - State.

<u>Attachment 1b</u> - Marine bioregions and terrestrial sub-bioregions and natural resource management regions - Southwest



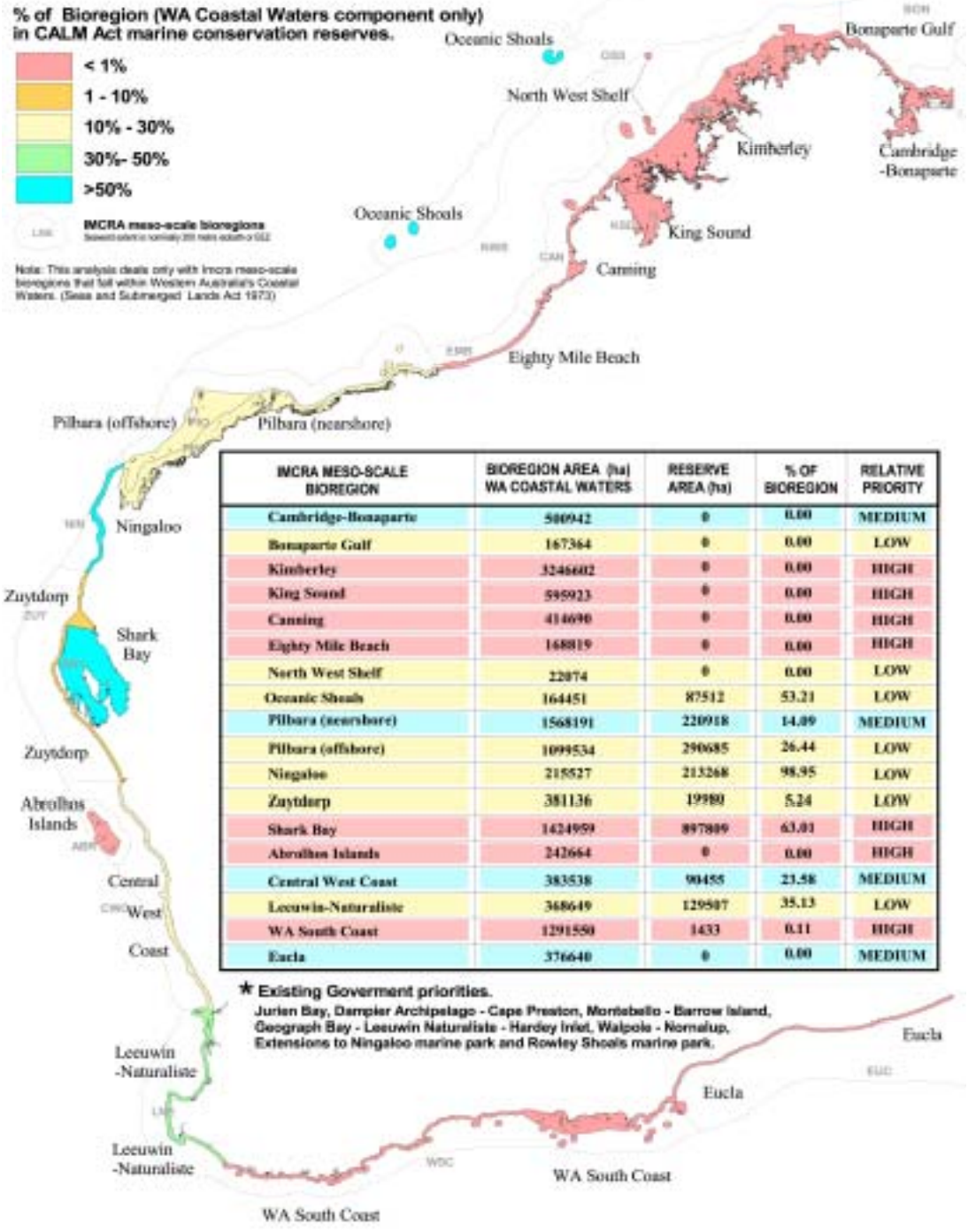
<u>Attachment 1</u>c – Map of priorities (high, medium or low) at a sub-bioregion level for the establishment of a Comprehensive, Adequate and Representative terrestrial conservation reserve system



<u>Attachment 1d</u> – Map of priorities (high, medium or low) at IMCRA sub-region level for the establishment of a marine conservation reserve system.

Attachment 2.

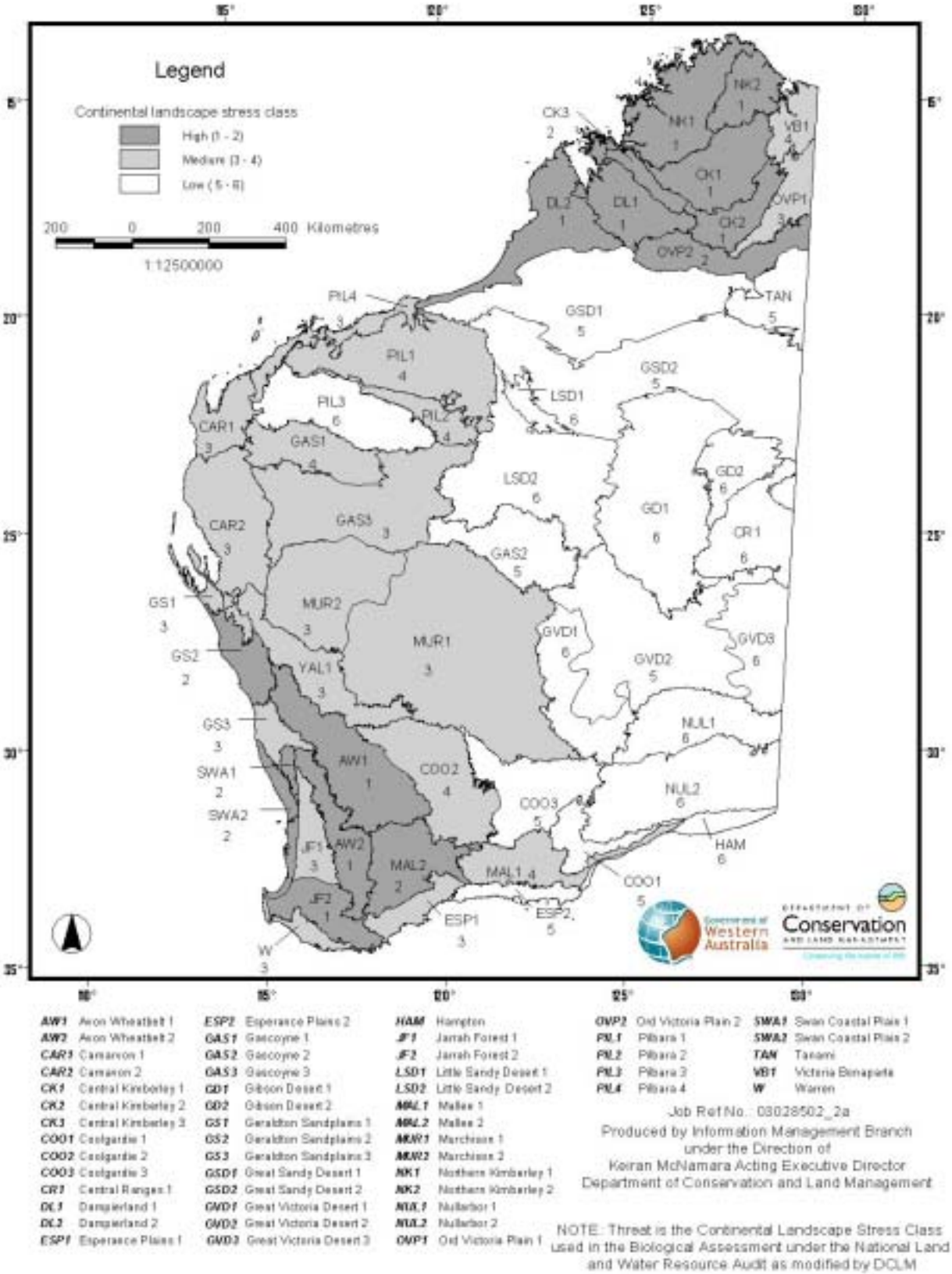
INTERIM MARINE AND COASTAL REGIONALISATION OF AUSTRALIA (IMCRA)
BIOREGION PRIORITIES FOR ESTABLISHMENT OF A MARINE CONSERVATION RESERVE SYSTEM
★ Assuming the implementation of existing Government priorities.

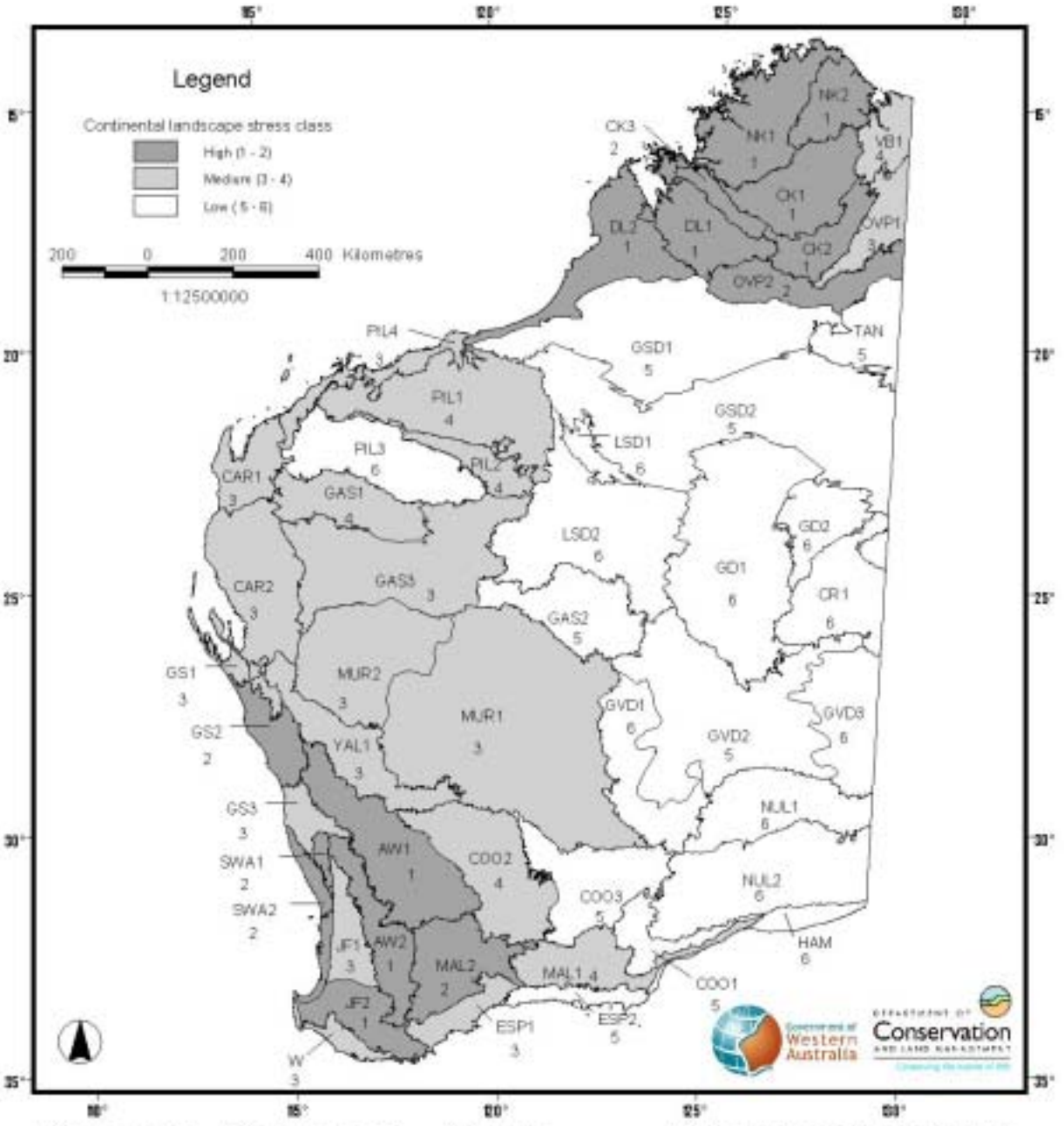


IMCRA MESO-SCALE BIOREGION	BIOREGION AREA (ha) WA COASTAL WATERS	RESERVE AREA (ha)	% OF BIOREGION	RELATIVE PRIORITY
Cambridge-Bonaparte	580942	0	0.00	MEDIUM
Bonaparte Gulf	167364	0	0.00	LOW
Kimberley	3246602	0	0.00	HIGH
King Sound	595923	0	0.00	HIGH
Canning	414690	0	0.00	HIGH
Eighty Mile Beach	168819	0	0.00	HIGH
North West Shelf	22074	0	0.00	LOW
Oceanic Shoals	164451	87512	53.21	LOW
Pilbara (nearshore)	1568191	220918	14.09	MEDIUM
Pilbara (offshore)	1099534	290685	26.44	LOW
Ningaloo	215527	213268	98.95	LOW
Zuytdorp	381136	19980	5.24	LOW
Shark Bay	1424959	897809	63.01	HIGH
Abrolhos Islands	242664	0	0.00	HIGH
Central West Coast	383538	90455	23.58	MEDIUM
Leeuwin-Naturaliste	368649	129507	35.13	LOW
WA South Coast	1291550	1433	0.11	HIGH
Eucla	376640	0	0.00	MEDIUM

★ Existing Goverment priorities.
Jurien Bay, Dampier Archipelago - Cape Preston, Montebello - Barrow Island, Geograph Bay - Leeuwin Naturaliste - Hardey Inlet, Walpole - Nornalup, Extensions to Ningaloo marine park and Rowley Shoals marine park.

Attachment 1e. Continental landscape stress class for each IBRA sub-bioregion





AW1	Avon Wheatbelt 1	ESP2	Esperance Plains 2	HAM	Hampton	OVP2	Old Victoria Plain 2	SWA1	Swan Coastal Plain 1
AW2	Avon Wheatbelt 2	GAS1	Gascoyne 1	JF1	Jarrah Forest 1	PIL1	Pilbara 1	SWA2	Swan Coastal Plain 2
CAR1	Carnarvon 1	GAS2	Gascoyne 2	JF2	Jarrah Forest 2	PIL2	Pilbara 2	TAN	Tanami
CAR2	Carnarvon 2	GAS3	Gascoyne 3	LSD1	Little Sandy Desert 1	PIL3	Pilbara 3	VB1	Victoria Bonaparte
CK1	Central Kimberley 1	GD1	Gibson Desert 1	LSD2	Little Sandy Desert 2	PIL4	Pilbara 4	W	Warren
CK2	Central Kimberley 2	GD2	Gibson Desert 2	MAL1	Mallee 1				
CK3	Central Kimberley 3	GS1	Geraldton Sandplains 1	MAL2	Mallee 2				
COO1	Coolgardie 1	GS2	Geraldton Sandplains 2	MUR1	Murchison 1				
COO2	Coolgardie 2	GS3	Geraldton Sandplains 3	MUR2	Murchison 2				
COO3	Coolgardie 3	GSD1	Great Sandy Desert 1	NK1	Northern Kimberley 1				
CR1	Central Ranges 1	GSD2	Great Sandy Desert 2	NK2	Northern Kimberley 2				
DL1	Dampierland 1	GVD1	Great Victoria Desert 1	NUL1	Nullarbor 1				
DL2	Dampierland 2	GVD2	Great Victoria Desert 2	NUL2	Nullarbor 2				
ESP1	Esperance Plains 1	GVD3	Great Victoria Desert 3	OVP1	Old Victoria Plain 1				

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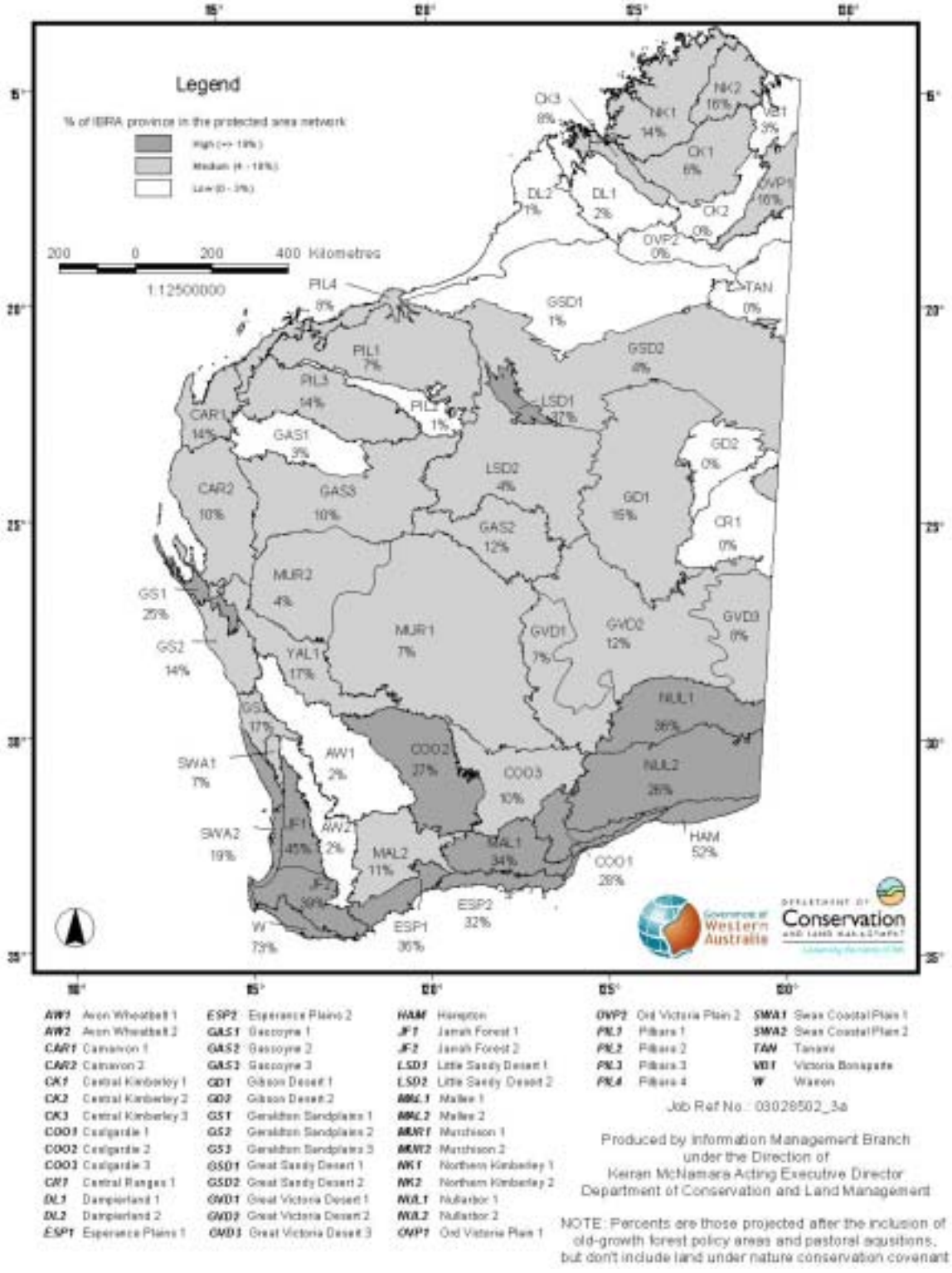
Keiran McNamara Acting Executive Director
Department of Conservation and Land Management

NOTE: Threat is the Continental Landscape Stress Class used in the Biological Assessment under the National Land and Water Resource Audit as modified by DCLM

Attachment 1f. Proportion of protected area network per IBRA sub-bioregion.



AW1 Avon Wheatbelt 1	ESP2 Esperance Plains 2	HAM Hampton	OVP2 Old Victoria Plain 2	SWA1 Swan Coastal Plain 1
AW2 Avon Wheatbelt 2	GAS1 Gascoyne 1	JF1 Jarrah Forest 1	PIL1 Pilbara 1	SWA2 Swan Coastal Plain 2
CAR1 Carnarvon 1	GAS2 Gascoyne 2	JF2 Jarrah Forest 2	PIL2 Pilbara 2	TAN Tanami
CAR2 Carnarvon 2	GAS3 Gascoyne 3	LSD1 Little Sandy Desert 1	PIL3 Pilbara 3	VB1 Victoria Bonaparte
CK1 Central Kimberley 1	GD1 Gibson Desert 1	LSD2 Little Sandy Desert 2	PIL4 Pilbara 4	W Warren
CK2 Central Kimberley 2	GD2 Gibson Desert 2	MAL1 Mallee 1		
CK3 Central Kimberley 3	GS1 Geraldton Sandplains 1	MAL2 Mallee 2		
COO1 Coolgardie 1	GS2 Geraldton Sandplains 2	MUR1 Murchison 1		
COO2 Coolgardie 2	GS3 Geraldton Sandplains 3	MUR2 Murchison 2		
COO3 Coolgardie 3	GSD1 Great Sandy Desert 1	NK1 Northern Kimberley 1		
CR1 Central Ranges 1	GSD2 Great Sandy Desert 2	NK2 Northern Kimberley 2		
DL1 Dampierland 1	GVD1 Great Victoria Desert 1	NUL1 Nullarbor 1		
DL2 Dampierland 2	GVD2 Great Victoria Desert 2	NUL2 Nullarbor 2		
ESP1 Esperance Plains 1	GVD3 Great Victoria Desert 3	OVP1 Old Victoria Plain 1		

Job Ref No.: 03028502_3a

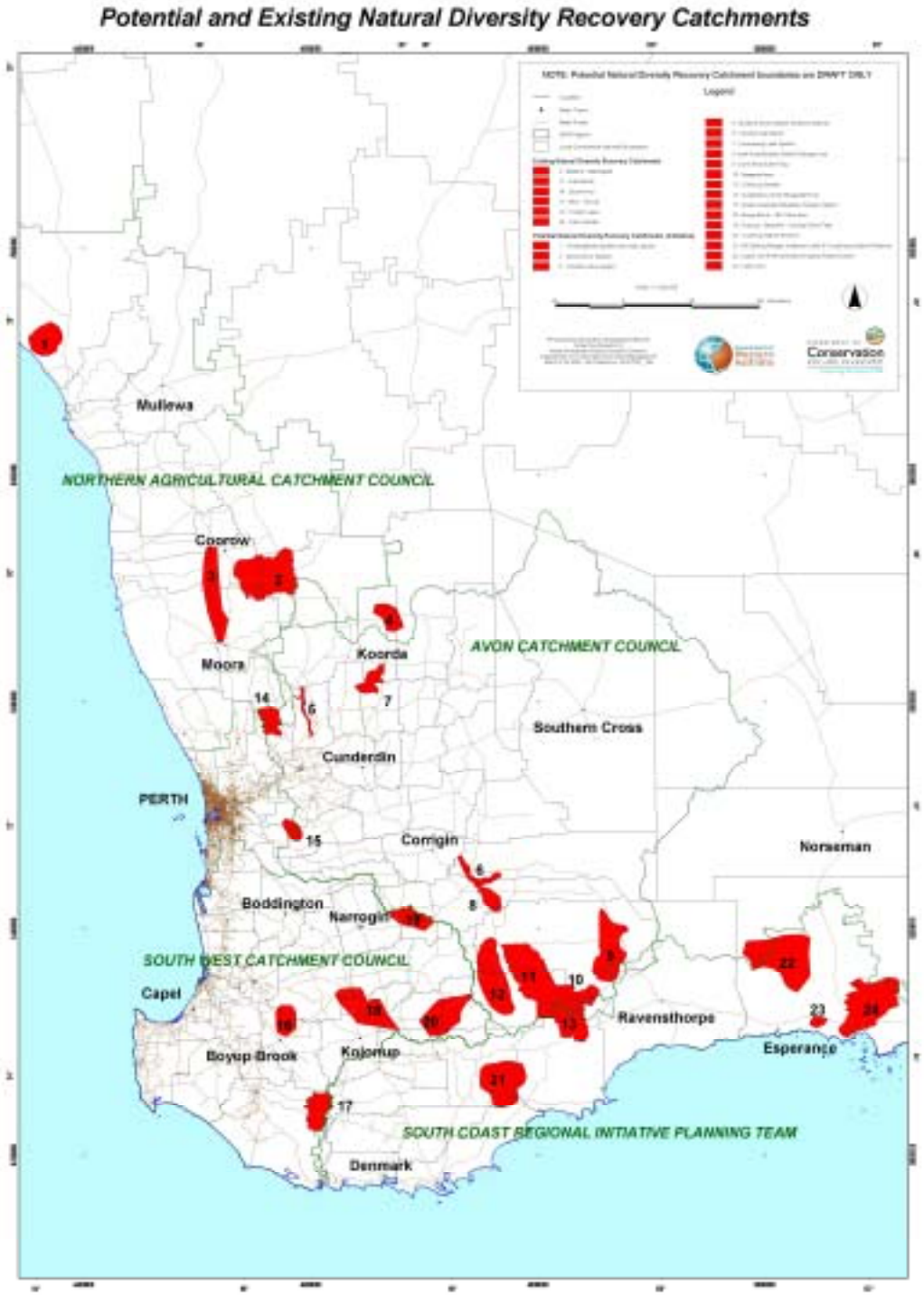
Produced by Information Management Branch
under the Direction of
Kieran McNamara Acting Executive Director
Department of Conservation and Land Management

NOTE: Percents are those projected after the inclusion of old-growth forest policy areas and pastoral aquisitions, but don't include land under nature conservation covenant

<u>Attachment 1g</u>: Threat Vs value matrix for threatened species/ecological communities, and priority species/ecological communities.

	FLORA										TEC							FAUNA									
Province	CR	EN	VUL	1	2	3	4	Not ranked	Extinct	Total	CR	EN	VUL	Priority	Lower risk	Presumed totally destroyed	Total	CR	EN	VUL	Conservation dependant	Lower risk	1	2	3	4	Total
AW1	26	22	17	35	26	18	16	2		**162**	1	2	5	5		1	***14***	1	2	4			3		1	2	***3***
AW2	20	23	18	17	39	21	23			**161**	1	2		2	1		***6***		2	3	3				2	4	***6***
CAR1				1		1				**2**	2						***2***	4	5	9			2	2		3	***9***
CAR2										**0**							***0***			7			5			3	***3***
CK1			1							**1**			1				***1***		1	1		1	1	1	1	2	***6***
CK2										**0**							***0***										***0***
CK3										**0**							***0***			1							***1***
COO1					1	1	2			**4**							***0***										***0***
COO2	3	3	13	14	11	5	8	1		**58**			1	1			***2***			3			1			5	***5***
COO3	1		3	8	2	1	2			**17**			2	1			***3***			1						4	***4***
CR1				1						**1**							***0***		1	1							***9***
DL1										**0**			1				***1***			2				3		2	***2***
DL2		1					1			**2**			3	2			***5***			4				1		7	***7***
ESP1	15	23	22	22	50	21	22			**175**	1	1	1	2			***5***		4	11	3		2	2	1	7	***9***
ESP2	2	2	3	7	4	3	5			**26**				3			***3***		4	6	2		1			4	***4***
GAS1										**0**							***0***			1						1	***1***
GAS2				4						**4**							***0***			2				1		1	***5***
GAS3			2	5						**7**							***0***			2						2	***2***
GD1										**0**							***0***		1	4						2	***2***
GD2										**0**							***0***										***0***
GS1				1	2	1	1			**5**							***0***		1	5					1		***1***
GS2	6	14	1	13	10	9	8			**61**	1			1			***2***		1	4	1			1	1	2	***4***
GS3	17	16	13	20	31	40	27			**164**	1	5	1	1			***8***		1	1				2	2	3	***5***
GSD1										**0**		2					***2***			3						2	***2***
GSD2										**0**							***0***		2	1						4	***4***
GVD1		1	1							**2**							***0***		2	1				1		1	***6***
GVD2			1							**1**							***0***		2	1						1	***1***
GVD3										**0**							***0***		1							1	***1***
HAM					1	1				**2**							***0***			5						1	***2***
JF1	7	11	16	16	29	34	45			**158**	1	1	1				***3***		2	7	3		3	2	5	7	***17***
JF2	16	23	22	24	48	53	43			**229**	2	2	2	1			***7***	2	3	15	3		2	4	6	9	***21***
LSD1										**0**							***0***		1	1						2	***38***
LSD2			1							**1**							***0***			1						1	***1***
MAL1	2	2	4	7	13	5	7			**40**			1				***1***			2			1			1	***1***
MAL2	9	10	17	32	54	15	11			**148**	2		1				***3***		2	5	3		4		1	4	***2***
MUR1	1		1	8		2	3			**15**			1				***1***			3			1			1	***1***
MUR2				6	1	2	1			**10**							***0***		1	1						2	***2***
NK1										**0**		1	4				***5***		2	4			3	6	5	9	***3***
NK2			1							**1**							***0***							4		2	***2***
NUL1										**0**							***0***									2	***2***
NUL2										**0**							***0***			3			1			3	***4***
OVP1										**0**							***0***		1					1		3	***3***
OVP2										**0**							***0***			1		1	3			1	***1***
PIL1					1					**1**							***0***			3		1	3			6	***4***
PIL2										**0**				1			***1***			1				1		3	***3***
PIL3			2	2	1					**5**		1	1	2			***4***						1			7	***7***
PIL4				1		1				**2**							***0***			18			2			9	***10***
SWA1	4	6	5	8	1	23	17			**64**		1					***1***			2			1			1	***1***
SWA2	17	18	14	21	22	54	40			**186**	10	6	9	1			***26***		4	10	2		3	1	6	7	***17***
TAN										**0**							***0***			1							***18***
VB1				1						**1**				1			***1***		1	2					1	2	***3***
W	4	12	9	11	33	35	25		1	**130**	5	3					***8***	1	2	11	3		3	3	3	9	***18***
YAL1	4	2	1	11	1	3	1			**23**							***0***		1	1							***21***
TOTALS	154	189	188	296	381	349	308	3	1	**1869**	27	27	35	24	1	1	***115***	8	50	175	23	3	46	36	36	155	***532***

Attachment 1h: Map showing existing and potential natural diversity recovery catchments



Attachment 2 – Rangelands

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Biodiversity assets (Rangelands)

Refer to appendix 1a and 1b

Agricultural Perspective (Rangelands)

Refer to section5.3

Water Resource assets (Rangelands)

Waterscape Assets North West		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Fitzroy River Ord River Downstream of Dam Fortescue River Harding River downstream of Dam Munni Munni Creek to Yule River important wetlands specifically identified in reports commissioned by WRC		
	Medium Intermediate time and/or not that greater extent 2020-2075	Chamberlain River Durack River Forrest River King Edward River King River Mitchell River (MR) Ord River Dam upstream Pentecost River Salmond River Maitland (Munni Munni) Robe River Sherlock River Directory of Important wetlands Ramsar Wetlands	Carson River Lennard River May River Meda River Morgan River Yule River	DeGrey River
	Low Long term >2075 Or already impacted significantly	Berkeley River Calder River Charnley River Drysdale River Drysdale, King George and Berkeley Rivers Glenelg River Harding River Dam upstream Hunter River Isdell River King George River Moran River Prince Regent River Roe River Sale River	Cambridge Gulf Cane River	Ashburton River

Water Supply North West		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Broome (RIWIA) Broome WR (PDWSA) Derby (RIWIA) Derby WR (PDWSA) Gascoyne River WR (PDWSA) Harding Dam CA (PDWSA)	Aboriginal communities (SW) (Health Act) Finucane Island WR (PDWSA) Fitzroy Crossing WR (PDWSA) Halls Creek WR (PDWSA) Marble Bar WR (PDWSA) Nullagine WR (PDWSA) Private drinking sources (Health Act) Warmun (Turkey Creek) WR (PDWSA)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Cane River WR (PDWSA) De Grey River WR (PDWSA) Irrigation schemes - Lake Argyle (RIWIA) King River Pools WR (PDWSA) Kununurra WR (PDWSA) Millstream (West Pilbara) WR (PDWSA) Moochalabra Dam CA (PDWSA) Newman WR (PDWSA) Panawonica WR (PDWSA) Paraburdoo WR (PDWSA) Pilbara (RIWIA) Roebourne WR (PDWSA) Tom Price WR (PDWSA) Turner River WR (PDWSA) Yule River WR (PDWSA)	Camballin WR (PDWSA) Canning-Kimberley (RIWIA) Exmouth WR (PDWSA) Private stock & irrig'n sources (RIWIA) NW	
	Low Long term >2075 Or already impacted significantly		Private sources for industry & commerce (RIWIA) Private sources for landscape and recreation irrig'n (RIWIA) NW	

Aquatic Assets and Fish Resources (Rangelands)

Fisheries Assets Rangelands		Value		
		High	**Medium**	**Low**
Threat	**High**			Ports (small)(all regions) Ports (large)(all regions) North Coast Shark (combined JANSF & WANCSF) (R)
	Medium	Marine fish stocks(all regions) Coastal waters (offshore 3 nm) Inshore Kimberley waters Estuaries (R) Pink Snapper (R) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) Shark Bay Snapper (R) Onslow Prawn (R) Broome Prawn (R) Kimberley Prawn (R) Pilbara Demersal Finfish (R) Spanish Mackerel (R)	Nickol Bay Prawn (R) Barramundi Farming (R)
	Low	Corals and benthic (R, NA, Swan, SW) Inshore reefs (R, NA, SC, SW) West Coast Rock Lobster (SW, Swan, NA, R) Shark Bay Prawn (R) Exmouth Gulf Prawn (R) Shark Bay Scallop (R) Pearl Oyster (R) Recreational - Kimberley and Pilbara Regions (R) Rock Lobster (R; NA; Swan; SW)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) West Coast Blue Swimmer Crab (SW; Swan; NA, R) West Coast Deep-sea Crab (SW; Swan; NA; R) Northern Demersal Scalefish (R) Black Snapper (R) Recreational - Northern Inland (R) Freshwater Angling (All Regions)	Shark Bay Beach Seine and Mesh Net (R) Kimberley Gillne and Barramundi (R) Lake Argyle Freshwater Catfish (R)

Attachment 3 – Northern Agriculture

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Agricultural Perspective (Rangelands)

Refer to section5.3

Biodiversity assets (Northern Agriculture)

Refer to appendix 1a and 1b

Water Resource assets (Northern Agriculture)

Assets are identified by Department of Environment boundaries.

Waterscape Assets Mid West		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Gingin Brook Conservation category wetlands Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 Hill River Estuary Hutt River Irwin River Estuary Moore River Estuary Murchison River Estuary Gingin Brook Lower Moore / Gingin Bk	Chapman River Chapman River Estuary Lake Logue/Indoon System (ANCA) Moore Catch/River	Irwin River Lake Moore Lake Pinjarrega Mongers Lakes Yarra Yarra Lakes
	Medium Intermediate time and/or not that greater extent 2020-2075	Environmental Protection (Swan Coastal Plain Lakes) Policy 1992- Mid West Greenough River Estuary	Bowes Estuary Gascoyne River Greenough River Lake McLeod Minor streams between Moore and Arrowsmith Rivers Murchison River	Bowes River Buller River Eneabba Creek Hutt Estuary Oakagee River
	Low Long term >2075 Or already impacted		Lakes of Bee Keeper Management Area and other coastal lakes (MR) Lyndon River to Minilya River	Wooramel Basin Yarra Monger Trib

Water Supply Mid West		Value			
		High	**Medium**		**Low**
Threat	**High** Existing and/or near and substantial <2020	Allanooka WR Dongara-Denison WR (PDWSA) Carnarvon (RIWIA) Jurien (RIWIA) Wicherina CA (40km east of Geraldton) (PDWSA) Bindoon / Chittering WR (PDWSA) Gingin WR (PDWSA) Gingin (RIWIA)	Aboriginal communities (NW) (Health Act) Arrowsmith WR (Perenjori) (PDWSA) Cue WR (PDWSA) Dathagnoorara WR (21km SW of Carnamah) (PDWSA) Dookanooka WR (16km west of 3 Springs) (PDWSA) Eneabba WR (PDWSA) Gascoyne Junction WR (PDWSA) Jurien WR (PDWSA) Meekatharra WR (PDWSA) Menzies WR (PDWSA) Mingenew WR (54km W of Dongara) (PDWSA) Nabawa WR (35km NE of Geraldton) (PDWSA) New Norcia WR (PDWSA) Guilderton WR (PDWSA) Lancelin WR (PDWSA) Ledge Point WR (PDWSA) Miling WR (35km NE of Moora) (PDWSA) Sovereign Hill (new see WC) WR (PDWSA) Woodridge WR (PDWSA)	Northampton WR (PDWSA) Perenjori WR (PDWSA) Private drinking sources (Health Act) Sandstone WR (PDWSA) Seabird WR (PDWSA) Three Springs WR (PDWSA) Varley WR (42 km N of Lake King) (PDWSA) Watheroo WR (40km N of Moora) (PDWSA) Wiluna WR (PDWSA) Yalgoo WR (PDWSA) Yerecoin WR (20km NE of New Norcia) (PDWSA) Yerina Spring WR (PDWSA) Yuna WR (35km E of Northampton) (PDWSA) Calingiri WR (40km SW of Wongan Hills) (PDWSA) Seaview Park (new see WC) WR (PDWSA)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Arrowsmith (RIWIA)	Arrino Bores WR (PDWSA) Badgingarra WR (60km NW of Moora) (PDWSA) Carnarvon WR (PDWSA) Cervantes WR (PDWSA) Coomberdale WR (20km N of Moora) (PDWSA) Dandaragan WR (PDWSA) Denham WR D7 - 2 artesian bore desalinated (PDWSA) East Murchison (RIWIA) Gascoyne (RIWIA) Green Head WR (PDWSA)	Horrocks Beach WR (PDWSA) Jurien - Turquoise Coast WR (PDWSA) Kalbarri WR (PDWSA) Leeman WR 30km SW of Eneabba (Midway bore) (PDWSA) Moora WR (PDWSA) Mount Peron WR (20 km NE of Jurien) (PDWSA) Port Gregory WR (PDWSA) Private sources for industry & commerce (RIWIA) Private stock & irrig'n sources (RIWIA) MW	
	Low Long term >2075 Or already impacted significantly		Private sources for landscape and recreation irrig'n (RIWIA) MW New Norcia (RIWIA)		Depot Springs WR (80km E of Sandstone) deproclaim? (PDWSA) Yerecoin (RIWIA)

Aquatic Assets and Fish Resources (Northern Agriculture)

Fisheries Assets North Ag		Value		
		High	**Medium**	**Low**
Threat	**High**	Freshwater fish (SC,SW,NA) Estuaries(SW, Swan, NA) Marron stocks (NA, Swan, SW)		Ports (small)(all regions) Ports (large)(all regions)
	Medium	Marine fish stocks(all regions) Estuaries (remote) Coastal waters (offshore 3 nm) Recreational Marron (NA, SW, SC, Swan) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) Minor Scallops Abrolhos Island and Mid West Trawl (NA) West Coast Demersal Scalefish (NA, Swan, SW) Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	Ornamental Fish Farming (Swan, NA, SW, SC)
	Low	Abrolhos Islands (NA) Corals and benthic (R, NA, Swan, SW) Inshore reefs (R, NA, SC, SW) West Coast Rock Lobster (SW, Swan, NA, R) Rock Lobster (R; NA; Swan; SW)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) West Coast Blue Swimmer Crab (SW; Swan; NA, R) West Coast Deep-sea Crab (SW; Swan; NA; R) Freshwater Angling (All Regions)	Lower West Coast Beach and Embayment West Coast Beach Bait (Fish Net) (NA, Swan, SW, SC) Kimberley Gillne and Barramundi (R) Lake Argyle Freshwater Catfish (R) Coastal aquaculture: pearl and pearl oysters + others (NA, SC)

Attachment 4 – Avon Basin

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Agricultural Perspective (Swan)

Refer to section5.3

Biodiversity assets (Avon)

Refer to appendix 1a and 1b

Water Resource assets (Avon)

Waterscape Assets Avon		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Avon River (Dale to Mortlock Rivers) Brockman River Dale River Gingin Brook Conservation category wetlands Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 Lower Moore / Gingin Bk important wetlands specifically identified in reports commissioned by WRC	Avon River (Beverley upstream) Wooroloo Brook Avon River Lower Avon River Middle Chittering Lakes (ANCA) Lake Grace System (ANCA) Lockhart Catch/River Yealering Lakes System (ANCA) Yenyening Lakes System Yilgarn Catch/River	
	Medium Intermediate time and/or not that greater extent 2020-	Directory of Important wetlands Ramsar Wetlands Environmental Protection (Swan Coastal Plain Lakes) Policy	East Mortlock River Lake Bryde Catchment Wannamal Lake System (ANCA)	North Mortlock River
	Low Long term >2075 Or already impacted		Yorkrakine Rock Pools (ANCA)	

Water Supply Avon		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Gnangara (RIWIA) Jandakot (RIWIA) Lake King CA (70km NW of Ravensthorpe) (PDWSA)	Aboriginal communities (Health Act) Bolgart WR (PDWSA) Brookton - Happy Valley WR (PDWSA) Brookton Dam CA (PDWSA) Laverton WR (PDWSA) Leinster (Goldfields) WR (PDWSA) Leonora WR (PDWSA) Private drinking sources (Health Act)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Dumbleyung CA (39km E of Wagin) (PDWSA) Goldfields (RIWIA)	Private stock & irrig'n sources (RIWIA)	
	Low Long term >2075 Or already impacted significantly	Private sources for industry & commerce (RIWIA)	Private sources for landscape and recreation irrig'n (RIWIA)	Bolgart East (RIWIA) Condingup (RIWIA) Happy Valley (RIWIA) Westonia (RIWIA) Yenart (RIWIA)

Aquatic Assets and Fish Resources (Avon)

Fisheries Assets Avon		Value		
		High	**Medium**	**Low**
Threat	**High**			
	Medium		Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	
	Low		Freshwater Angling (All Regions)	Trout Farming (SC, SW)

Attachment 5 – Swan

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Agricultural Perspective (Swan)

Refer to section5.3

Biodiversity assets (Swan)

Refer to appendix 1a and 1b

Water Resource assets (Swan)

Waterscape Assets Swan		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Conservation category wetlands Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 important wetlands specifically identified in reports commissioned by WRC Swan River	Wooroloo Brook Chittering Lakes (ANCA)	
	Medium Intermediate time and/or not that greater extent 2020-	Directory of Important wetlands Ramsar Wetlands Environmental Protection (Swan Coastal Plain Lakes) Policy 1992- Swan		
	Low Long term >2075 Or already impacted			

Water Supply Swan		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Bickley Brook CA (PDWSA) Mirrabooka (RIWIA) Mirrabooka UWPCA (PDWSA) Perth (including Gwelup) (RIWIA) Rottnest (RIWIA) Swan (RIWIA) Wanneroo (RIWIA) Wanneroo UWPCA (PDWSA) Yanchep (RIWIA)	Aboriginal communities (Health Act) Gwelup UWPCA (PDWSA) Jane Brook (PDWSA) Perth Coastal UWPCA (PDWSA) Private drinking sources (Health Act) Lower Helena Pipehead Dam CA (PDWSA)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Canning River CA (Kangaroo Gully WR, Araluen?) (PDWSA) Churchman Brook CA (PDWSA) Gnangara UWPCA (PDWSA) Lower Bickley Re CA (PDWSA) Mundaring Weir CA (PDWSA) Victoria CA (PDWSA)	Private stock & irrig'n sources (RIWIA)	
	Low Long term >2075 Or already impacted significantly	Private sources for industry & commerce (RIWIA)	Private sources for landscape and recreation irrig'n (RIWIA) Red Swamp Brook (Future Dam site PDWSA)	

Aquatic Assets and Fish Resources (Swan)

Fisheries Assets Swan		Value		
		High	**Medium**	**Low**
Threat	**High**	Freshwater fish (SC,SW,NA) Inshore reefs (Urban)SW, Swan Estuaries(SW, Swan, NA) Marron stocks (NA, Swan, SW)	Cockburn Sound (Swan) Inshore reefs (Swan)	Ports (small) (all regions) Ports (large) (all regions)
	Medium	Marine fish stocks(all regions) Recreational Marron (NA, SW, SC, Swan) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) West Coast Demersal Scalefish (NA, Swan, SW) Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	Minor Scallops South West Trawl (SW) Lower West Coast Beach and Embayment Cockburn Sound Finfish (Swan) Ornamental Fish Farming (Swan, NA, SW, SC)
	Low	Corals and benthic (R, NA, Swan, SW) West Coast Rock Lobster (SW, Swan, NA, R) Rock Lobster (R; NA; Swan; SW)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) West Coast Blue Swimmer Crab (SW; Swan; NA, R) West Coast Deep-sea Crab (SW; Swan; NA; R) West Coast Estuarine (SW, Swan) West Coast Purse Seine (Swan) Mussel Farming (SC, Swan) Freshwater Angling (All Regions)	Lower West Coast Beach and Embayment West Coast Beach Bait (Fish Net) (NA, Swan, SW, SC)

Attachment 6 – Southwest

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Agricultural Perspective (Southwest)

Refer to section5.3

Biodiversity assets (Southwest)

Refer to appendix 1a and 1b

Water Resource assets (Southwest)

Waterscape Assets South West		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Conservation category wetlands Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 important wetlands specifically identified in reports commissioned by WRC Broadwater Gingilup-Jasper Wetland Sys (ANCA) Hardy Inlet Leschenault estuary Lower Blackwood Estuary (ANCA) Peel-Harvey Estuarine system Preston River Scott Lower Vasse-Wonnerup Warren river	Thompsons Lake (RAMSAR) Coyrecup Lake (ANCA) Lake Toolibin (proposed RAMSAR) Leeuwin Ridge streams Murray River Serpentine River	Geographe Bay Streams
	Medium Intermediate time and/or not that greater extent 2020-2075	Directory of Important wetlands Ramsar Wetlands Cape Leeuwin System (ANCA) Doggerup Creek Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 - South west Meerup River	Benger Swamp (Wellesley) (ANCA) Blackwood lower Brunswick River Harvey River Margaret River McCarleys Swamp (Ludlow) (ANCA) Toby Inlet Vasse Catch/River Wagin Lakes	Wellesley River
	Low Long term >2075 Or already impacted significantly	Collie River Donnelly River	Blackwood River Boyup upstream Dumbleyung Lake (ANCA) Margaret River Mouth Muir-Unicup (proposed RAMSAR) Towerinning Lake	

Water Supply **South West**		**Value**				
		High		**Medium**		**Low**
Threat	**High** Existing and/or near and substantial <2020	Cockburn (RIWIA) Rockingham (RIWIA) Jandakot UWPCA (PDWSA) Preston Beach WR (PDWSA) Waroona CA (PDWSA) Badgarning (6km W of Wagin) (PDWSA) Balingup (see Padbury and Greenbushes) CA (PDWSA) Bridgetown CA (Hester Dam) (PDWSA) Bunbury (RIWIA) Bunbury WR (PDWSA) Busselton WR (PDWSA) Busselton-Capel (RIWIA) Collie (RIWIA) Donnybrook WR (PDWSA)	Dunsborough/ Yallingup WR (PDWSA) Greenbushes Dams (see Padbury Reservoir) CA (PDWSA) Kojonup dam (PDWSA) Leeuwin Spring Dam (PDWSA) Lefroy Brook CA (see Pemberton) (PDWSA) Manjimup Dam CA - Phillips Creek & Scabby Gully (PDWSA) Millstream CA (PDWSA) Mullalyup WR & Mullalyup Dam CA (20km SE of Donnybrook) (PDWSA) Pemberton - Lefroy Brook, Big Brook Dam CA (PDWSA) Quinninup Dam CA (PDWSA) SW Coastal (RIWIA) Warren River WR (PDWSA) Wellington Dam CA (PDWSA)	Dandalup River System (RIWIA) Harvey Irrigation District (RIWIA) Lower Serpentine (Goorolong) CA (PDWSA) Karnup Dandalup UWPCA & WR (PDWSA) Pinjarra CA (PDWSA) Private drinking sources -e.g. Dirk Bk Private stock & irrig'n sources (RIWIA) KP Yunderup (Mandurah) WR (PDWSA) Binningup Beach WR (PDWSA) Cowaramup - soak WR (PDWSA) Eaton WR (PDWSA) Kirup Dam CA (16km SE of Donnybrook) (PDWSA) Mungalup Dam on Collie R (PDWSA) Myalup WR (20km W of Harvey) (PDWSA) Nyabing Dam on Blackwood R (60km NE of Katanning) (PDWSA) Padbury reservoir CA (PDWSA) Perup River PHS (Future Dam site PDWSA) Pinwernying Dam (5km NW of Katannning) (PDWSA) Private drinking sources eg Ferguson R. (Health Act) Private sources for landscape and recreation irrig'n (RIWIA) SW	
	Medium Intermediate time and/or not that greater extent 2020-2075	Murray (RIWIA) Serpentine (RIWIA) Conjurunup Creek Pipehead Dam CA (PDWSA) Dwellingup WR (PDWSA) North Dandalup Pipehead Dam CA (PDWSA) Samson Bk CA (Dam and pipehead) (PDWSA) Serpentine Dam CA (PDWSA) South Dandalup Dam CA (PDWSA) Bancell Brook CA (PDWSA) Boddington Dam CA (PDWSA) Brunswick Water Supply (Beela Dam) CA (PDWSA)	Capel River (RIWIA) Harris River Dam (PDWSA) Harvey Dam CA (PDWSA) Margaret River/ Ten Mile Brook CA (PDWSA) Nannup - Tanjanerup Dam CA (PDWSA) Preston Valley Irrigation (RIWIA) Rocky Gully on Frankland R (PDWSA) Stirling Dam CA (PDWSA) SW Yarragadee WR (PDWSA) Warren R DS55 (Future Dam site PDWSA) Wokalup (Wellesley River) CA	Serpentine PH CA (PDWSA) South Dandalup PH C A (PDWSA) Private sources for industry & commerce (RIWIA) Brunswick River WR (PDWSA) Donnelly River WR (PDWSA) Farm Irrigation schemes-Drakesbrook, Waroona, Logue Bk & Glen Mervyn reservoirs (RIWIA) Felix Bk on Blackwood R (PDWSA) Kukerin catchment & reservoir (40km W of Lake Grace) (PDWSA) Private stock & irrig'n sources (RIWIA) SW Puntapin Rock (PDWSA) Record Bk on Donnelly R (PDWSA) Wilgarup R DS (Future Dam site PDWSA)	
	Low Long term >2075 Or already impacted significantly	Wungong CA (PDWSA) Private sources for industry & commerce e.g Oakley Bk dam (RIWIA)		Lower South Dandalup (& pipehead dam?) CA (PDWSA) Private sources for landscape and recreation irrig'n (RIWIA) KP Abba R DS (Future Dam site PDWSA) Big Brook Weir (Future Dam site PDWSA) Big Easter Bk (Future Dam site PDWSA) Big Hill Bk DS (Future Dam site PDWSA) Boyinup Brook Dam (TWS) (Future Dam site PDWSA) Carey Bk DS4 (Future Dam site PDWSA) Dalgarup Bk DS1.5 (Future Dam site PDWSA)	Dombakup BK DS (Future Dam site PDWSA) Hester Dam (Bridgtn TWS) (PDWSA) McAtee Bk DS (Future Dam site PDWSA) Norilup Bk DS1.5 (Future Dam site PDWSA) Phillips Dam CA (PDWSA) Scabby Gully Dam (ManjTWS) (PDWSA) St John Bk (Future Dam site PDWSA) Tanjannerup Dam (Nannup TWS) (PDWSA) Tinkers Bk PHS (Future Dam site PDWSA)	Adelaide Bk (Future Dam site PDWSA) Long Gully DS2 (Future Dam site PDWSA) Milyeannup Bk DS (Future Dam site PDWSA) Nannup Bk DS6 (Future Dam site PDWSA) Red Gully (Future Dam site PDWSA) Rosa Bk DS (Future Dam site PDWSA) Davies Bk on Murray River (PDWSA) Dwellingup (RIWIA)

Aquatic Assets and Fish Resources (Southwest)

Fisheries Assets Southwest		Value		
		High	**Medium**	**Low**
Threat	**High**	Freshwater fish (SC,SW,NA) Margaret River Marron stocks(SW) Inshore reefs (Urban)SW, Swan Estuaries(SW, Swan, NA) Marron stocks (NA, Swan, SW)		Ports (small)(all regions) Ports (large)(all regions)
	Medium	Marine fish stocks(all regions) Estuaries (remote) Coastal waters (offshore 3 nm) Recreational Marron (NA, SW, SC, Swan) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) West Coast Demersal Scalefish (NA, Swan, SW) Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	Minor Scallops South West Trawl (SW) Ornamental Fish Farming (Swan, NA, SW, SC)
	Low	Corals and benthic (R, NA, Swan, SW) Inshore reefs (R, NA, SC, SW) West Coast Rock Lobster (SW, Swan, NA, R) Rock Lobster (R; NA; Swan; SW)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) West Coast Blue Swimmer Crab (SW; Swan; NA, R) West Coast Deep-sea Crab (SW; Swan; NA; R) West Coast Estuarine (SW, Swan) Freshwater Angling (All Regions)	Lower West Coast Beach and Embayment West Coast Beach Bait (Fish Net) (NA, Swan, SW, SC) Trout Farming (SC, SW)

Attachment 7 – South Coast

Note: Results contained within this report do not represent a final priority listing of assets for investment, but provide a starting point or guide for further discussion and investigations that will contribute to a final investment decision.

Agricultural Perspective (South Coast)

Refer to section5.3

Biodiversity assets (South Coast)

Refer to appendix 1a and 1b

Water Resource assets (South Coast)

Waterscape Assets South Coast		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Environmental Protection (SW Agricultural Zone Wetlands) Policy 1998 Bremer River Fitzgerald River and estuary Oldfield River Oyster Harbour Princess Royal Harbour Wilson Inlet important wetlands specifically identified in reports commissioned by WRC	Beaufort Inlet Johnston River Kalgan River King River Lake Gore Marbellup main drain Pallinup River Robinson Drain Torbay Inlet Torbay main drain Yakamia Creek	Bitter Water Creek Cape Arid to Coomalbidgup Gairdner River Gordon River Hunter River Mills Lake Wetland system PARRY INLET
	Medium Intermediate time and/or not that greater extent 2020-2075	Bandy Creek Caramup Creek Coobidge Creek Coomalbidgup Creek Dalyup River Denmark River Doonabup Creek Frankland River Hamersley River Jerdacuttup River and Lakes (LR) Kateup Creek Lake Warden System Oldfield Estuary Stokes inlet Walpole-Nornalup Inlet Wellstead Inlet Directory of Important wetlands Ramsar Wetlands	Balicup Lake System (ANCA) Bowe River Corackerup Creek Culham Inlet Irwin inlet Karri and Cordubup Creeks Kent River Mortijinup Lake System (ANCA) Munglinup River Owingup Swamp System (ANCA) Peenebup Creek Taylor Inlet Yellilup Yate Swamp Sys (ANCA)	Collu Collu Creek Cowenup Brook Cuppup drain, Munster, Robinson, Torbay Devil Creek Gordon Inlet Jam Creek Lake Shaster Needilup River Peniup Creek Pinjalup Creek Slab Hut Gully SLEEMAN RIVER Torradup River Towerlup River Uannup Brook Wadjekanup River Yallabup Brook
	Low Long term >2075 Or already impacted significantly	Alexander river Big Creek Black Cat Creek – Moates Lake Bluff River Broke Inlet Copper Mine Creek Cordinup River Deep River Dempster Inlet Dempster River Eyre River Forth River Gardener River Goodga River – Moates Lake Hammersley Inlet Inlet River King Creek King George Sound Mullocullup Creek Princess Royal Harbour Fitzgerald Biosphere Shannon River Thomas River Walpole River Waychinicup River Willyun Creek Wonderup Creek	Blackboy Creek Coramup Creek Duke River Fern Creek Fitzgerald Inlet (ANCA) Gentle Creek Jenamullup Creek JERDACUTTUP LAKES Lake Muir (ANCA) Lort River Mungliginup Creek Neridup Creek Phillips River Steer River Sussetta River Weamerjungup Creek West River Young River Hay River	CHEYNE INLET Jackitup Creek Martaquin Creek Moolyall Creek Six Mile Creek Warperup Creek

Water Supply South Coast		Value		
		High	**Medium**	**Low**
Threat	**High** Existing and/or near and substantial <2020	Albany (RIWIA) Armstrong spring & weir (PDWSA) Blackwood (RIWIA) Esperance (RIWIA) Esperance WR (PDWSA) Grass Patch CA (70km N of Esperance) (PDWSA) Marbelup Bk WR (PDWSA) Quickup River Dam CA (PDWSA) Ravensthorpe CA (PDWSA) Salmon Gums CA (100km n of Esperance) (PDWSA)	Gibson WR (25km N of Esperance) (PDWSA) Lake Seppings CA (Albany) (PDWSA) Private drinking sources e.g Carey Bk on Donnelly R, East Bk, Smith Bk, Treen Bk, & Wilgarup R on Warren R, Fly Bk on Donnelly R (Health Act)	
	Medium Intermediate time and/or not that greater extent 2020-2075	Angove Creek CA (PDWSA) Bolganup Creek CA (PDWSA) Denmark River CA (PDWSA) Dumpling Gully on Blackwood R (PDWSA) Gnowangerup CA (PDWSA) Kent River CA (PDWSA) Limeburners Creek CA (PDWSA) SC WR (PDWSA) Scotsdale Brook CA (PDWSA) Walpole CA-Butlers Creek (PDWSA) Tambellup Dams on Frankland R (49km S of Katanning) (PDWSA)	Barlee Bk- Donnelly River (PDWSA) Bremer Bay (RIWIA) Bremer Bay WR (PDWSA) Condingup WR (65km E of Esperance) (PDWSA) Deep River CA (PDWSA) Frankland WR (PDWSA) Hopetoun (RIWIA) Hopetoun WR (PDWSA) Jerramungup Dams Munglinup WR (80km E of Ravensthorpe) (PDWSA) Northcliffe WR (PDWSA) Private stock & irrig'n sources (RIWIA) SC	
	Low Long term >2075 Or already impacted significantly		Private sources for industry & commerce (RIWIA) Private sources for landscape and recreation irrig'n (RIWIA) SC	Gibson (RIWIA) Kondinin-Ravensthorpe (RIWIA) Quickup River

Aquatic Assets and Fish Resources (South Coast)

Fisheries Assets South Coast		Value		
		High	**Medium**	**Low**
Threat	**High**	Freshwater fish (SC,SW,NA)		Ports (small)(all regions) Ports (large)(all regions)
	Medium	Marine fish stocks(all regions) Estuaries (remote) Coastal waters (offshore 3 nm) Recreational Marron (NA, SW, SC, Swan) Abalone (R, NA, Swan, SW, SC) Tailor (R, NA, Swan, SW, SC)	Shark stocks(all regions) Minor Scallops South Coast Trawl (SC) Demersal Gillnet and Demersal Longline (DGDLF) (SC) Marron Farming (NA, Swan, SW, SC) Yabby Farming (NA, Swan, SW, SC)	Ornamental Fish Farming (Swan, NA, SW, SC)
	Low	Inshore reefs (R, NA, SC, SW) Greenlip and Brownlip Abalone (SC) Roe's Abalone (SC) Recreational - Kimberley and Pilbara Regions (R) Recreational - South Coast (SC)	Coastal waters (offshore 12-20 nm)(all regions) Coastal waters (offshore 3 – 12 nm)(all regions) Mussel Farming (SC, Swan) South Coast Rock Lobster (SC) Freshwater Angling (All Regions)	Lower West Coast Beach and Embayment West Coast Beach Bait (Fish Net) (NA, Swan, SW, SC) South Coast Estuarine (SC) Western Australian Salmon (SC) Australian Herring (SC) South Coast Purse Seine (SC) Coastal aquaculture: pearl and pearl oysters + others (NA, SC) Trout Farming (SC, SW)