NOTE: This appendix forms part of a much larger report on the Salinity Investment Framework being prepared by a State Steering Committee, chaired by Rachel Siewert, working under the auspices of the Natural Resource Management Council. The larger report deals with priority setting for land, water, biodiversity and social assets.

Salinity Investment Framework

APPENDIX 2

Identification and Ranking of Important Biodiversity Assets – South West Agricultural Region

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CONTENTS

INTRODUCTION

Background to the Salinity Investment Framework

The Salinity Investment Framework (SIF) was developed by the State Salinity Council to ensure that funding for salinity projects is distributed at State, regional and catchment scales to projects which best protect assets of high public value. To evolve the SIF into an effective operational tool it is being developed and tested at two scales: across the whole south west agricultural zone for assets of State significance; and within the Avon Basin for assets of regional significance.

The SIF established a six-step process for setting priorities:

1. Set broad objectives and goal;
2. Assess assets and risks;
3. Set specific goals for action;
4. Assess options;
5. Set priorities; and
6. Take action.

In this particular project we only dealt with steps (1) and (2).

The Department of Conservation and Land Management (CALM), as the key State agency for biodiversity conservation, is involved in both the State and regional level projects developing the SIF. This paper describes the method developed by the Department to identify biodiversity assets that are, at a State level, a high priority for public funding in relation to salinity management.

The State level component of the project aimed to identify the most important biodiversity assets within the south west agricultural zone from the perspective of the State community. This latter point needs some explanation.

During the project, problems arose because the various interests of local, regional, State and National communities have not always been recognised or articulated with regard to setting priorities among natural resource assets. That these interests will sometimes be consistent, and at other times compete, has also not always been recognised. It is important to emphasise that, as a State agency, CALM's responsibilities[1] are to the State community[2].

While the State level biodiversity conservation component of the SIF was developed, three related projects were also in progress. Firstly, a parallel project on the regional scale application of SIF is progressing with the Avon Catchment Council. This work will be reported separately. Secondly, planning work is underway to underpin CALM's Wheatbelt Regional Plan (Wallace *et al.* in draft). This work has contributed to the development of the biodiversity conservation component of SIF, and many of the matters described in the draft work are relevant to this document. Thirdly, regional planning on a draft set of targets for the Avon Catchment Council (see Wallace *et al.* 2002a) also provided an important opportunity to test and develop some of the ideas used in the SIF.

The strong interaction of the SIF work with other projects emphasizes the importance of collaboration in developing effective priority-setting processes. Work to date has also confirmed the iterative nature of priority setting for biodiversity conservation. That is, the methods proposed here will change and develop with new knowledge and ideas.

As the project evolved, a number of fundamental questions were addressed to enable the development of a method for identifying and ranking important biodiversity assets in the south west agricultural zone. The two most critical issues were:

1. Defining natural biodiversity; and

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[1] These responsibilities are outlined in legislation and managed by a State Minister of the Crown.

[2] The term "community" is used in many ways. By State community, we recognise citizens of Western Australia (people on the State electoral role) and their children

2. Describing why natural biodiversity is important.

These two issues, and the geographic area for the project, are dealt with in the remainder of this section.

Geographic boundaries of project for biodiversity conservation

The analyses conducted for this project were restricted to the south west agricultural zone. It should be noted that, while State forest, nature reserves and national parks subject to the current forest management planning process, and the Swan Coastal Plain portion of the Perth Metropolitan area were both included in this analysis, they will be excluded from further analyses and priority setting because:

1. They are already subject to a rigorous biodiversity conservation planning process involving significant resources; and
2. Government has already made decisions concerning the future management of these areas.

Finally, it is important to emphasise that while the Department manages large areas of natural environments, mainly bushland and wetlands, in the south west agricultural zone, this priority setting process is designed to incorporate all biodiversity assets, irrespective of the tenure on which they occur.

What is biodiversity?

During the development of SIF it became apparent that there are a number of ways to define biodiversity. Because the definition of biodiversity defines what is to be managed and conserved, it is essential to be clear on how the term is used.

The definition of biodiversity in *The National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996) – a document that has been endorsed by the Commonwealth and all Australian state governments – is:

> "The variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form." [Note that this definition is taken from the Glossary of the report – this differs slightly from the definition given in the introduction of the same report.]

However, in developing our investment framework we have not included the non-living parts of ecosystems in the definition of biodiversity, as they are not tangible, biological entities. To include abiotic components in the definition of biodiversity would have caused several problems.

Firstly, it is difficult to develop effective classification systems when different types of entities – in this case tangible biological entities and intangible processes – are included together. Secondly, defining biodiversity assets (see section below on Assessing Assets and Risk) is more appropriately linked to tangible entities. Thirdly, the most readily monitored outcomes of natural biodiversity conservation will be the persistence in natural (or near natural) environments of viable populations of living organisms. The latter point also reflects that there are circumstances under which ecosystem processes might be conserved, but all the native biota may not.

Thus in defining biodiversity assets, we recognized the following as important elements of biodiversity:

- Genetic diversity;
- Species diversity;
- Natural assemblages of living things (such as communities, or the living components of a specific ecosystem); and
- Structural diversity of the above three components.

Adopting this approach, ecosystem processes are dealt with as elements that must be managed to conserve biodiversity assets. Thus ecosystem processes are critical (through threat analyses) for planning and implementing biodiversity conservation.

Note also that we only deal with natural biodiversity in this report. That is, native plants, animals and other wildlife. We excluded non-native plants and animals – such as cows, sheep, foxes, and cereal crops – from

consideration. However, throughout the rest of this report the term biodiversity is used as shorthand for natural biodiversity.

Why is biodiversity important?

During work on SIF and other planning projects, we found that it was essential to be clear on why biodiversity is important, as this has important implications for goal setting and the definition of assets. There are many ways for describing how conservation of biodiversity is critical to protecting an important range of human needs. The structure of human needs, or values, used in this project is briefly summarized in Table 1. This is one of many ways of classifying human values. Issues relating to these points are explained in more detail in Wallace *et al.* (in draft).

Table 1: Contributions of biodiversity to human values.

Human Value	Examples of the contribution of natural biodiversity to human values in the agricultural area of south west WA
Consumptive Use Values	These include the values of natural products that are harvested for domestic use and that do not pass through a market. For example, farmers' use of on-farm timber from native vegetation for fencing, firewood, etc.
Productive Use Values	Are the values of natural products that are harvested commercially. Examples include timber harvesting, use of kangaroos for hides and pet meat, wildflower harvesting.
Opportunity Values	The native flora and fauna of the south west are unique. The flora, in particular, is renowned internationally for its diversity. This diversity represents enormous potential for the development of new products, including industrial and medicinal products.
Ecosystem Service Values	Are those values that contribute to the maintenance of our environment and ensure that life can persist. For example, the role of wetlands and their native plants and animals in flood mitigation and nutrient stripping, the contribution of native vegetation to water use and erosion control, the role of native animals in pest control.
Amenity Values (including aesthetics)	The amenity values of biodiversity in agricultural areas include pockets of bushland around houses and yards that provide shade, shelter from wind, and aesthetic values. Road verge vegetation provides important aesthetic values.
Scientific and Educational Values	For example, areas of native vegetation are essential if we want to understand our land and how it works. For our children to understand the future and how to manage for it, they need to understand the past. Many institutions use areas of natural lands for educational purposes. Another example is that native vegetation provides the only source of reference material if we wish to assess how agricultural practice has affected soil structure and other properties.
Recreation Values	The enormous importance of natural environments for recreation and tourism is well known. Research links recreation in natural environments to both physical and mental health.
Spiritual/Philosophical/Moral Values	While not an area that is often discussed, there are many ways in which natural environments are an important part of our spiritual and moral framework. In many areas, the strong association between communities and particular patches of bush, granite outcrops, or lakes often shows this. Also, there are many people who feel that other living things have the "right" to persist – this reflects deeply held spiritual/philosophical/moral values.

In this particular work, we have focused on identifying the biodiversity assets to meet human values related to:

- Opportunity values;
- Ecosystem service values;
- Amenity values;
- Scientific and educational values;
- Recreation values (but restricted to passive recreation, such as picnicking and birdwatching, as these are most compatible with conserving biodiversity); and
- Spiritual/moral/philosophical values.

If these values are not adequately reflected in the broad goal and assets (see below), then it is essential to change one or more of: the values targeted, broad goal, or assets.

METHODS

This section deals with how we identified the most important biodiversity assets threatened by salinity. It is stressed that the aim of this work was to select the most important biodiversity assets that require urgent management with respect to salinity – we have not aimed to describe and rank every important asset.

The method used to identify biodiversity assets is consistent with the process outlined in earlier documentation of the SIF. In particular, we have used a broad goal to identify the relevant assets. We have also dealt with viability/risk analysis in regards to salinity. However, a more comprehensive viability analysis can be undertaken provided there is sufficient interest in the methods described below.

Broad goal (Step 1[3])

The relevant goal in the *State Salinity Strategy* was taken as a starting point for the development of a broad goal. The relevant statement in the strategy is:

> "To protect and restore high value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the region." (State Salinity Council 2000)

However, as this goal also includes physical diversity – such as rocks, hills and so on – as well as biodiversity, we used the following CALM goal that relates only to biodiversity.

> "To protect, conserve and, where necessary and possible, restore Western Australia's natural biodiversity". (Corporate Plan 2002-2005 Department of Conservation and Land Management)

This goal is consistent with the *Salinity Strategy* goal. During the development of SIF and other, similar work, the pivotal role of goal setting in the process of defining assets was reinforced. Also, it is important that the goal reflects the human values it seeks to address (see Table 1 and accompanying text).

Finally, for this work we aimed to apply the broad goal to the south west agricultural region, with a timescale of 50 years[4].

[3] Step numbers refer to those used in the Project Management Brief dated 19 June 2002.

[4] While longer would be desirable, 50 years represents the longest planning horizon we could be expected to sensibly consider to achieve the broad goal. However, this timescale is well within the return times of important natural cycles. Therefore, it would be desirable to plan over much longer periods – these issues were left to consideration of specific threats.

Assessing Assets and Risk (Step 2)

Assessing Assets

Definition and Description of Assets

An asset is defined as "a useful or valuable thing or person" (Concise Oxford English Dictionary). In this part of the SIF project, an asset is therefore a valuable thing in the context of the broad goal and values to humans of biodiversity described above. More specifically for this work, assets are biodiversity elements that occur at a specific site (can be at a range of scales) and are valuable to the State community. Given the broad goal used, and the wide range of human values attached to this goal, the sum total of biodiversity assets is taken to be every living individual of the State's biodiversity. It should also be noted that, in some cases, the scale of management required to conserve an asset is larger than the asset itself. For example, where a biodiversity asset is a living assemblage occurring in a wetland, the scale of management will generally be a catchment. Matters such as this have important implications for how assets are described and evaluated.

As this work is about establishing priorities for the investment of resources, the next question we asked is: What specific biodiversity assets do we need to protect, conserve and restore as priorities to meet the goal? In answering this question, we were conscious of the need to focus on specific biodiversity assets (living things valuable to humans), and deliberately excluded the environment[5] of biodiversity assets. In this sense, particular environments are needed to conserve particular biodiversity assets, but are not themselves the asset. (For a more complete explanation of this and related issues see Wallace *et al.* in draft.)

Also, it should be stressed that generating a list of asset categories will inevitably exclude elements of the State's biodiversity as defined above. That is, the listing of asset categories is effectively the first act of priority setting.

The draft list of biodiversity categories developed included a long list of things such as:

- Rare[6] native plants, animals and other organisms;
- Rare ecological communities;
- Representative samples of native plants and animals (including common species);
- Plants/animals at the limits of their natural range;
- Uncommon genetic variants;
- Unusual living assemblages;
- "Ancient" species;
- Living natural assemblages that have high levels of biodiversity and/or endemism; and
- A living assemblage that represents a local ecotype.

From work to date it is apparent that a more comprehensive definition of biodiversity assets is required, and a consultant is currently working on this issue. For example, obvious gaps in the asset list include the need to either better reflect amenity and ecosystem service values, or to acknowledge that they are two human values not fully represented by the broad goal and asset list. When these matters are examined, it is likely that additional criteria, such as replication of assets, will be included when assessing current importance as well as viability.

Despite the need for further work, the biodiversity asset categories above provided a useful basis for progression to the next stage of analysis

[5] In this context we propose that the terms "environment" and "habitat" are synonymous.

[6] The term "rare" is generally used for something that is uncommon or unusual. This is the sense in which it is used here, and not the statutory meaning defined under the *Wildlife Conservation Act 1950.*

Evaluation of Assets - Current Importance

Background

In this work we have deliberately separated questions about the current importance of an asset to goal achievement, from questions concerning the long-term viability of that asset. While it is difficult to do this, it is important because:

i. We must be clear on what are the really important assets, independent of viability. If important assets are recognized as unviable, they tend to be intuitively accorded low importance, irrespective of their actual importance. This may result in important assets being ignored, or accorded inappropriately low priority;
ii. Some factors affecting viability, such as lack of knowledge or socio-political support to supply resources, can rapidly and unexpectedly change. Being clear about current importance places managers in a much better position to take advantage of changing circumstances; and
iii. A well-constructed framework for valuing assets encourages criteria development and transparent processes. Separation of current importance from viability is an important element of such a framework.

Of the asset categories listed in the previous section, the three typically used in the past as drivers for biodiversity conservation are:

1. Rare species;
2. Rare communities (of plants and animals); and
3. Areas that provide good representative samples of biodiversity. In more recent times, this can be equated to the goal of developing a system of conservation areas that is comprehensive, adequate and representative. Given that the definitions of comprehensive and representative overlap (Conservation Commission of Western Australia 2002), and adequacy is about viability (treated in the next section), this asset in simple terms relates to representative samples that reflect the diversity of regional ecosystems, and the variability within them. However, effective networks of natural environments for conservation will necessarily include important biodiversity assets on freehold lands. In this regard the concept of a comprehensive, adequate, and representative reserve system is too limiting for SIF. Thus in this project we have focused on identifying important, representative samples of biodiversity wherever they occur.

These three asset categories, by and large, contribute the most towards conserving biodiversity[7]. Therefore these three categories were selected for this analysis as the biodiversity assets that will make the greatest contribution to achieving the biodiversity goal provided above. To rank these types of assets we considered criteria based on the attributes of rareness, specialness (in the sense of icon species, living assemblages that reflect biodiversity hotspots or endemism, Gondwanan relics, etc.) and representativeness. Rarity and representativeness were the particular asset attributes used in this work to rank assets – "specialness" is a concept that needs to be further developed in relation to evaluating other asset types.

As asset types (1) to (3) do not fully represent the draft list of biodiversity assets, nor do they reflect other types of biodiversity assets that may be needed to meet the human values listed as important, work continues on defining assets. As noted above, a consultant is currently undertaking the initial work to better define and describe assets. This issue is also discussed again under the section below titled "Other assets of biodiversity importance".

Current importance – rare species and communities

In the case of rare species and communities, there are existing, well-documented processes for ranking their importance for biodiversity conservation (Attachment 1). While there are issues about better separating current importance from viability, the existing processes were accepted for the SIF as sound and useful. They are not considered further here.

[7] As might be expected, a skim through how biodiversity conservation priorities have been developed historically is consistent with these three assets providing the most important contribution to conserving biodiversity.

Current importance – representative samples

With regard to the definition and ranking of representative samples, available processes are less clear. There has been considerable research on the topic (see, for example, Burgman and Lindenmayer 1998), and criteria have been developed in the case of Western Australian forests (Conservation Commission of Western Australia 2002). All of these methods require a level of biodiversity information that does not exist for most of the south west agricultural zone, although this situation will improve considerably when results from the recent biological surveys have been fully analysed (Keighery and Lyons 2001, Keighery 2002).

Until our knowledge improves, the project group developed the following process for identifying important representative samples of biodiversity within the south west agricultural region.

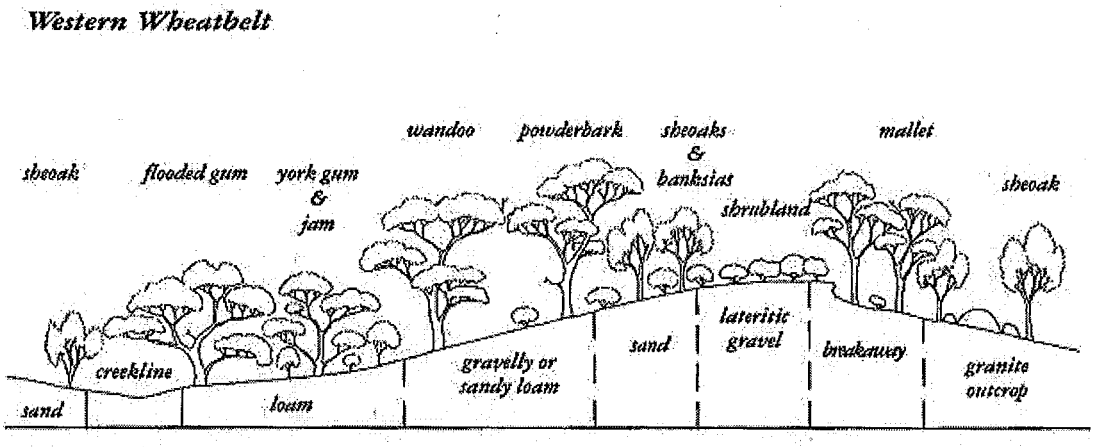

Figure 1: Idealized cross-section of wheatbelt landscape (taken from Bamford 1995, page 12).

Figure 1 shows an idealized cross-section of a wheatbelt landscape. While the figure shown is more typical of the western wheatbelt, a similar pattern is recognizable throughout most of the south west agricultural zone. At the very least, a representative sample of local biodiversity would need to sample the full range of soil-landform-vegetation types shown by this pattern. Not only does this diagram indicate the range of soil-landform-vegetation types that need to be sampled, it also emphasizes the need to identify representative samples at landscape scales.

While the distance over which this landscape sequence is broadly repeated tends to be shorter in the west and south, and longer in the east and north, in the central wheatbelt it rarely occurs (in its full expression) inside 10 kilometers – that is, roughly 10,000 ha. (This assessment is based on rough measurements of several ridge-to-ridge distances along the Great Eastern Highway between Northam and Kellerberrin, with adjustments based on how many of the soil-landform-vegetation elements were missing.) Thus a minimum landscape-scale sample size should be 10,000 ha or more to provide a reasonable probability of sampling the full range of soil-landform-vegetation types.

At the same time, the high species turnover of plants between sites in the agricultural region (Burgman 1988, Brown 1989) means that, if one wants to sample living assemblages of plants (and presumably the related fauna), representative samples must occur within relatively short distances. Burgman calculated for his study site that this distance is 15 kilometers. If this result is transferable elsewhere in the agricultural region, it suggests that, to sample assemblages of plants, sample sizes should be less than 18,000 ha (area of circle with a radius of 7.5 kilometers is about 17,700 ha).

Given the preceding, it was felt that sampling the agricultural region using 10,000 ha polygons was a reasonable, first up basis for selecting representative samples of biodiversity in the region. This does not necessarily apply in other landscapes.

At the same time, in Figure 1 there are eight landform/soil components across the catena, each of which typically carries a particular range of vegetation and other habitat components. One could expect at least three major variations within each of these eight landform/soil units, thus giving 24 elements overall. Assuming, conservatively, that one needs a minimum of 100 ha per element to capture species, genetic and structural diversity, one would need a minimum of 2,400 ha for each landscape unit of 10,000 ha to contain a representative sample of the biota. This equates to about 25% of the landscape unit, and given the turnover and species diversity of wheatbelt landscapes, is a very conservative estimate.

This estimate is very conservative, and is based on a number of assumptions that are rarely met in reality. For example, it was assumed that remaining natural environments in each locality sample the full range of soil-landform-vegetation complexes. This assumption is rarely met in reality. Again, this serves to emphasize that the argument developed here is very conservative – generally much larger areas of natural environments are required at the landscape scale merely to adequately sample biodiversity, irrespective of the issue of viability.

Despite the limitations of the above approach, the project group considers that it provides a useful starting point until more information becomes available and the concepts used may then be further developed. Therefore, this method of identifying landscapes that are likely to contain important representative samples of biodiversity was used in the current project. These landscapes were named target landscapes; a sub-set of representative landscapes, and a description of how they were selected is given in Attachment 2.

Additionally, there are a number of landscapes that have been identified through past work as containing very important samples of wildlife. These areas include:

a. Natural diversity recovery catchments that have been formally endorsed and funded on the basis of their importance for biodiversity and high level of threat from salinity.
b. Potential natural diversity recovery catchments. These have been proposed by experts (Dr G Keighery and Mr M Lyons) on the basis of their importance for biodiversity and high level of threat from salinity.

Most of the areas identified in (a), and all of those in (b), are based on preliminary results from the recent biological survey of the agricultural area (Keighery and Lyons 2001, Keighery 2002). It is emphasized that the potential natural diversity recovery catchments may, following a more detailed analysis of their importance, be downgraded in rank. Thus it is critical to note that they are potential, not proposed, natural diversity recovery catchments.

It should also be noted that, while one would not normally amalgamate two data sets generated by different methods, it was important in this instance to combine the results from both processes. A high priority for further development of this work is to integrate both processes.

Thus, the final list of areas that we considered would provide good, representative samples of local biodiversity combined:

i. Landscapes >10,000 ha that had 25% or more of their area in natural vegetation (area in natural environments would have been the preferred data set, but there are currently none available);
ii. Natural diversity recovery catchments; and
iii. Potential natural diversity recovery catchments.

In the case of (i), the landscapes selected were ranked according to:

- Amount of native vegetation remaining within their boundaries;
- Counts of rare/threatened species and threatened ecological communities (used as a measure of biological diversity. The greater the number of these, the more biodiverse the local area is likely to be); and
- Measures of wetland importance (Ramsar, Nationally Important, etc.). This was the best mechanism available for assessing wetland environments.

A full description of the ranking process is given in Attachment 2. Note that attempts were made to use the data of Beard as upgraded by CALM and the Department of Agriculture (Beeston *et al.* 2002) to provide a better measure of diversity, however, no useful method could be developed in the time available.

In the case of (ii) and (iii), the ranking process was undertaken by Dr G Keighery and Mr M Lyons, research scientists with CALM (see also comments above).

It is emphasized again that while the criteria and methods described above provide a valuable starting point for priority setting, they are inadequate in the longer term. Considerably more work is required to develop a more complete method based on a range of criteria. Despite this, the project group is satisfied that the general framework is sound, and should be broadly applicable across bioregions with appropriate adjustments to criteria.

Assessing Risk

Background

To undertake a risk assessment for the biodiversity assets defined above, the project group proposed to deal with three groups of issues that, taken together, measure the longer-term viability of assets:

a. Existing biological and physical threats: in this work, only the threat posed by salinity was assessed. However, there are many other important threats that affect the viability of assets, and some significantly interact with salinity. Thus, a more comprehensive threat analysis is required in developing priorities beyond those tackled in this paper. Specifically, this would pick up the range of threats listed in Attachment 3.

b. Our knowledge and technical capacity to manage threats: in many cases, we do not have the knowledge or technical capacity to manage particular threats. For example, while we have a general understanding of the development and management of salinity, we do not have sufficient knowledge of how revegetation interacts with salinity, nor do we have the technologies to cost-effectively manage discharge.

c. Socio-political capacity to manage threats: while in some cases we know how one might better tackle a particular threat, there may not be the local support, or the State level support, to apply the necessary resources. These are examples of socio-political issues. (Sometimes the solution to a socio-political issue is to change the knowledge or existing technology in a way that makes a known technological fix economically viable.)In this particular work, only the risk of salinity was taken into consideration for the representative landscapes, and a less than complete range of threats in the case of rare species and communities. As noted above, this places limitations on this work, and (a) to (c) would all need to be addressed to develop a final list of priorities for landscapes.

Viability, salinity risk, rare species and communities

Rare species and communities were assessed using standard procedures (Attachment 1). Where the threats are sufficiently high, rare species and communities are accorded various levels of threatened status. To assess the salinity risk to threatened populations, GIS was used to intersect salinity risk as defined from Land Monitor, with the locations of threatened species and communities. The output is species and communities that are at risk from salinity. See Attachment 2 for more details.

Viability, salinity risk, representative landscapes

The salinity risk to representative landscapes was also assessed using Land Monitor salinity data within a GIS. Risk was quantified as the area of remaining vegetation within a representative landscape that was at risk of salinisation but not yet salt effected. See Attachment 2 for more details. Note that the high salinity risk to existing and proposed natural diversity recovery catchments was identified when they were assessed.

As noted previously, to improve the current work it would be essential to consider the full range of threats, to evaluate our technical capacity to manage threats, and to assess our socio-political capacity to implement management works. While salinity was the only threat considered in relation to the representative landscapes selected in this project, it should be noted that the 25% rule used in this work has been used

elsewhere (Wallace *et al.* in draft) as a measure of viability in relation to the threat of "insufficient resources to maintain viable populations" (see Attachment 3).

Other assets of biodiversity importance

The assets described above, namely rare species and communities, and representative landscapes, do not cover all the important assets that need to be protected, conserved or restored to meet the broad biodiversity conservation goal. However, they provide a valuable starting point, and are those assets that will contribute most to achieving the goal.

In the original documentation proposing the broad methods for assessing biodiversity conservation priorities (Wallace *et al.* 2002b), it was stated that:

> "Given the limited human resources available for management, it is important to acknowledge that priority setting processes will result in many areas and biological assets not receiving a high priority ranking. This does not mean that they are unimportant for biodiversity conservation, but that either they are considered so resilient they currently need little management, or that they are not going to provide as large a conservation return for resources allocated as the selected priorities. In other cases sites may have so little probability of retaining their value in the longer term that they will not be considered for funding.
>
> However, as knowledge and technical capacity improve, or if additional resources are allocated to management, then the number of intensively managed biological assets may be expanded.
>
> Furthermore, it is important to allocate some resources to slowing the rate of biodiversity decline outside selected priorities. This acknowledges both the importance of many (non priority) remnants of natural habitat to biodiversity conservation, and the value, from the viewpoint of socio-cultural change, of engaging a wide range of land managers in conservation activities.
>
> Thus it is important that some funds are allocated to areas outside the priorities selected from the process described below. Vehicles for such programs already exist in the work of Land for Wildlife and other State schemes and management by agencies, and further State and Commonwealth programs may be developed through natural resource management regional groups. Other organizations, such as World Wide Fund for Nature and Greening Australia (WA), may also provide programs."

Later work served to emphasize, rather than diminish, these points. Therefore, the project group recommends that the State community should continue to support, through State agencies, the conservation of important natural environments outside the priority areas listed by the SIF. These not only include a wide range of existing conservation reserves and other Crown lands, but also natural environments on freehold land.

Important changes required to greatly improve the current system in this regard relate to:

- Better defining and describing assets. While the three asset categories used in this analysis are likely to contribute most to biodiversity conservation, there are many other assets that are essential to achieve the broad goal, and many of these asset types occur as remnants of natural environments;
- Ensuring that the value of all lands, including Crown lands, are adequately recognized in funding allocations. There is a risk, for example, that freehold natural environments will be provided with government funds for management ahead of more important Crown land. This would not be consistent with meeting the broad conservation goal stated at the outset;
- Developing improved methods for ranking natural environments for biodiversity conservation. This will involve, in particular, methods that integrate criteria for assessing areas of natural vegetation, wetlands, rock outcrops, caves and other important categories of natural environment. The qualities of rareness, specialness and representativeness are likely to again provide the criteria for evaluation, with specialness being of particular importance; and
- As far as practicable, allocating resources across the priority areas in a way that best meets the broad goal of biodiversity conservation.

RESULTS

Representative landscapes

Using the methods described above and in Attachment 2, representative landscapes were derived and rated in relation to their biodiversity importance and their level of threat from salinity. This information was further subdivided into three groups – termed tiers in this work (Figure 2):
Tier 1: those representative landscapes ranked highest (rank 1) for biodiversity importance that are also highly threatened by salinity;
Tier 2: those representative landscapes ranked either second (rank 2) for biodiversity importance, or moderately threatened by salinity, or both; and
Tier 3: those representative landscapes ranked either third (rank 3) for biodiversity importance or with a low salinity threat, or both.

These tiers then present a useful starting point for allocating funds to priority public assets of this asset type. While it would be useful to have access to other information from risk analyses to provide more information on the viability of a particular landscape and the likelihood of management success, it was decided from this work that Tier 1 assets should be those assessed further, as a matter of priority, for funding.

There are a number of alternative approaches. It might be argued, for example, that landscapes ranked 1 for biodiversity, and at either moderate or low threat from salinity, should be the priority target for funding given that success in their management is more likely. However, this would effectively condemn Tier 1 assets to a low probability of retaining the full range of their current biodiversity values. On the basis of current information and the broad goal provided above, it was not considered acceptable to take this step without further risk analysis. It was also accepted that working in some of the more highly threatened areas would be more likely to deliver a better understanding of managing salinity, including the development of new technologies.

It is therefore proposed that a more detailed risk analysis be conducted for Tier 1 assets, and that they be ranked as priorities for investment in the light of this additional information. However, it should be noted that the outcome from further analyses is likely to be that particular landscapes are downgraded in priority, and others elevated.

The three tiers of landscape assets were mapped and developed within a Geographic Information System, and the resulting map is shown in Figure 3.

SOUTH WEST DIVERSITY ASSETS		BIODIVERSITY VALUE		
		RANK 1	RANK 2	RANK 3
SALINITY THREAT	HIGH	Lake Warden Kojonup - Beaufort - Carrolup River 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 Lagon Upper Lort River (possibly including Pyramid Lake) Headwaters of the Fitzgerald River Kondinin Salt Marsh Tooliban Lake Chinocup System Coyrecup Nature Reserve Mortlock River System (Northern Branch) Lake Gore Cowcowing Lake System 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	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	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

Figure 2: Representative Landscape Assets – Biodiversity Rank vs Threat Analysis – Numbers refer to specific landscape units.

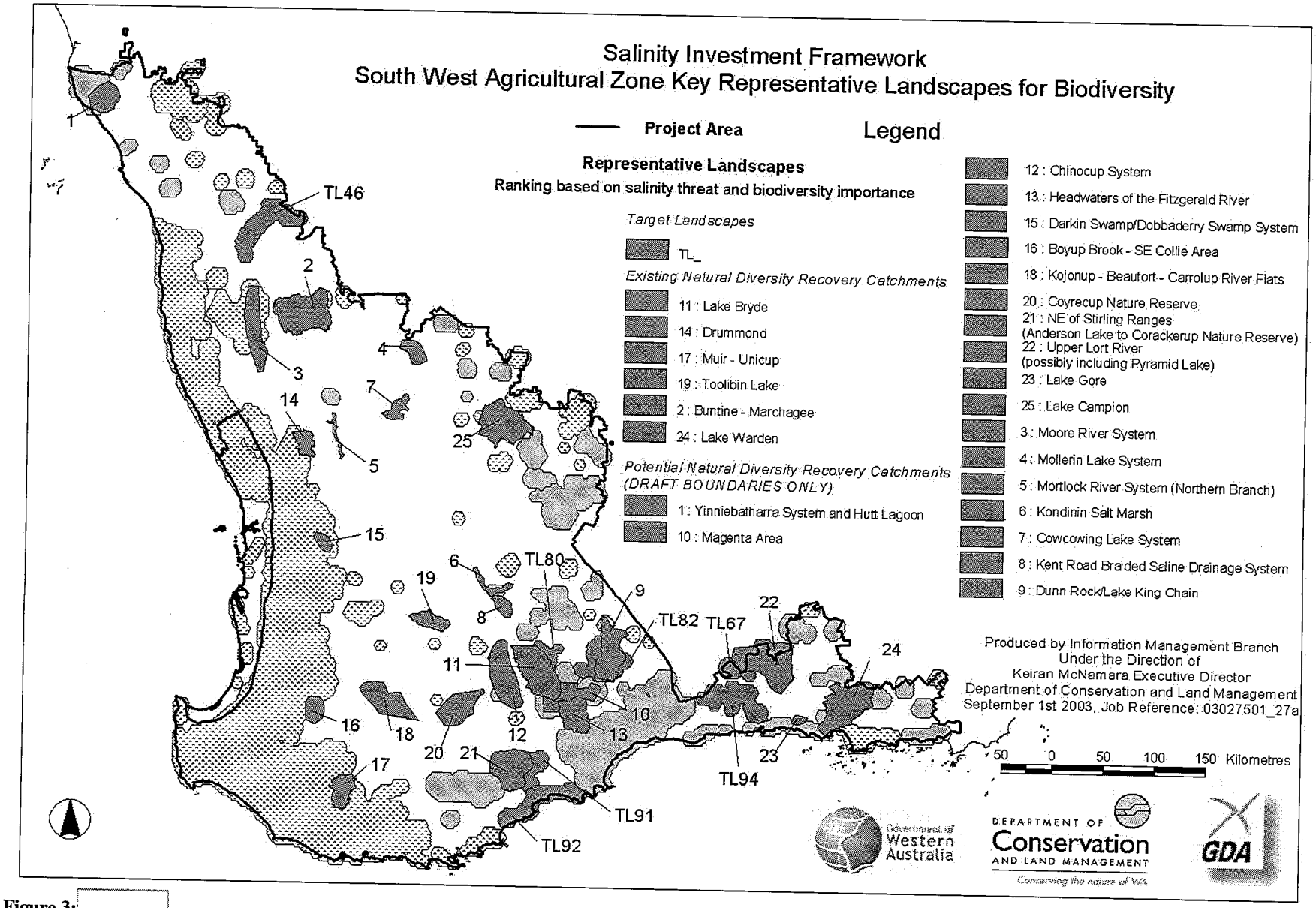
Salinity Investment Framework
South West Agricultural Zone Key Representative Landscapes for Biodiversity
Project Area
Legend
Representative Landscapes
Ranking based on salinity threat and biodiversity importance
Target Landscapes
TL_
Existing Natural Diversity Recovery Catchments
11 : Lake Bryde
14 : Drummond
17 : Muir - Unicup
19 : Toolibin Lake
2 : Buntine - Marchagee
24 : Lake Warden
Potential Natural Diversity Recovery Catchments
(DRAFT BOUNDARIES ONLY)
1 : Yinniebatharra System and Hutt Lagoon
10 : Magenta Area
12 : Chinocup System
13 : Headwaters of the Fitzgerald River
15 : Darkin Swamp/Dobbaderry Swamp System
16 : Boyup Brook - SE Collie Area
18 : Kojonup - Beaufort - Carrolup River Flats
20 : Coyrecup Nature Reserve
21 : NE of Stirling Ranges
(Anderson Lake to Corackerup Nature Reserve)
22 : Upper Lort River
(possibly including Pyramid Lake)
23 : Lake Gore
25 : Lake Campion
3 : Moore River System
4 : Mollerin Lake System
5 : Mortlock River System (Northern Branch)
6 : Kondinin Salt Marsh
7 : Cowcowing Lake System
8 : Kent Road Braided Saline Drainage System
9 : Dunn Rock/Lake King Chain
TL46
TL80
TL82
TL67
TL94
TL91
TL92
Produced by Information Management Branch
Under the Direction of
Keiran McNamara Executive Director
Department of Conservation and Land Management
September 1st 2003, Job Reference: 03027501_27a
50 0 50 100 150 Kilometres
Government of Western Australia
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA
GDA

Figure 3:

Threatened species and communities

Threatened species and communities were assessed in relation to the threat of salinity as described in the Methods section above and Attachments 1 and 2. The resulting map is shown as Figure 4.

It is clear from the map that there are many threatened species and communities that are at risk from salinity. In setting priorities within this group of assets, it would be essential to first:

1. Rank the threatened species and communities for action in line with how endangered they are (see Attachment 1); and
2. Undertake a field assessment (or preferably, obtain local advice) concerning the salinity risk to the subset of species determined from (1) above. This is necessary to confirm the level of threat from salinity. The Land Monitor data used to calculate salinity risk does not provide information concerning local hydrogeology. For example, while a plant population may occur in a valley floor threatened by salinity, the plant itself may only occur on low, sandy dunes within valley floors, and as such not be threatened by salinity. This level of discrimination is not available from Land Monitor.

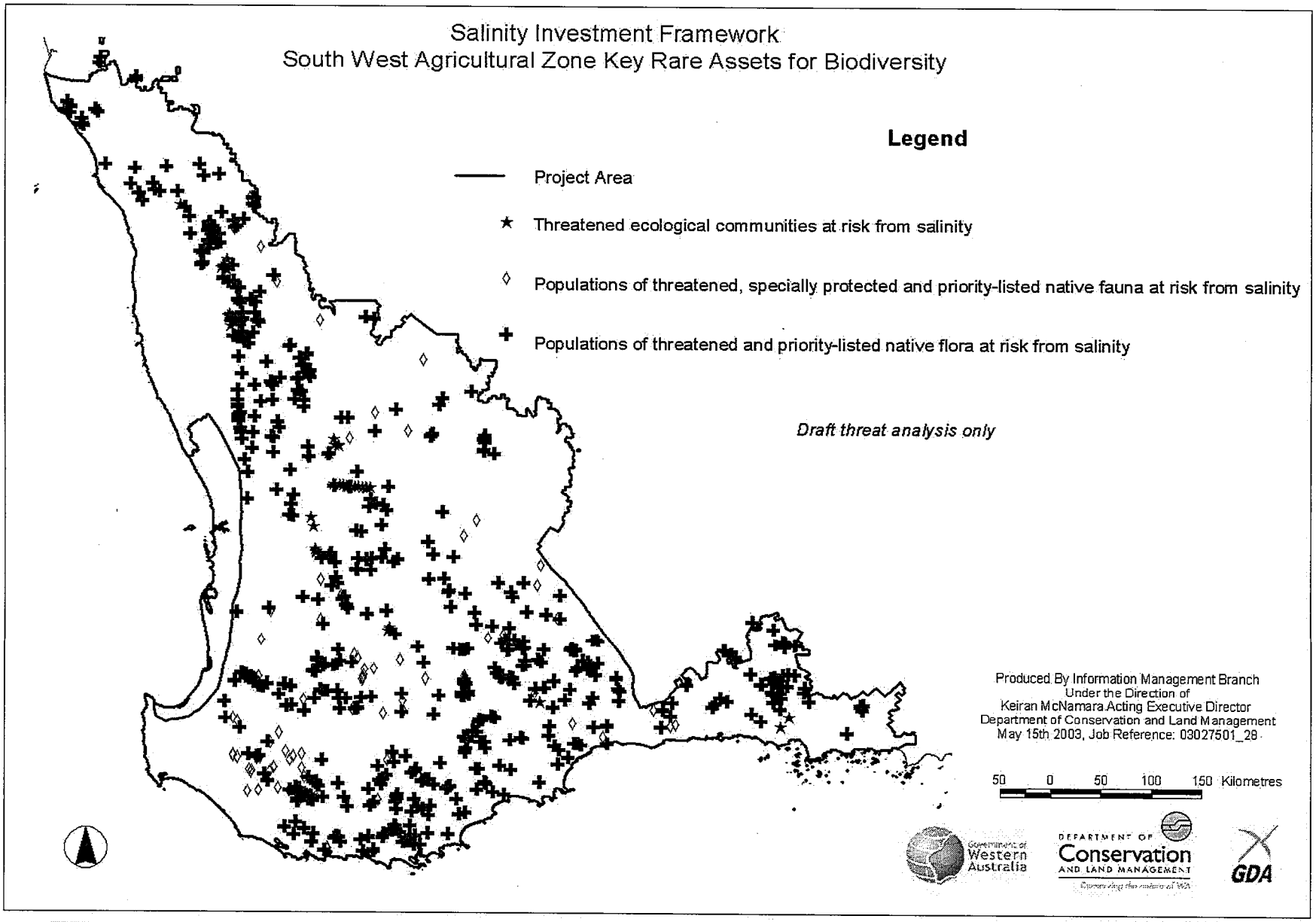
Salinity Investment Framework
South West Agricultural Zone Key Rare Assets for Biodiversity
Legend
Project Area
Threatened ecological communities at risk from salinity
Populations of threatened, specially protected and priority-listed native fauna at risk from salinity
Populations of threatened and priority-listed native flora at risk from salinity
Draft threat analysis only
Produced By Information Management Branch
Under the Direction of
Keiran McNamara Acting Executive Director
Department of Conservation and Land Management
May 15th 2003, Job Reference: 03027501_28
50 0 50 100 150 Kilometres
Government of Western Australia
DEPARTMENT OF Conservation AND LAND MANAGEMENT
GDA

Figure 4:

CONCLUSIONS AND RECOMMENDATIONS

The methods and results described above have covered the first two steps of the six steps proposed in the Salinity Investment Framework. Additionally, in the case of risk assessment, only salinity (see Attachment 3) has been considered, and this has been considered using a broad scale analysis of salinity threat that does not take into consideration local topography, hydrology and other site characteristics.

Whether steps 3-6 of the Salinity Investment Framework are completed depends on the acceptance of the work to date. If the above process (with suitable amendment) is accepted, then steps 3-6 are necessarily applied at the level of specific, individual assets that are agreed to be of high priority for action. These steps require much more site-specific work and the application of considerable resources. While ideally one would assess in detail the importance of all biodiversity assets, in reality this would be a poor allocation of resources. There are only sufficient funds to fully assess the most important and most threatened assets.

Conclusions

The project group is confident that the methods and results described above provide a useful framework and starting point for investing in biodiversity assets threatened by salinity. However, a range of issues must be addressed to improve the methods used. These issues include developing better, and more generic criteria for describing and ranking assets, and risk assessments that encompass the full range of threats. However, before embarking on this work, it is essential that stakeholders fully review the methods proposed here.

Recommendations

The project group recommends that:

1. Biodiversity assets identified in the SIF are checked and assets of equal or greater importance proposed by interested members of the Avon regional community as part of the project involving that region. For State funds, the Minister for the Environment holds the ultimate authority and responsibility for deciding priority assets. However, it is noted that there is a need to better engage the Avon regional community (work currently in progress).

2. Work continues to improve methods for describing and ranking biodiversity assets, particularly with respect to the full range of human values covered by the broad goal.

3. A high priority is given to developing a methodology and criteria that integrates priority setting across all landscape types (for example, natural diversity recovery catchments and other landscape types). This is consistent with existing recommendations in CALM's review of its salinity programs (Wallace 2001).

4. Priority setting processes for natural environments are developed for assets not included within the priority categories proposed above of rare species, rare communities, and representative landscapes.

5. The greater part of State government salinity funds for biodiversity conservation is allocated in 2003-04 to the priorities (threatened species, threatened communities, and Tier 1 representative landscapes) identified by this document. Given that the recovery of few additional landscapes can be started in any one financial year, the allocation of funds will depend on additional criteria and risk assessment to rank Tier 1 representative landscapes in order of priority for action. In the case of threatened species and communities, those that are critically endangered and threatened by salinity are the recommended priority for action. (Note, there are technical issues that need to be resolved before the threatened species and communities data can be fully integrated with Land Monitor data.)

6. Depending on the final outcome of SIF work with the Avon Catchment Council, results from this work are extended to other regional NRM groups.

It must be emphasized that priority setting is a continuing process that must be reviewed on the basis of new knowledge and technical information. Some of the above recommendations reflect the need to begin now

the process of review, both of this methodology and of the allocation of specific priorities. Either re-allocation of existing funds, or allocation of new funds, will be needed to develop and implement SIF processes.

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ATTACHMENT 1

Processes for Selecting Threatened and Specially Protected Native Species

[This Attachment was originally prepared for a document dealing with goals and targets in the Avon Region. A Sub-Committee of the Avon Catchment Council prepared the document]

Under State legislation there are statutory mechanisms for formally listing various categories of threatened native flora and fauna. For listing of both flora and fauna the process is:

1. A species or other taxon is nominated for listing. Any person or organization may nominate a species for listing; however, certain information is required (see below).
2. Once a year, the schedules of threatened flora and fauna are considered by the WA Threatened Species Scientific Committee (TSSC). There is a public advertisement for membership of this committee which is appointed by the WA Minster for the Environment. At this meeting nominations for listing and de-listing of species are considered against specific criteria and a list of recommendations to amend the list prepared. The membership of the TSSC is given in Addendum 1.
3. Lists of recommended changes are sent to the Conservation Commission of WA for endorsement.
4. Lists of recommended changes are sent to the Corporate Executive of the Department of Conservation and Land Management for endorsement.
5. Lists of recommended changes are sent to the Minister for the Environment and Heritage for endorsement.
6. Lists, as amended, are published in the *Government Gazette.*

As an organization, the Department of Conservation and Land Management has formal procedures for ranking threatened species against each other. Generally, management efforts focus on those that are critically endangered - the most at risk category.

Additionally, a large number of native flora are under consideration for listing as threatened, and other species are known to be rare but are not threatened. The Department lists flora within each of these groups under various categories of Priority Flora (Atkins 2001).

Criteria for selecting threatened flora

According to the policy of the Department of Conservation and Land Management, protected flora may be recommended for gazettal as declared rare flora (threatened species) if they satisfy the following criteria:

1. The taxon (species, subspecies or variety) is well-defined, readily identified and represented by a voucher specimen in a State or National Herbarium. It need not be formally described under conventions in the International Code of Botanical Nomenclature, but such a description should be undertaken as soon as possible after listing on the schedule.

2. It has been searched for thoroughly in the wild by competent botanist during the past five years in most likely habitats, according to guidelines approved by the Executive Director.

3. Searches have established that the plant in the wild is either:
   a. Rare; or
   b. In danger of extinction;
   c. Deemed to be threatened and in need of special protection; or
   d. Presumed extinct.

4. In the case of hybrids, or suspected hybrids:
   a. They must be a distinct entity, that is, the progeny are consistent within the agreed taxonomic limits for that taxon group;
   b. They must be [capable of being] self perpetuating, that is, not reliant on the parent stock for replacement; and
   c. They are the product of a natural event, that is, both parents are naturally occurring and cross fertilisation was by natural means.

With the exception of one species – which is rare in WA but not in the eastern states – the State list should be identical to the Commonwealth list of threatened flora. In practice there are some differences due to delays in listing State changes on the Commonwealth list.

Criteria for selecting threatened and specially protected fauna

Threatened Fauna

The Minister may declare animals (including fish and invertebrates) that are protected fauna under the Wildlife Conservation Act as threatened fauna. Currently all invertebrates except jewel beetles (family Buprestidae) and ants of the genus *Nothomyrmecia* have been declared not protected by Ministerial notice. If any invertebrate taxa not in these groups are to be declared as threatened fauna they will first need to be protected by removal from the provisions of the Ministerial notice.

A taxon may be recommended for declaration as threatened fauna by the Threatened Species Scientific Advisory Committee if it satisfies the following criteria:

1. The taxon is part of the indigenous fauna of Australia or its external territories, and is well defined in the taxonomic literature or, in the case of an undescribed or poorly defined taxon, it is represented by a voucher specimen in a State or National Museum or some other collection recognised by the Western Australian Museum as a proper repository for taxonomic material. It need not necessarily be formally described under conventions in the International Code of Zoological Nomenclature, but such a description is preferred and should be undertaken as soon as possible after listing on the schedule.

2. It has been established that the taxon in the wild is either:
   a. presumed to be extinct;
   b. in imminent danger of or threatened with extinction, that is - it is likely to decrease in numbers and possibly become extinct if factors causing its decline continue to operate (includes taxa whose numbers have been reduced to a critically low level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction, and taxa that are not yet rare but are under threat from serious adverse factors throughout their range);
   c. dependent on or restricted to habitats that are vulnerable and/or subject to factors that may cause its decline; or
   d. very uncommon, even if widespread.

The Committee may recommend taxa if it believes that they meet one or more of the above criteria, even if insufficient information exists to accurately establish their status at the time.

Taxa may also be declared by the Minister if they have been declared to be threatened by other Australian States or Territories (including taxa on the Official List of Endangered Vertebrates of Australia and its Island Territories adopted by the Council of Nature Conservation Ministers) or are classified as threatened in a treaty to which Australia is a party. Western Australia has agreed to list all species listed under Article M of the Japan - Australia Migratory Birds Agreement (JAMBA). These birds are those on the Official List of Endangered Vertebrates of Australia and its Island Territories that do not occur naturally in Western Australia.

The status of a threatened taxon in captivity has no bearing on the above criteria.

The Threatened Species Scientific Advisory Committee may recommend that a taxon be removed from the schedule of threatened fauna where:
i) recent zoological survey has shown that the taxon no longer meets the above criteria;
ii) the taxon is no longer threatened because it has been adequately protected by habitat protection and its population numbers have increased beyond the danger point.

The Committee also prepares a "Reserve" List including animal taxa:
a. that have recently been removed from the list of threatened fauna;

b. that have a restricted distribution, are uncommon or are declining in range and/or abundance, but which do not meet the criteria for listing as threatened fauna; and
c. for which there is insufficient information for the Committee to make an assessment of their status.

The Reserve list is also reviewed at least every three years.

Specially Protected Fauna

The Schedule of Specially Protected Fauna is dealt with in the same way as the Schedule of Threatened Fauna. The criteria for addition to the schedule are the same, except for the addition of the criterion that: it has been established that the taxon in the wild is either.

a) likely to be taken because of high commercial value and the standard penalty for taking is insufficient deterrent; or
b) uncommon, but not threatened at present, but is either of commercial or intrinsic value or is perceived to be damaging a commercial or hobby enterprise, and taking may lead to the taxon becoming threatened.

The Threatened Fauna Scientific Advisory Committee may recommend that taxa be removed from the schedule of specially protected fauna where:

a. recent zoological survey has shown that the taxon no longer meets the above criteria;
b. the commercial or other incentive to take has disappeared or has been removed by some other means.

Addendum for Attachment 1

Membership List for the Threatened Species Scientific Committee

Chairman

Mr Keiran McNamara, Director of Nature Conservation, CALM

Members (Alphabetical order)

Member	*Area of Expertise for Committee*	*Professional position*
Dr Ken Atkins	Flora ecology and conservation management (especially threatened flora)	Principal Botanist, CALM Wildlife Branch
Dr Allan Burbidge	Avian fauna ecology, conservation and biogeography	Senior Research Scientist, CALM Science and Information Division
Dr Andrew Burbidge	Threatened species management (especially vertebrate animals), Chair of Commonwealth Endangered species Advisory Committee	Director, WA Threatened Species and Communities Unit, CALM
Dr David Coates	Flora conservation genetics and management	Principal Research Scientist, CALM Science and Information Division
Dr Mark Harvey	Invertebrate animal taxonomy and distribution	Curator of Arachnids, Western Australian Museum
Dr Stephen Hopper	Flora ecology and conservation management	Director, Kings Park and Botanic Garden
Dr Rick How	Vertebrate animal taxonomy and distribution	Curator of Biogeography and Ecology, Western Australian Museum
Assoc. Prof. Jonathon Majer	Invertebrate animal ecology and conservation	School of Environmental Biology, Curtin University of Technology and also Convenor of the Australian Entomological Society's Conservation Committee

ATTACHMENT 2

Implementing a Methodology for Priority Setting for Biodiversity Conservation within the South West Agricultural Zone Using a Geographic Information System (GIS)

Background

The methodology outlined here follows and further develops in part the target landscape methodology outlined in Wallace *et al.* (in draft).

Although documented here as a series of linear steps, the process is iterative and indeed steps may be run parallel or subsequent steps commenced before full completion of the preceding one.

Boundaries of the Project Area

Although identified in the preliminary process as areas for exclusion, the forested areas within the RFA boundary and those within the Perth Metropolitan area have been carried through, within this initial South west Agricultural Zone analysis, to step 4. The boundaries are the coastline and the clearing line. The delineation of the project area boundary has implications on the ultimate location of resulting target landscapes; the process run over the same general area within differing project area boundaries will possibly result in different target landscapes or landscapes with differing external boundaries.

Step 1: Establishing a broad goal

This part of the process has already been discussed in this report in some detail and little further elaboration is required here. The importance of re-affirming and refining the initial goal cannot be over emphasised, when proceeding through subsequent steps.

Step 2: Identification of South West Agricultural Zone Biodiversity Assets

Representative landscapes have been defined here as being of two types:

- Type 1 - Areas with a Minimum Specified proportion of Remaining Native Vegetation (Target Landscapes)

The definition of remaining native vegetation has been based in this process on the Department of Agriculture (DAWA) vegetation extent dataset. Some modifications had already been made to this dataset to address perceived anomalies over areas of plantation, and subsequent to this, as part of this process, a 1-hectare filter was applied to remove patches too small to provide significant habitat.

The minimum specified proportion within a 10,000 ha area varied spatially with a threshold of 40% being used along the more heavily vegetated coastal strip, and a threshold of 25% applied to the remaining fragmented portion of the project area. Some manual editing of internal boundaries occurred in larger landscapes to reduce the range of landscape sizes as a precursor to step 3.

Biodiversity assets defined in this manner are indicative areas of potential interest. The specific line boundary is based on the sampling units (hexagons). Their precise location would need to be determined through ground-truthing and broader discussion.

- Type 2 - Existing and Potential Natural Diversity Recovery Catchments

Boundaries of existing Natural Diversity Recovery Catchments already held by the Department of Conservation and Land Management (CALM) were used, whilst boundaries for potential Natural Diversity Recovery Catchments were created for this process and are draft and indicative boundaries only.

Rare species and communities have been identified in this process using existing CALM databases for declared rare and priority flora (DRF), threatened fauna and threatened ecological communities (TEC).

This definition of biodiversity assets may not be appropriate to all scales of use nor at all spatial locations. Ongoing refinement is an inherent characteristic of the process and may include the addition or exclusion of existing asset types or the refinement of types such as the variation of target landscape parameters.

Information from the Wheatbelt Biological Survey and National Land and Water Resource Audit Bioregional Biodiversity Audit were not available for guiding the definition of biodiversity assets at this stage of the process (February 2003).

Step 3: Evaluation of Assets - Current Importance

The relative current biodiversity value of each representative landscape was determined as a numeric count in the following manner:

the area of remaining native vegetation within each landscape divided by x
+
count of declared rare and priority flora species within each landscape multiplied by y
+
count of threatened fauna within each landscape
+
count of threatened ecological communities within each landscape multiplied by z
+
count of Ramsar wetlands within each landscape
+
count of nationally important wetlands within each landscape
+
count of additional wetlands of interest identified by Stuart Halse (CALM) within each landscape,
+
biodiversity importance measures derived from a preliminary analysis of data from the Wheatbelt Biological Survey.

Where x = 1,000 for assets with an area of remaining native vegetation < 100 000 ha
x = 10,000 for assets with an area of remaining native vegetation => 100 000 and < 250 000 ha
x = 100,000 for assets with an area of remaining native vegetation => 250 000 ha

y = 5 for critically endangered flora in the DRF database
y = 3 for endangered flora in the DRF database
y = 1 for vulnerable and un-ranked endangered flora in the DRF database
y = 0 for extinct rare flora in the DRF database
z = 5 for critically endangered communities in the TEC database
z = 4 for endangered communities in the TEC database
z = 3 for priority communities in the TEC database
z = 2 for vulnerable communities in the TEC database
z = 1 for lower risk communities in the TEC database
z = 0 for totally destroyed communities in the TEC database.

Established processes exist for the assessment of threatened species and communities as discussed already in this report.

It should be noted that this methodology for defining assets and the relative value of those assets is highly reliant on data availability and quality. Representative landscapes have been treated as being distinct even in instances where they are spatially coincident, and biodiversity assets located near one another may in combination be assigned quite different values than when treated separately. Additionally it does not currently include any measures of comprehensiveness, representativeness and adequacy (CAR), connectivity, fragmentation, general asset condition, and the impact of threats other than salinity on an assets value. However, it should be noted that the acceptance into the analysis of landscapes with 25 % or more of their area in natural vegetation is, itself, a measure of viability (see Wallace *et al.* in draft). Existing agency

legislative responsibilities in relation to land management and priorities and programs have not been measured against or included in this current valuation methodology. Nor has the validity and rigour of the weighting schema in particular been tested within CALM.

Step 4: Evaluating Salinity Threat (Risk Assessment)

The salinity threat to each representative landscape and rare species and community was quantified using the Land Monitor salinity and salinity risk datasets. Within each representative landscape the area of remaining native vegetation at risk from salinisation and not already salt affected has been calculated as a percentage of all the remaining native vegetation within that asset. Rare species and communities were classified as at risk of salinisation when they were coincident with the salinity risk dataset.

The Land Monitor data was used without modification and thus any calculation of risk is dependent on any limitations of this dataset in a particular location. Technical feasibility or the capacity to manage the threat were not considered, nor was the urgency or time to maximum impact.

Representative landscapes were grouped into the following classes as a means of incorporating them into the three-tiered value threat matrix:

- Value Classes

  Rank 1 representative landscapes are those that have a value score of 100 or above. Rank 2 representative landscapes are those with a value score of between 10 and 99, whereas rank 3 representative landscapes are those with value scores between 0 and 9. In this manner, approximately 25% of all these assets fall within each of the high and low classes and 50% within the medium class.

- Risk Classes

  Representative landscapes at high risk have been defined as those with 11% or more of their remaining native vegetation at risk. Medium risk representative landscapes are those with between 5 and 10% at risk, and low risk representative landscapes as those with between 0 and 4% at risk. In this manner, approximately 25% of all these assets fall within each of the medium and low classes and 50% within the high class.

After applying this approach, any existing and potential natural diversity catchments that lay outside Tier 1 were, based on expert knowledge, placed into Tier 1. In future processes it is planned to develop and use better criteria for assessing biodiversity importance so that the entire process is quantitatively based.

All biodiversity assets identified using the methodology outlined here are by definition of high value, and thus tiering of representative landscapes is a means of initial prioritisation and assets that do not fall within the high value class at this stage are medium or low only in relation to a group of assets already defined as important.

As discussed above the current threat analysis does not include timing of threat. It may not be appropriate for high value representative landscapes to be in the third tier based purely on their having a relatively small area at risk from salinisation given that that risk may be imminent. Biodiversity asset urgency data at a scale that is relevant to the landscape or smaller asset is not currently available across the south west agricultural zone.

Additionally, and as mentioned above, the spatial relationships and interdependencies between the different types of landscapes was not considered in this analysis.

ATTACHMENT 3

Categories of Threats

[Extract from Wallace *et al.* in draft – see references]

1. Altered biogeochemical processes: Management issues include:
a. hydrological processes, particularly salinity and negative impacts of drainage;
b. nutrient cycles, including eutrophication;
c. carbon cycle and climate change.

2. Impacts of introduced plants and animals: Management issues include:
a. weed eradication;
b. control of feral predators;
c. preventing the new introductions of damaging species;
d. grazing of remnants by stock.

3. Impacts of problem native species: Management issues include:
a. explosion in numbers of some parrots, due to habitat change, resulting in grazing damage and competitive exclusion of some other native species;
b. defoliation by scarab beetles and other damage by excessive numbers of native herbivores.

4. Impacts of disease: Management issues include:
a. dieback (*Phytophthora* spp);
b. armillaria.

5. Detrimental regimes of physical disturbance events: Management issues include:
a. fire regimes that lead to local extinction of one or more species;
b. cyclones;
c. drought.

6. Impacts of pollution: Management issues include:
a. herbicide use and direct impacts on plants, including effects of fungicides;
b. pesticide surfactants and impacts on vertebrate reproduction;
c. oil and other chemical spills.

7. Impacts of competing land uses. Management issues include:
a. recreation management;
b. management of agricultural impacts;
c. management of consumptive uses (wildflower cutting, timber cutting, etc.);
d. management of illegal activities;
e. management of mines and quarries on bushland.

8. An unsympathetic culture: Management issues include:
a. attitudes to conservation;
b. poor understanding of nature conservation values and their contribution to human quality of life.

9. Insufficient resources to maintain viable populations: The management issue here is:
Ensuring that there are sufficient resources (see Table 1), if threats (1) to (8) inclusive are held constant, to allow viable populations of organisms to persist. This includes sufficient space for habitat replication so that disturbance regimes, see threat (5) above, may be managed. Revegetation to create buffers and corridors, habitat reconstruction, and regeneration of degraded areas are important management techniques in this context.