Sustainable development in the Rangelands of Western Australia — a Position Statement

Environmental Protection Authority
Perth, Western Australia
January 1996

Public comment

The public are invited to comment on this Position Paper, with copies available from -

- Perth, Karratha and Kalgoorlie offices of the Department of Environmental Protection;
- offices of Agriculture Western Australia (formerly Department of Agriculture); and
- relevant Shire offices.

Comments on the Position Paper should be received no later than 31 May 1996, and addressed to:

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Summary

The Western Australian Government has announced a framework for sustainable development in the rangelands. This announcement includes a commitment to establishing a comprehensive conservation reserve system and ensuring the ecological and economic viability of the pastoral industry.

The Environmental Protection Authority endorses the Government initiative in the rangelands and has published this Position Statement to support and guide that process. In doing this the EPA has reviewed the location and nature of the rangelands (section 3), conservation and environmental issues associated with sustainable rangeland development (section 4), principles for sustainable development and environmental protection (section 5), proposed preliminary rangeland environmental objectives (section 6) and identified the EPA's role in the Government initiative.

The EPA regards the Government initiative, in conjunction with current legislative review, as an extraordinary opportunity to begin to address the very substantial economic and environmental protection issues facing the pastoral industry and rangeland conservation.

1. Introduction

The Western Australian Government recently announced its Policy on the State's Pastoral Areas, "Managing the Rangelands" (Appendix A). This Policy has been prepared to guide the future of the pastoral industry and to underpin associated Commonwealth funding and rural adjustment. The Government has also seen the opportunity to set environmental goals and establish sustainable development principles and practice for rangeland management. This document forms the EPA's response to the Government Policy.

The pastoral industry utilises 38% of the State's area under lease from the Crown, with the pastoral region extending from the Nullarbor to the North West and the Kimberley. It is the most extensive land use in the State, has caused very substantial, long term and widespread environmental degradation, and yet in relative terms represents a modest contribution to the State's total Agricultural production.

The rise of environmental awareness, particularly over the last 20 years, development of various international environmental conventions and national strategies, in conjunction with State of the Environment Reporting, have firmly placed environmental management of the rangelands on the global, national and State agenda.

The proposed restructuring of the pastoral industry and legislative review underway represents an extraordinary opportunity to establish a framework for the conservation of biological diversity and sustainable pastoralism in the rangelands. The "Managing the Rangelands" initiative is probably the most significant opportunity over the last 20 years to address sustainable development issues in the rangelands.

The purpose of this document is to ensure that rangeland related environmental considerations are presented to the Western Australian community for review and comment. In doing this the Position Statement endeavours to outline rangeland management, conservation and environmental issues, management principles, environmental objectives and a preliminary environmental strategy to achieve environmental objectives.

2. Managing the rangelands

The "Managing the Rangelands" initiative will seek to develop and implement long term strategies for the pastoral industry and land use in the rangelands of Western Australia, with the principal objective being to establish a framework for ecological and pastoral sustainability. The strategy will initially focus on the southern pastoral industry in the Murchison and Gascoyne.

Cabinet has established an industry based Steering Group with an interagency Government Officers Support Team (GOST) to assist with this task.

The EPA supports this initiative and endorses the view that it will require an "all of government" approach to resolve the difficult problem of ensuring sustainable pastoral rangeland management.

3. The nature of the rangelands

3.1 The rangelands

Rangelands cover 85% of Western Australia, being all that land to the north and east of the south west agricultural zone (Figure 1).

The National Rangelands Strategy Working Group (1994) has defined the rangelands as:

> *They are generally native grasslands, shrublands and woodlands which cover a large proportion of the arid and semi-arid regions and also include tropical savanna woodland..... The majority of the Australian Mainland, particularly the arid and semi-arid zones, is rangeland.*

The rangelands of Western Australia have three principal regions, the Kimberley Pastoral Zone, Arid Pastoral Zone and Desert (Figure 1), across five climatic zones (Table 1 & Figure 2), comprising of 19 biogeographic regions (Figure 3) and extensive river and drainage systems (Figure 4).

Table 1: Climatic zones and seasonal characteristics of Western Australia (see Figure 2).

CLASSIFICATION	SEASONAL CHARACTERISTICS	
	Summer	**Winter**
Tropical	Heavy periodic rains (heavier in coastal & highland areas) Hot generally Humid in coastal areas	Generally rainless Mild to warm Dry
Temperate - moderate to heavy winter rainfall	Irregular rain, mostly light Warm to hot	Reliable rain (moderate to heavy) Cool to mild
Temperate - moderate winter rainfall	Mostly light irregular rain Warm to hot	Reliable rain (mainly moderate) Cool to cold
Subtropical - arid	Variable rain Hot to extreme Very dry	Mainly irregular light rain Mild to warm Dry
Warm Temperate to Subtropical	Very irregular rain Hot to extreme Very dry	Variable rain, mainly light Cool to mild Dry

The State of the Environment Report provides a summary of the rangelands, though the rangelands here are discussed as the Kimberley, Nullarbor, Central Desert, Goldfields and North West region (Appendix C).

45% of the rangelands are incorporated into pastoral leases, with the remainder predominantly vacant Crown Land, with smaller areas of Aboriginal lands, National Parks and other conservation reserves.

Figure 1: Pastoral regions of Western Australia

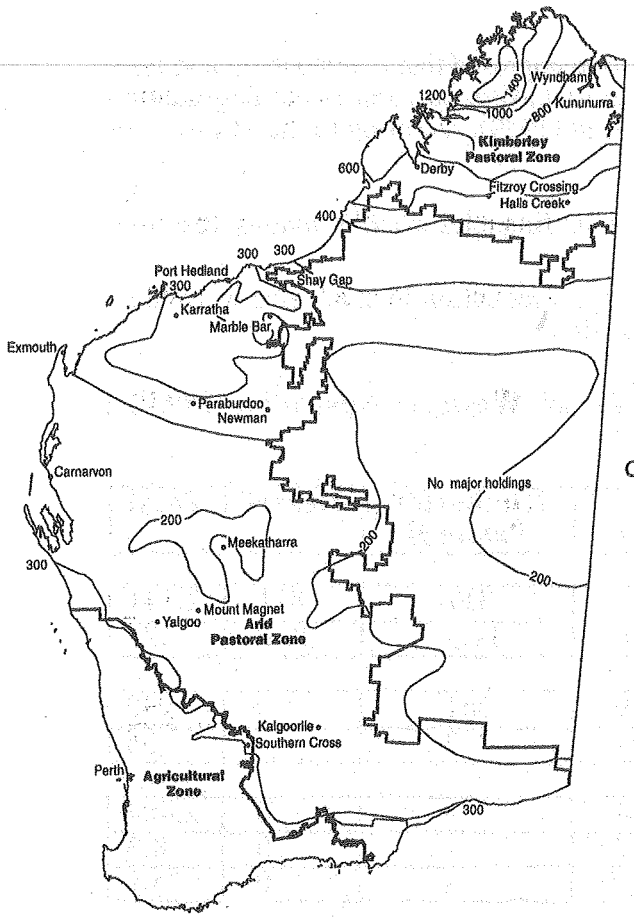


Figure 2: Climatic zones of Western Australia

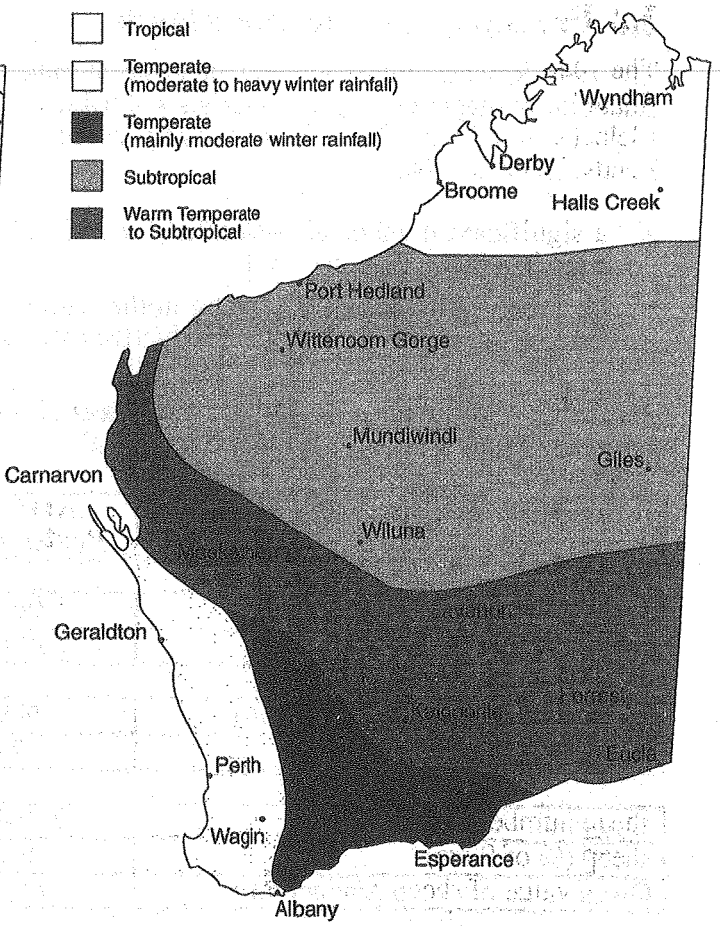


Figure 3: Biogeographic regions of Western Australia

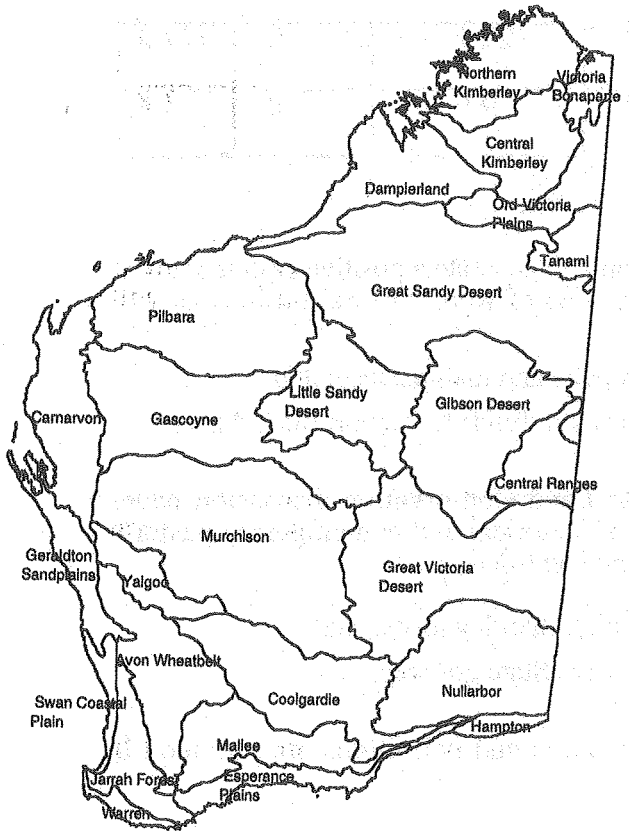
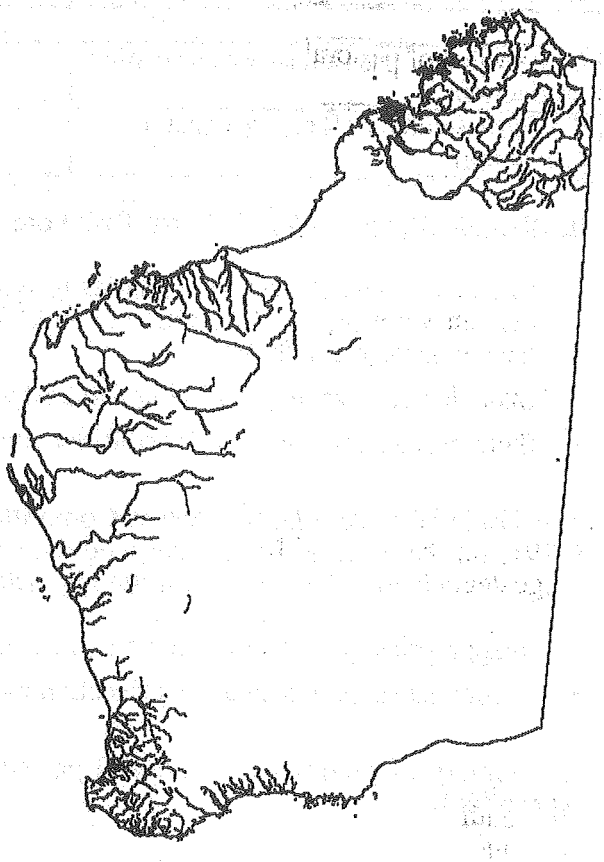


Figure 4: River systems of Western Australia



3.2 Pressures on the rangelands

The 1940 Royal Commission into the Pastoral Industry recognised that overstocking and poor financial management by pastoralists contributed to extensive pastoral range degradation (Select Committee, 1991). More recently, Jennings *et al* (1979), reporting to the Minister for Lands, identified that -

- a significant number of pastoralists were in serious financial trouble, mainly resulting from insufficient income; and
- because of ongoing overstocking in the Kimberley, a reduction in stock was warranted. Overstocking was prevalent in productive riverine areas.

Table 2: Pastoral activity in the rangelands of Western Australia, 1993/94 (source Agriculture Western Australia).

Rangeland Regions	Arid Pastoral	Kimberley Pastoral	Desert	Total
Total area (approximate `000 km^2)	1,003	317	821	2,141
Area of State (%)	39.8	12.5	32.6	85
Area of pastoral leases (`000 km^2)	689	251	0	940
Area of State (%)	27	9	0	38
sheep number (`000)	2,464	-	0	2,464
sheep (% of State)	8.3	-	0	8.3
Gross value of sheep production	75.9	-	0	75.9
cattle number (`000)	253.2	487.6	0	740.8
cattle (% of State)	15	28.9	0	44
Gross value of cattle production ($M)	22.8	29.1	0	51.9
Gross value of pastoral sheep and cattle production	98.2	29.1	0	127.3
% of gross value of State agricultural production	2.9	0.9	0	3.8

In 1993, the Pastoral Wool Industry Task Force observed that -

- "virtually no wool pastoral properties in WA are able to generate a positive cash income at current wool prices" (1993 prices) and "30% to 60% of wool pastoral businesses will have to leave the industry";
- many leases have reduced labour and postponed repairs and maintenance; and
- there was an ongoing need for considerable government funds to support the industry.

The Legislative Assembly's Select Committee into Land Conservation discussion paper (1991) on the Pastoral Region outlined the causes of historical and contemporary pastoral range degradation. Two main contributing factors were identified -

- inappropriate pastoral management practices and high stocking levels; and
- inadequate supervision and intervention by successive State governments.

A summary of preliminary rangeland pressure indicators and definitions are provided in Appendix B.

3.3 Environmental condition of the rangelands

Extensive areas of the pastoral rangelands are recorded as being in poor to fair condition. For example in the Murchison, approximately 42% by area of all vegetation has been assessed as in poor to very poor condition, 37% in fair condition and 21% was still in good to very good condition (Curry *et al*, 1994).

Pringle *et al* (1994) have found that land degradation in the Goldfields pastoral district is not as extensive as elsewhere, however here only "small" proportions of land represent large areas and high proportions of preferred grazing land systems.

Table 3: Estimated areas affected by various forms of rangeland deterioration within the Western Australian Pastoral Region (from SoER, 1992).

	Alienated area	Wind erosion		Sheeting/ willing		Gullying		Vegetation *	
Zone	km^2	km^2	%	km^2	%	km^2	%	km^2	%
Kimberley, non arid	43 958	439	1	439	1	44	0.1	439	1
Kimberley, arid	142 099	12 078	8.5	19 041	13.4	3 979	2.3	27 710	19.5
Spinifex**, mulga zone	520 636	41 130	7.9	33 321	6.4	8 330	1.6	111 416	21.4
Goldfields	180 770	5 423	3	5 423	3	904	0.5	21 692	12
Nullabor	61 717	1 234	2	-	-	-	-	15 429	25
Total	949 180	60 304	6.4	58 224	6.3	13 257	1.3	176 686	18.6

* Vegetation condition for pastoral purposes rated "poor" or "very poor" on a five-point scale.

** Includes the Ashburton, Pilbara, Murchison and Gascoyne Pastoral areas.

\+ Percentage of area affected in brackets.

The State of the Environment Report for WA (SoER, 1992) provides some information on rangeland condition, observing that -

- there are major gaps in the nature conservation reserve system across the rangelands;
- "... a great need exists to protect the nature conservation values on vacant Crown land" and that "nature conservation in the rangelands still requires setting aside ... land that can be managed specifically for conservation, and that can function as reference areas for comparison with grazed areas.";
- for the Kimberley, "only the isolated rainforests, the riverine forests and the swamp communities associated with the mouth of what was once the ancient Mandora River are considered to be in danger of major structural or floristic change in the short to medium term. In the longer term, the diversity of savannah woodland communities is at risk in pastoral areas unless management practices change. However, several other communities are considered to be geographically restricted and may become endangered";
- for the Eremaean (the arid pastoral region), "a number of communities within the Eucla District on the Nullarbor Plain are considered to be threatened with major structural and floristic change".

The International Union for the Conservation of Nature (Caracas Action Plan, 1992) has recommended that in design of an adequate conservation reserve system, a minimum of 10% of the original areal extent of all vegetation associations should be incorporated in the reserve system. Two recent investigations by the Departments of Conservation and Land Management and Agriculture contrast this requirement with aspects of the current rangeland conservation reserve system.

Pringle (1995) states that for the north-eastern Goldfields, less than 1% of the survey area is in a conservation reserve, with only two of the 11 poorly known and threatened plant species represented in reserves.

CALM and Agriculture Western Australia have recently analysed Beard's vegetation mapping data for WA and compared this with the conservation estate (Hopkins *et al*, 1995). For the Gascoyne Region as defined in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell, 1995) there is a total of 71 vegetation types, where:

- 7 have at least 10% of their original extent in the conservation estate;
- 30 have up to 10% of their original extent in the conservation estate (9 have a total area less than 2000 hectares); and
- 34 are not represented in the conservation estate.

A summary of preliminary rangeland environmental condition indicators and definitions are provided in Appendix C.

4. Conservation and environmental issues

4.1 Biodiversity and sustainable development

International conventions on biodiversity and sustainable development provide a basis for setting strategies for achievement of environmental objectives in the rangelands. The following selected conventions and national strategies apply to rangeland management, providing direction for national and state actions -

UN Rio Declaration (United Nations, 1992), states that:

> *"To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption..."*

UN Convention on Biological Diversity (United Nations, 1992), requires that contracting states should:

> *"Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity."*
>
> *"Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas."*

National Strategy for the Conservation of Australia's Biological Diversity (ANZECC, 1994), observes that:

> *"Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with a sympathetic management of all other areas, including agricultural and other resource production systems."*
>
> *"Processes for and decisions about the allocation and use of Australia's resources should be efficient, equitable and transparent."*

4.2 Conserving biological diversity

Of primary importance to the conservation of biological diversity is the establishment of a system of protected areas or reserves. A regional framework for reserve selection has been developed under the National Reserves System Cooperative Programme (Thackway & Cresswell, 1995). Biogeographic regions have been identified for Western Australia and these units or groups of units should be the basis for reserve selection (see Figure 3).

A protocol for reserve selection should provide for:

- *Comprehensiveness*: ensuring the full range of communities are included, as distinguished at a particular scale (the IBRA regions should be employed here);
- *Adequacy*: ensuring the size, number and arrangement of communities and reserves that optimise their chance of long-term survival and continued evolution;
- *Representativeness*: that the full range of assemblages, species and genetic variation that occurs in plant and animal communities across the landscape is accounted for (ANZECC, 1994), with selection based on the refinement of Beard's vegetation surveys (Hopkins *et al*, 1995);
- the location of Declared Rare, Threatened and Priority Flora, along with areas of recognised species richness;
- specialist knowledge on environmental quality and threatened communities is utilised and that highest quality remnant areas are set aside for conservation (this will require the use of remote sensing and rangeland survey information);
- that planning should account for the boundary effect, where patterns of endemism and genetic variation are often associated with biogeographic ecotones; and
- where possible, catchment boundaries and landscape elements are employed as natural boundaries between pastoral and conservation areas, and that important habitats (eg, high conservation value wetlands) are included in the conservation or protected area systems.

It will not be possible, and in some instances may not be necessary, to include all important habitats in the conservation reserve network. Therefore special measures must be in place to protect high conservation value ecosystems outside the conservation reserve network.

4.3 Conserving pastoral production

To date significant areas of rangeland with low (20ha/sheep) or very low (30ha/sheep) carrying capacity have been included into pastoral leases. This has led to economically and ecologically unviable enterprises (Jennings *et al*, 1979). Therefore, regardless of other land uses within a pastoral lease, such as horticulture or ecotourism, pastoral leases should be designed to maintain long term pastoral viability as an exclusively pastoral enterprise.

Though land may be suitable for pastoral production the land can be readily and irreversibly degraded due to excessive stocking rates and total grazing pressure. It is therefore necessary to identify and require adoption by land managers of appropriate stock management strategies - "Best Management Practices" - including the maintenance of sustainable stocking rates and total grazing pressure, even distribution of watering points, control of environmental weeds and introduced animals, and the fencing of lands according to pastoral land systems.

4.4 Controls on pastoral rangeland management

This section looks at the current pastoral legislation and its provisions relevant to pastoral production and rangeland conservation, and possible approaches for the future.

At present the Pastoral Board and the Minister for Lands under the *Land Act* 1933, and the Commissioner of Soil and Land Conservation under the *Soil and Land Conservation Act* 1945, are the authorities responsible for pastoral rangeland conservation.

The two Acts provide opportunities to control stocking rates, the principal management issue for rangeland conservation. It is notable that -

- a condition of a pastoral lease is that the lease is to be maintained in good soil and plant condition;
- any pastoral lease is liable to forfeiture if the lessee permits all or part of the land to deteriorate;
- the Minister for Lands may prohibit the lessee from increasing stock numbers, require the lessee to reduce the number of stock, or require the lessee to provide and maintain suitable fencing to control stock; and
- the Commissioner of Soil and Land Conservation can serve a notice on the owner or occupier of a pastoral lease to adopt or refrain from adopting any pastoral method or practice which in his opinion is or is likely to cause land degradation.

Submissions received by the Select Committee (Parliament of WA, 1991) indicate that, despite these very substantial powers to protect and conserve the rangeland resource, inadequate supervision and intervention by successive State Governments has been a major factor in rangeland degradation. It is the EPA's position that in the preparation of any new legislation applying to pastoral activities and leases, that these powers should be the minimum provision for environmental protection and that they should be enforced.

A preliminary summary of present responses to rangeland environmental condition and definitions are provided in Appendix C.

5. Preliminary principles for sustainable development and environmental protection

5.1 Conditions and limitations

Should the "Managing the Rangelands" strategy proceed (section 2), practical environmental protection principles should be in place to guide the pastoral industry and other development in the rangelands (sections 3 &4). The establishment of guiding principles for industry and government agencies will help integrate management to achieve environmental objectives. The principles should help ensure decisions affecting the use of the rangelands are open, consistent and systematic.

The precautionary principle (section 5.3), whilst being criticised by some as vague and impractical, cannot be ignored. It is stated in most international agreements and, directly or by implication or delegation, in all Australian policy (eg, National Strategy for ESD, National Greenhouse Response Strategy, Intergovernmental Agreement on the Environment, National Forest Policy Statement, National Strategy for the Conservation of Australia's Biological Diversity). However, it should be noted that these are non-binding policies. Official wordings of the precautionary principle do not necessarily have the same implications as are

asserted in the literature (Dovers, 1995). Importantly, it is emerging in State law, including in NSW the *Protection of the Environment Administration Act* 1991 and by reference the *Water Board (Corporatisation) Act* 1994, and in SA the *Environment Protection Act* 1993. On this basis, it is also beginning to be debated in the Courts (Dovers, 1995) which in due course will result in a clearer definition.

The preliminary principles (Commonwealth of Australia, 1995), consistent with the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia, 1992), are comprehensive and reflect the complexity of the issues and concepts which compete for attention. They are not necessarily mutually exclusive; rather they attempt to balance competing values in order to achieve ecologically sustainable development. No single principle predominates and so decision makers will be expected to exercise judgement in application of competing principles.

The following preliminary environment principles (sections 5.2 to 5.6) are proposed to assist decision making. However before these principles are applied there needs to be extensive consultation with the pastoral industry, peak bodies representing conservation and industry, government agencies and the public.

5.2 Integrated assessment

1) The ecological and physical links between terrestrial systems such as soils, near surface geology, land forms, surface water and ground waters, must be taken into consideration in use and management;

2) The environmental, economic, social and cultural considerations should be identified and as far as practical the impact of uses should be determined before decisions are made;

3) As far as practical assessment should be made on local, regional, national and global scales. Long term impacts on the resource itself should be considered. Negative effects should be minimised;

4) Cumulative effects should be considered before land use decisions are made. As far as practical negative cumulative effects should be avoided. It is necessary to guard against unintended negative effects of numerous small decisions;

5) The resource should be monitored to ensure impact assessments are accurate. If impacts are significantly different from those predicted, remedial actions should be taken;

5.3 Precautionary principle

6) If there is a high risk of serious or irreversible adverse impact resulting from use of a resource, that use should be permitted only if those impacts can be mitigated or there are overwhelming grounds for proceeding in the State or National interest;

7) If a use is assessed as having a low risk of causing serious or irreversible adverse impacts or of there is insufficient information with which to assess fully and with certainty the magnitude and nature of impacts decision making should proceed in a conservative and cautious manner. The absence of scientific certainty should be no reason for postponing measures to prevent or mitigate negative impacts;

5.4 Resource allocation

8) Resources should be allocated to the use with the greatest long term community benefit, where benefit is determined by taking into account environmental, economic, social and cultural considerations;

9) Areas in or near their pristine state may be developed for uses which diminish their value if development provides considerable benefit and no other viable alternative exists;

10) Development should occur in accordance with predetermined strategic management plans;

11) Public access should be maintained for recreation, tourism and other public activities. However the extent, location and type of access may need to be controlled to mitigate adverse effects of this access, or to resolve incompatible uses, or maintain public safety;

5.4 User pays

12) The costs of development including environment assessment, management and monitoring and costs of managing natural hazards should be borne by the development proponents;

13) When development results in increased tourism and recreational use it is necessary to assess hazards (eg flood or tropical cyclone) that may effect users and to develop facilities for managing the increased use;

5.5 Resource conservation

14) Natural physical processes should be safeguarded. Development should account for natural processes and be located so as to disrupt or be effected by these process as little as possible. When disruption to natural processes is unavoidable every attempt should be made to limit that disruption and its impact on adjoining areas;

15) Biological diversity and biological processes on which it relies should be maintained. As fas as practical use of the rangelands should have minimal effect on regional biological diversity and biological processes;

16) Disposal of waste particularly near rivers and water courses, and into groundwater aquifers should be limited to the extent that the environment about the receiving point or area is not degraded;

5.6 Public participation

17) Effective public consultation and participation are essential to the planning process and should be encouraged before decisions are made. Processes for management decisions should be open and allow scrutiny;

18) Local industry and local communities should be encouraged to share direct responsibility for management of local areas and to participate in development and implementation strategies.

6. Preliminary rangeland environmental objectives

Given international and national conventions and strategies for biodiversity and sustainable development (section 4.1), objectives for the conservation of biodiversity and rangeland productive capacity (sections 4.2 & 4.3), the current controls to protect the pastoral rangeland resource (section 4.4), using the principles of section 5, the preliminary environmental objectives for managing the rangelands are to:

1) protect rangeland biodiversity, high conservation value habitats and ecosystems by establishing and maintaining a comprehensive, adequate and representative system of conservation reserves;

2) protect important habitats and ecological systems as far as practical in the areas out side of the reserve systems;

3) protect the pastoral and other productive capacities by ensuring the rangeland use is fit for the purpose;

4) encourage, promote and where necessary require adoption of best environmental practice for rangeland management;

5) ensure that State of Environment Reporting regularly reviews and reports on the rangelands;

6) develop environmental management plans, policies, guidelines and codes with industry and government, and in consultation with the public;

7) promote and develop performance monitoring, auditing and periodic review of rangelands at catchment and local scales; and

8) develop and administer appropriate enforcement mechanisms to protect the rangeland environment.

7. An environmental strategy for rangeland conservation

7.1 Role of the EPA

The EPA supports the Western Australian Government's "Managing the Rangelands" initiative (section 2) and establishment of an industry-community based Steering Group and an associated Government Officers Support Team (GOST).

Section 15 of the Environmental Protection Act 1986 states that the objective of the EPA is to use its best endeavours to: (a) protect the environment; and (b) prevent, control and abate pollution. Generally the EPA approaches these objectives by requiring the environmental assessment of proposals likely to degrade the environment, prepare and seek approval or endorsement by Government for environmental protection policies (in their broadest form), publishing industry based environmental codes of practice, through specific site, area or regional environmental investigations, and the provision of advice to Government.

The EPA wishes to work co-operatively with the Steering Group and the GOST to identify strategies to achieve environmental objectives in the rangelands, and intends to provide ongoing advice to the Minister for the Environment on progress of the "Managing the Rangelands" initiative. The Steering Group and the GOST, where appropriate, should use the

EPA to assist in developing and implementing rangeland environmental strategies and to identify effective rangeland environmental protection measures.

Experience indicates that regular consultation and negotiation greatly reduces any difficulties over differing opinions on environmental matters. However, the EPA will if necessary use the provisions of the *Environmental Protection Act* 1986 to protect the rangeland environment and provide formal public advice and recommendations to the Minister for the Environment.

7.2 Integrating the EPA's preliminary position with "Managing the Rangelands" — a rangeland environmental strategy

The EPA's preliminary position on sustainable development and environmental protection (section 5 & 6) is readily integrated with specific environmental objectives of the "Managing the Rangelands" statement. Relevant extracts of the Statement are italicised below, according to the section in which they appear.

1. "*developing a program* (for economic and structural change) *which adopts ESD principles*";

   the EPA will review and provide advice on sustainable development principles, guided by section 5 of this report;

2. "*ensuring legislation complements natural resource management legislation*";

   the EPA will continue to investigate development of environmental protection legislation, including a possible statutory Environmental Protection Policy (EPP) if required to underpin and guide sustainable natural resource management in the rangelands, guided by sections 4, 5 & 6 of this report;

3. "*reviewing legislation pertaining to natural resource management administered by the Agriculture Portfolio, in accordance with ESD principles*";

   the EPA will provide public advice to the Agriculture Portfolio on sustainable development and environmental protection in the rangelands, guided by sections 4, 5 & 6 of this report;

4. "*monitoring the achievement of sustainable land use through appropriate environmental, financial and societal indicators and reporting on a regular basis*";

   the EPA will review and provide advice on appropriate environmental indicators based on current State of the Environment Reporting, guided by section 3 & 4, and Appendix B, of this report;

5. "*considering the opportunities arising from implementation of the National Rangeland Strategy and Action Plan*";

   the EPA will promote and coordinate achievement of rangeland environmental objectives (section 6) through resource management agencies and authorities, regional strategies, and implementation of the National Rangelands Strategy and associated Commonwealth and industry programmes";

6. "*identifying and establishing a comprehensive reserve system representing the full range of landforms and biological communities*";

   the EPA will monitor the process of reserve selection for the purpose of this strategy, guided by section 4 of this report;

7. *"supporting the conservation of biological diversity through strategic protection of native flora and fauna and representative habitats"*;

guided by section 4 of this report, the EPA will protect high conservation value habitats and land systems through environmental impact assessment procedures and advice to decision-makers; and

8. *"establish environmental objectives for broadscale land use"*;

the EPA will review and provide advice on environmental objectives, guided by section 6 of this report.

The above undertakings represent the EPA's proposed environmental strategy for the rangelands.

7.3 Progressing the environmental strategy

The EPA's proposed environmental strategy is intended to contribute to implementation of the Government's "Managing the Rangelands" statement. Accordingly, the EPA:

1) invites public comment on indicators -

- of the pressures of human activity in the rangelands (cf section 3);
- of the condition of the rangelands as a result of human activity (cf section 3);
- of the societal responses necessary to address the degraded condition of the rangelands, especially the pastoral rangelands (cf section 4); and
- that are suitable for State of the Environment Reporting (cf Table 2).

2) invites comment on sustainable development and environmental protection principles and objectives and the proposed environmental strategy (cf sections 5, 6 & 7);

3) seeks to assist the Steering Group and the GOST on matters relating to sustainable development and the environment (this may include, from time to time, receiving presentations from the Steering Group and GOST);

5) will provide advice to the Minister for the Environment on implementation of the Managing the Rangelands statement; and

6) endeavour to forecast the State of the rangelands in 10, 20 and 50 years following implementation of the "Managing the Rangelands" statement.

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Appendix A

Government Statement "Managing the Rangelands", October 1995.

GOVERNMENT POLICY STATEMENT
"MANAGING THE RANGELANDS"

WHAT ARE THE RANGELANDS

The Rangelands of Western Australia are those vast areas of land north and east of the agricultural area.

The Rangelands include:

- *the State's pastoral areas which comprise land made available by lease to pastoral and mining interests (often concurrently), and to a much lesser extent, agricultural interests. Pastoral leases cover 98 million hectares which stretch from the Great Australian Bight to the Kimberley. The area includes various national parks, conservation reserves and special leases;*
- *large tracts of Crown Land; and,*
- *Aboriginal Reserves.*

The importance of the Rangelands are that they:

- *occupy 85 per cent of the State;*
- *produce most of the State's mineral and energy wealth;*
- *are the home of the majority of the Aboriginal population;*
- *support important segments of the beef and wool industry;*
- *offer major tourism potential.*

CHALLENGES

The Rangelands face special challenges:

- *the beef and wool industries are based on natural vegetation which has a limited and seasonal carrying capacity;*
- *current land tenure arrangements limit security of tenure, flexibility of land use and the development of alternative industries;*
- *communities are isolated and difficult to service.*

A number of reports have drawn attention to the need for Government to address these challenges, especially with respect to the Pastoral Areas.

POLICY OBJECTIVES

This policy statement is the first step in a process which will enable the community and Government to develop and implement long-term arrangements for the future of the Rangelands. The emphasis in the early stages will be on the Southern Pastoral area which stretches from south of Kalgoorlie to the Pilbara.

The Government is responsible for the Rangelands and must ensure they are properly managed. The Government is committed to:

- *ensuring that economic and social development opportunities are realised while conserving the rangeland;*
- *maintaining viable communities throughout the rangelands;*
- *conserving native flora and fauna, establishing and maintaining a comprehensive conservation reserve system and developing environmental objectives for broadscale land use;*
- *developing and maintaining commercial activities in accordance with the principles of Ecologically Sustainable Development (ESD) which:*

    - *sustain and enhance productivity over the long term;*
    - *avoid, minimise or ameliorate adverse impacts on the natural resource base and associated ecosystems;*
    - *maximise the net social benefit;*
    - *manage the production systems sufficiently to cater for the risks associated with the vagaries of climate and market.*

ACTION

1. **Economic development and structural change will be supported by:**

    1.1 Developing a program which:

    - *provides secure tenure over pastoral lands to the extent possible under the Commonwealth NativeTitle Act;*
    - *gains community and Commonwealth Government support for regional development programs;*
    - *develops regional land use strategies in accordance with natural resource capability; and,*
    - *adopts ESD principles.*

    1.2 Ensuring legislation:

    - *encourages development of multiple land use and opportunities to augment or replace the existing pastoral use to the extent possible under the Commonwealth NativeTitle Act;*
    - *matches property rights and rentals with the designated land use.*
    - *complements natural resource management legislation;*
    - *establishes a process to encourage the economic development of pastoral businesses;*

- *provides a mechanism to remove land not suited to pastoral production from the industry; and,*
- *ensures that mining and petroleum industries are able to carry out exploratory and extractive operations on pastoral land on fair and equitable terms.*

1.3 Providing a land administration structure with wide representation, including Aboriginal interests, and increased responsibility for sustainable land use.

1.4 Reviewing legislation pertaining to natural resource management administered by the Agriculture Portfolio, in accordance with ESD principles.

1.5 Considering the establishment of an Aboriginal Commercial Land Corporation which will provide financial advice and assistance for economic development and commercial enterprises on Aboriginal lands.

2. **Sustainable land use will be supported by:**

2.1 Encouraging industry and the community to develop economically viable businesses based on strategic planning principles and environmentally sound management practices.

2.2 Monitoring the achievement of sustainable land use through appropriate environmental, financial and social indicators and reporting on a regular basis.

2.3 Managing threats to sustainable land use posed by specific animals, plants and diseases.

2.4 Ensuring that support measures are provided to all, including Aboriginal communities.

2.5 Ensuring that land disturbed by mining or other activities is adequately rehabilitated.

2.6 Considering the opportunities arising from implementation of the National Rangeland Strategy and Action Plan.

3. **Business activities will be supported by:**

3.1 Maintaining the five Regional Development Commissions in the rangelands.

3.2 Ensuring that economic planning is integrated into regional development programs.

3.3 Providing mechanisms which encourage regional development.

3.4 Providing information and referral centres for small business (Business Enterprise Centres.).

3.5 Providing assistance for tourism development in remote areas.

4. **Social considerations will be supported by:**

4.1 Providing support for social adjustment where appropriate.

4.2 Providing local government with increased flexibility to act in the best interests of the local community, including the introduction of differential rating.

5. **The environment will be protected by:**

5.1 Identifying and establishing a comprehensive reserve system representing the full range of landforms and biological communities.

5.2 Supporting the conservation of biological diversity through the strategic protection of native flora and fauna and representative habitats.

5.3 Establishing environmental objectives for broadscale land use.

5.4 Developing multiple land use models which integrate nature conservation and other uses.

5.5 Facilitating Aboriginal involvement in management of conservation reserves, including access for cultural purposes.

5.6 Providing the community with further opportunities to enjoy the natural values of conservation reserves.

Appendix B

Extract from *Environmental Indicators* (OECD, 1994) and Preliminary Application to the rangelands.

Inset 2. Criteria for Indicator Selection*

Policy relevance and utility for users

An environmental indicator should:

- provide a representative picture of environmental conditions, pressures on the environment or society's responses;
- be simple, easy to interpret and able to show trends over time;
- be responsive to changes in the environment and related human activities;
- provide a basis for international comparisons;
- be either national in scope or applicable to regional environmental issues of national significance;
- have a threshold or reference value against which to compare it, so that users are able to assess the significance of the values associated with it.

Analytical soundness

An environmental indicator should:

- be theoretically well founded in technical and scientific terms;
- be based on international standards and international consensus about its validity;
- lend itself to being linked to economic models, forecasting and information systems.

Measurability

The data required to support the indicator should be:

- readily available or made available at a reasonable cost/benefit ratio;
- adequately documented and of known quality;
- updated at regular intervals in accordance with reliable procedures.

**These criteria describe the "ideal" indicator and not all of them will be met in practice.*

Types of indicators

The PSR framework distinguishes three broad types of indicators:

- Indicators of environmental pressures correspond to the "pressure" box of the PSR framework. They describe pressures from human activities exerted on the environment, including the quality and quantity of natural resources.

- Indicators of environmental conditions correspond to the "state" box of the PSR framework and relate to the quality of the environment and the quality and quantity of natural resources. As such they reflect the ultimate objective of environmental policy making. Indicators of environmental conditions should be designed to give an overview of the situation (the state) of the environment and its development over time, and not the pressures on it. In practice, the distinction between environmental conditions and the pressures may be ambiguous and the measurement of environmental conditions can turn out to be difficult or very costly. Therefore, the measurement of environmental pressures is often used as a substitute for the measurement of environmental conditions.

- Indicators of societal responses correspond to the "response" box in the PSR framework. Societal response indicators are measurements which show the extent to which society is responding to environmental changes and concerns. Societal

Figure 1a. **Pressure - State - Response Framework**

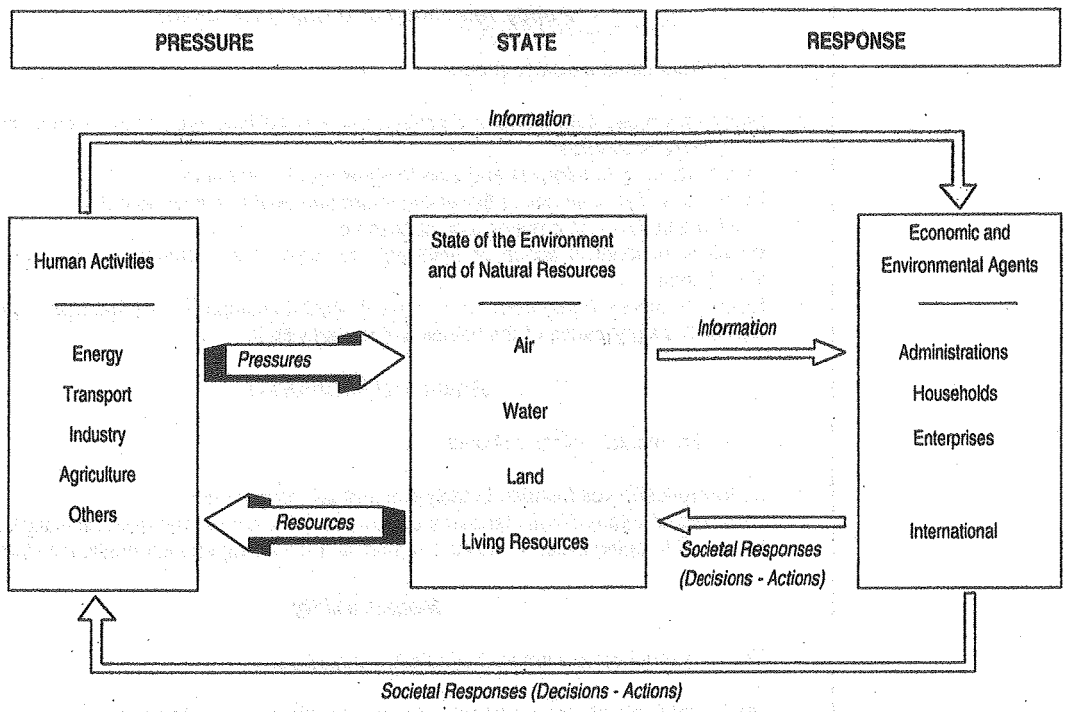
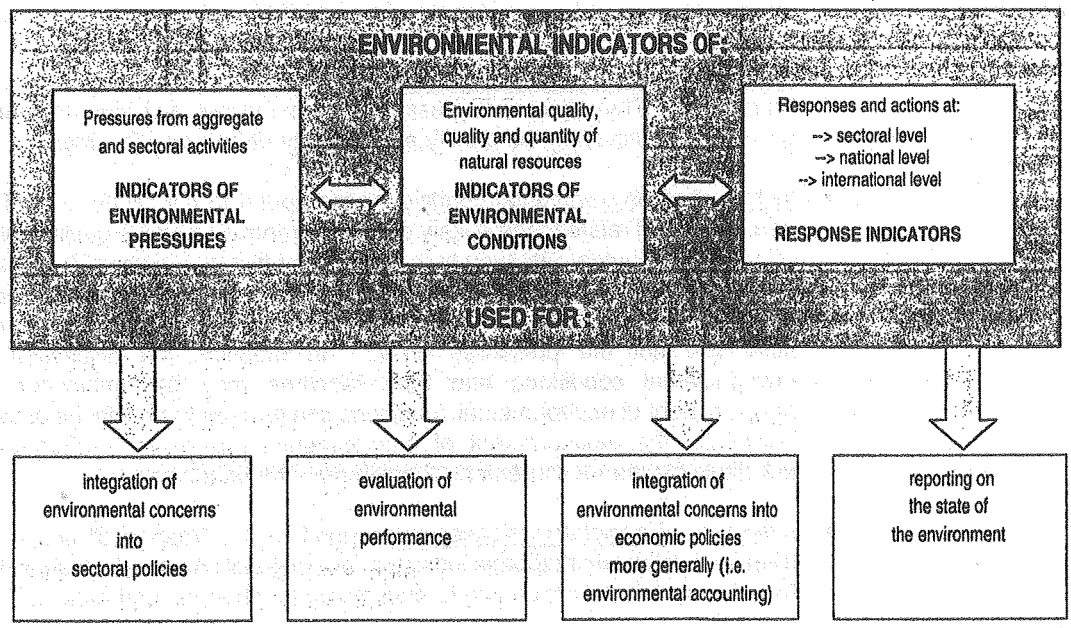


Figure 1b. **Nature and Use of Environmental Indicators**



responses refer to individual and collective actions i) to mitigate, adapt to or prevent human-induced negative impacts on the environment, ii) to halt or reverse environmental damage already inflicted and iii) to preserve and conserve nature and natural resources.

Compared to indicators of environmental pressures and many indicators of environmental conditions, most indicators of societal responses have a shorter history and are still in a phase of development, both conceptually and in terms of data availability. This must be taken into account in their use, to avoid misinterpretation.

Environmental issues

A list of issues which reflect current environmental challenges was identified to form a second structuring element for indicators. By necessity, they depend on changing and sometimes conflicting perceptions. The list of issues is not necessarily final nor exhaustive. In fact, the list is flexible and new issues can be incorporated or old ones abandoned according to their environmental relevance **(Table 1)**.

Table 1. **Structure of Indicators by Environmental Issue**

Issues	PRESSURE Indicators of environmental pressures	STATE Indicators of environmental conditions	RESPONSE Indicators of societal responses
Climate change			
Ozone layer depletion			
Eutrophication			
Acidification			
Toxic contamination			
Urban environmental quality			
Biodiversity			
Landscapes			
Waste			
Water resources			
Forest resources			
Fish resources			
Soil degradation (desertification & erosion)			
General indicators			

Broadly speaking, the first nine issues can be considered "sink-oriented", dealing with issues of environmental quality, whereas the other issues are "source-oriented", focusing on the quantity aspect of natural resources. Not all indicators can be directly associated with a specific environmental issue (e.g. population growth or economy-wide environmental expenditure). A category of general indicators has therefore been introduced in the framework.

USING INDICATORS

Uses and users

Different users of environmental indicators have different needs. Thus, the appropriate set of indicators depends on its particular use.

Conceptually, however, indicators for specific purposes (performance evaluation, reporting on the state of the environment) should be distinguished from specific types of indicators, i.e. indicators of environmental conditions, pressures, societal responses **(Figure 1b)**.

When using environmental indicators several principles should be respected:

Only one tool

- Indicators provide only one tool for evaluations and need to be supplemented by other qualitative and scientific information in order to avoid misinterpretation. Such information is particularly needed to explain driving forces behind indicator changes which form the basis for an assessment.

The appropriate context

- Indicators must be reported and interpreted in the appropriate context, taking into account the ecological, geographical, social, economic and structural features of countries.

Inter-country comparisons

- There is no single method of standardisation for the comparison of environmental variables across countries. When comparing indicators across countries, the outcome of the assessment will depend on the chosen denominator (GDP, population, land area) as well as on national definitions and measurement methodologies. Although standardisation is needed to facilitate inter-country comparisons, absolute values may be the appropriate measure where, for example, international commitments are linked to absolute values. Generally, inter-country comparisons should be subject to great caution.

PROSPECTS AND FUTURE WORK

Towards a core set of indicators

One of the objectives of the OECD work on environmental indicators is the measurement of the entire core set of indicators, designed to be a tool for the evaluation of environmental performance, and to provide a building block to construct indicators of sustainable development. To date, measurability varies greatly between individual indicators identified in the core set. Some of the indicators are immediately measurable, others need additional efforts before they can be presented and a third group will only be measurable in the long term, due to the absence of data **(Table 2)**.

The short term

The present publication is limited to indicators which are immediately measurable — i.e. based on data currently available for a majority of OECD countries. It thus provides a short term operational tool for current OECD work. Some of these indicators are already very close to the proposed core set, others only replace those of the core set which are not yet measurable, still others complement the message conveyed by the main indicator. Table 2 summarises the indicators proposed by the OECD Group on the State of the Environment and shows how this publication is placed within the overall core set.

A dynamic context

All these indicators have to be viewed in a dynamic context: none of them is necessarily final or exhaustive in character: they may change as knowledge and perception of environmental problems evolve. Furthermore, they are of varying relevance for different countries and different contexts.

Preliminary application of the Pressure-State-Response model to rangeland management.

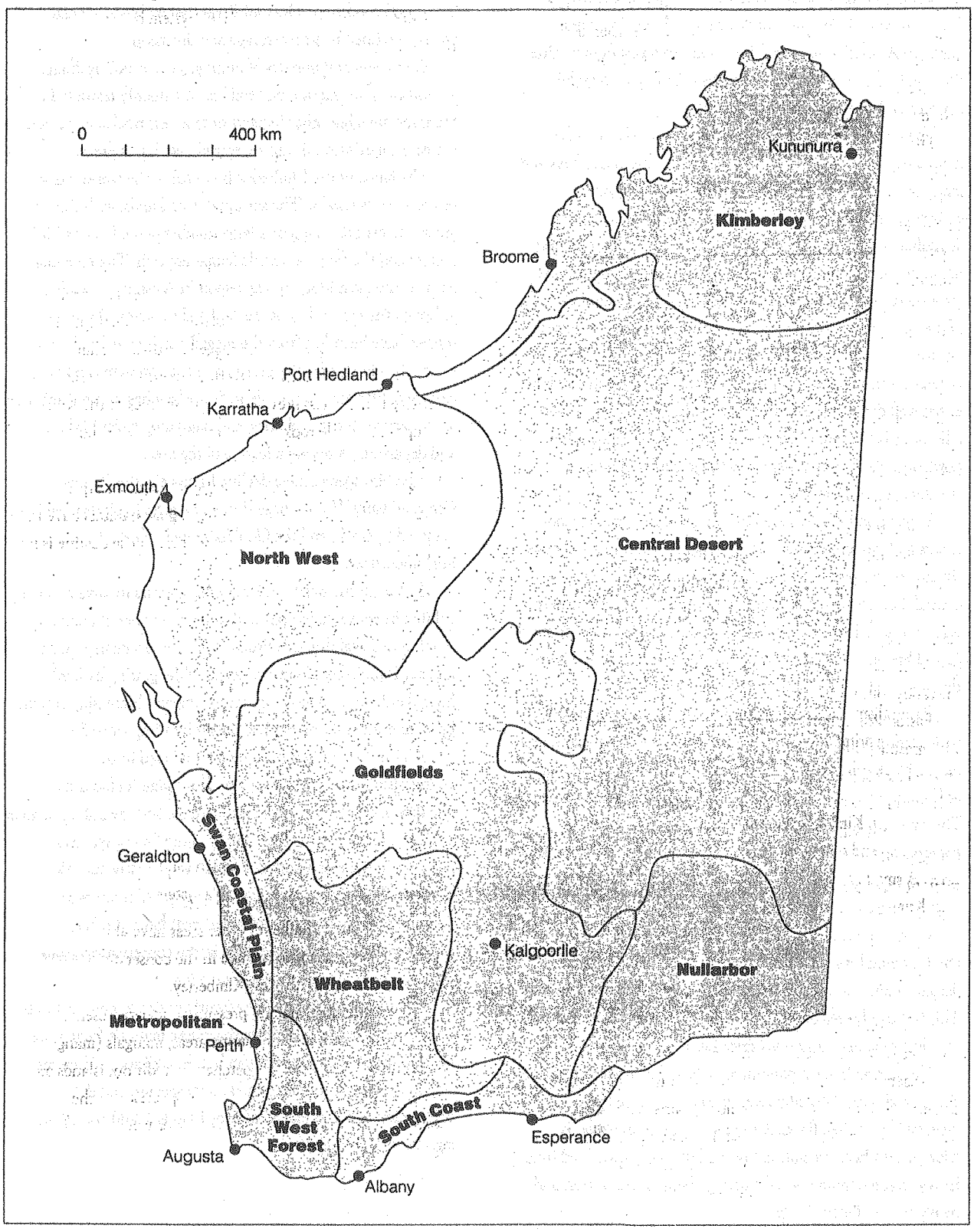
	PRESSURE Indicators of environmental pressures	STATE Indicators of environmental conditions	RESPONSE Indicators of societal responses
PRIMARY ISSUES **Biodiversity** **Land degradation** **ASSOCIATED ISSUES** **Climate change** **Desertification** **Landscape amenity**	PASTORAL PRODUCTION • artificial watering points for pastoral production • grazing (domestic, feral and native animals) • artificial land management boundaries • fire as a management tool MINING • mineral exploration, extraction and processing (Pilbara, Goldfields) OTHER • establishment of - - *horticulture (Kununurra, Carnarvon);* - *industry;* - *townsites; and* - *infrastructure (railways, roads, ports, communications)* • exotic and feral species (eg foxes, rabbits, cats, goats, pigs) • off-road vehicles • tourism	BIODIVERSTY • species and communities extinct, modified and threatened; eg, *11 [8%] terrestrial mammals extinct* *6 terrestrial mammals extinct on the mainland* *35 threatened vertebrate species* • vegetation clearance, degradation and loss • colonisation by introduced species LAND DEGRADATION • Land degradation, loss of rangeland productive capacity and increasing surface runoff and erosion *80% fair to good vegetation condition* *20% poor vegetation condition* *7% degraded by soil erosion* *2.5% serious soil erosion* OTHER • Reduced landscape amenity • increasing tourist visitation	BIODIVERSITY CONSERVATION • A comprehensive, adequate and representative conservation reserve system established • The protection and conservation of important ecosystems and habitats outside protected areas • control of exotic flora and fauna SUSTAINABLE DEVELOPMENT • Land use adjacent to protected areas is sympathetic to the conservation of protected areas • Land use is based on land suitability • Best environmental practice is the basis for pastoral and mining activities and land management

Appendix C

Extract of State of the Environment Report, Regional Summaries (December 1992).

REGIONAL SUMMARIES

Western Australia's regions



KIMBERLEY

The Kimberley has a summer wet season with thunderstorms, monsoonal rain and occasional tropical cyclones that may bring destructive winds and intense rain, and a long winter dry season. Its marine environment is affected by the warm nutrient-rich South Equatorial Current that flows through the Asian and northern Australian regions. The waters are turbid from marine life, and in the near shore areas are disturbed by strong tidal currents and river discharge in summer.

The region has a great landscape diversity. The coast has many steep, rocky and deeply incised inlets, some sandy bays and mangrove shores, and extensive tidal flats in the larger embayments. Some extend great distances inland, such as at Wyndham (Cambridge Gulf) and Derby (King Sound). Inland landforms vary from the dunefields in the southern and eastern areas on the edge of the desert to the very rugged ranges and hills of the central and northern areas. The western area comprises pindan red sand-clay with a three-tier grass wattle and eucalypt vegetation and low lying undulating land. The river channels are either well defined in the landscape by deep, steep valleys and falls, or by broad sandy beds and extensive flood plains. The north-west Kimberley experiences the largest tidal range in Australia, up to 11 metres.

Vegetation includes extensive mangrove forests, monsoon forests and rainforest remnants on or near the coast and in moist riverine or fire-protected sites, savannah woodlands in the central area and spinifex savannah in the southern and eastern parts of the region. The species are either of high rainfall tropical or arid Eremaean origin. Acacia shrublands (pindan) dominate the sandy soils in the south-west Kimberley.

Pastoralism is the most extensive landuse in the Kimberley, with grazing primarily on the floodplains of the major rivers, and on the black soil plains. Horticulture occurs on black soil plains at Kununurra, and there is mining in a few discrete locations. The southern Kimberley has been subject to petroleum exploration and some evidence of this still remains in old seismic lines. A small producing oil field is found at Blina in the south-west Kimberley. Tourism is also a major industry.

In the remote northern and north western areas, environmental systems appear to be in reasonable condition despite changes to fire regimes and the impact of feral animals. This is the only area of the State that seems not to have suffered any flora or fauna extinctions since European settlement.

Vegetation in most pastoral areas is in fair to poor condition. Some areas, especially silty river flood plains, have been degraded by grazing, fire and weed invasion. Soil erosion is widespread where vegetation loss has left soils unprotected from heavy seasonal rainfall, resulting in gullying, sheet erosion and heavy river sediment loads.

The little available information about Kimberley wetlands suggests that those in pastoral areas may be affected by grazing and weed invasion, but that elsewhere they are in good condition, and add significantly to the diversity of the environment. Sedimentation in many river systems is generally "shallowing", simplifying and degrading the aquatic environment. River catchments outside pastoral areas appear to be in good condition. The Ord River System has also been greatly modified by water storage and diversion.

Environmental impacts of mining, such as tailing dumps, groundwater abstraction and soil loss, are mainly restricted to the mine area, but other impacts from access tracks, weeds and fire associated with mining are spread over larger areas.

The fauna of the Kimberley is typical of the wet-dry tropics of northern Australia. The savannah woodlands, with their open grassy understorey, support a large number of seed-eating bird species and the frog and reptile faunas are rich. The mammal fauna is the most intact of any region in Western Australia, although the pastoral areas are depleted in mammal species. No species have been lost from the rugged north-west Kimberley where the effects of cattle on riverine environments and of extensive fires are less prevalent. Some beaches in the Kimberley are important turtle rookeries, and migratory wader bird entry and departure points are a feature of the area.

Two bird species have declined seriously, the Purple-Crowned Fairy Wren, whose river-bank grass habitats have been depleted by stock, and the Gouldian Finch whose decline is not fully understood.

Although the northern Kimberley appears to have a suite of wildlife intact since pre-pastoral times, a number of factors are tending to destabilize this situation. Of these a change in fire regimes is probably of most concern, while grazing by hard-hoofed animals also has a significant impact. Increasing activity by visitors and mining has had only minor impact so far.

Almost two million hectares are included in the conservation estate in this region. This figure includes the recently purchased Mt Hart pastoral lease and several other areas of Devonian limestone fossil reef acquired for conservation purposes in the east Kimberley which total nearly 500 000 hectares. This gives a good base to a system of reserves for conservation but a number of other areas have also been identified as important to include in the conservation estate, particularly in the north-west Kimberley.

Significant areas that are presently under-represented in the conservation estate include marine areas, mangals (mangrove communities) and rainforest patches. In addition, islands are important refuges for plant and animal species, and the reservation of additional Kimberley islands would contribute significantly to the system.

NORTH WEST

The North West region comprises the Pilbara, Exmouth, Gascoyne and Shark Bay areas. Its semi-arid climate and unreliable rainfall is derived from the northern tips of large cold fronts intersecting with tropical airstreams in winter and from tropical depressions and tropical cyclones in summer. The northern parts of the region are more influenced by cyclonic summer rainfall and less by winter rainfall. Inland areas get significant patchy rainfall from thunderstorms.

The landscape consists of broad, low-lying river catchments and plains between irregular rugged ranges and hills. Vegetation ranges from coastal mangroves and mudflats to inland tree savannah and grasslands. The major river catchments include the normally dry Fortescue, Ashburton, Gascoyne and Murchison rivers, which may flood after heavy rains, but then contract to a series of permanent pools. A large artesian water basin occurs on the western coastal edge of the region.

The marine environment is dominated by the South Equatorial and Leeuwin currents, and is commonly referred as being arid marine because of the prevailing dry off-shore winds.

Pastoralism is the most extensive landuse. Large-scale iron ore mining and oil and gas operations are also found in this region. Some horticulture occurs on the Gascoyne River floodplain at Carnarvon, and offshore commercial and recreational fishing is a feature of most coastal communities.. Tourism is widespread in both marine and terrestrial areas.

Vegetation on pastoral leases is in good to fair condition but some areas, mainly on river and coastal soils, are being severely degraded. Vegetation in national parks and nature reserves in the region is in good condition.

Rivers have generally retained their original qualities, except where fringing vegetation has been lost and pastoralism or mining operations have reduced soil stability and increased sediment loads. River banks are affected by introduced plant species, and by over-stocking. Groundwater quality is generally very good. However, at Millstream, public water supply abstraction has reduced spring flows feeding riverine vegetation and river pools.

Marine waters are influenced mainly by natural phenomena such as cyclones that cause turbid waters and alter shoreline environments. No major environmental changes to marine systems have resulted from activities such as fishing and offshore oil or gas production. However, little information is available about the effects of trawling, recreational fishing and shell collecting on non-commercial fish populations or habitats, or the possible effects of long-term, incremental changes in water quality in this region.

Air quality is good except for local problems with dust from mines, iron ore stock piles and loading areas at ports at Port Hedland, Cape Lambert and Dampier, and from some degraded pastoral areas during strong winds. Asbestos particles occur in the Wittenoom area.

Little information is available about the effects of horticulture on the Gascoyne River, but nutrient levels in groundwater are increasing. Mining activity and its associated environmental impacts are most obvious, but the effects of exploration, infrastructure and the mining town populations are more widespread.

The North West is rich in birds and reptiles, and some important remnant populations of previously widespread mammals are found on Barrow, Bernier and Dorre Islands and the Dampier Archipelago.

The conservation estate in the North West is very diverse and includes marine reserves and mainland and island terrestrial reserves.

Twenty conservation reserves cover the Pilbara's 150 islands, including Barrow Island, the Dampier Archipelago and the Montebello Islands, which have been recently returned to the State by agreement with the Commonwealth. Islands, in general, have extremely high conservation values. Unlike the mainland, they have not been subjected to the impacts of grazing, extensive wildfire and introduced exotic plants and animals. They provide important refuges for animals, particularly those animals that have restricted distributions or that have declined or disappeared from the mainland, and they present the opportunity to reintroduce these species to their former ranges. Four species of marine turtles and over 20 species of seabirds also nest on Pilbara islands where they are protected from introduced predators and human disturbance.

Ningaloo and Shark Bay marine parks and the Hamelin Pool Marine Nature Reserve are located on the North West coast. The Ningaloo coral reef has been infested by the marine snail Drupella cornus.

Shark Bay's outstanding natural values were internationally recognised in December 1991 with its listing as a World Heritage Area. These values include the stromatolites at Hamelin Bay, the dugongs, whales, seagrass meadows and other marine life of the waters of Shark Bay, the spectacular Zuytdorp Cliffs, and the diverse flora, fauna and landforms of the adjacent mainland.

Major terrestrial conservation reserves in the region include the Karijini (Hamersley Range), Purnululu (Bungle-Bungle), Millstream-Chichester, Cape Range and Collier Range national parks and the Barlee Range and Mungaroona Range nature reserves.

The conservation reserve system broadly represents the major vegetation types and landforms of the region. However, vegetation communities from river systems and the north and east Pilbara are poorly represented in reserves.

CENTRAL DESERT

The Central Desert is characterised by low irregular rainfall (150mm to 200mm) from summer tropical cyclones and winter cold fronts, and extreme summer heat and near-zero winter nights.

The landscape is generally flat throughout, especially in the Canning Basin, but many ranges, hills and small plateaus occur in the Laverton-Warburton-Giles area. The numerous salt pans become lakes and support large waterbird populations following rainfall. Soils are weathered, infertile and often salt-prone.

The Region is almost completely covered with vegetation, ranging from open woodlands in the southwest near Cosmo Newberry to tree savannah and hummock grasslands near Giles. Most linear dunes are covered with spinifex, with shrubs in swales. Short-lived herbs are prolific after rain.

Surface water from heavy rainfall flows through floodways and short, shallow channels into salt pans and depressions or seeps into the ground. Groundwater varies from fresh in the Canning Basin to mostly brackish and saline elsewhere. Rare permanent pools and springs are critically important to water-dependent fauna.

Land uses include Aboriginal community areas, mineral and petroleum exploration, tourism and conservation.

The soil, water and vegetation systems are mostly in good condition. The main impact on plant communities has been fire. However, in some pastoral leases grazing has diminished vegetation. Extensive seismic lines are found throughout the central and northern parts of this region, some of which have not satisfactorily rehabilitated because of slow natural regrowth and because they have diverted stormwater run-off and become eroded channels.

Except for the central ranges, the fauna of the central desert is reasonably well known because of systematic biological surveys undertaken between 1975 and 1980, and ongoing work in the Gibson Desert Nature Reserve.

The spinifex grasslands are relatively poor in bird species, but the reptile fauna and the historic mammal fauna are rich. The reptile fauna is richer here than in any other desert ecosystem in the world. However, the medium-sized mammal fauna (more than one third of the mammal species) has been almost completely lost in the last 40 years. The main factors are thought to be changes to burning patterns, particularly Aboriginal patch-burning practices, and introduced predators (cat and fox) and herbivores (rabbits). It will be necessary to deal with these factors to avoid further extinctions. CALM has embarked on a project to reintroduce endangered mammals to desert nature reserves, which involves patch burning and the control of introduced foxes and cats.

The flora of the region is poorly known, but species richness is much less than in the south-west and far fewer species are declared as threatened. The flora is part of the central Australian desert, and extends into central Northern Territory, Queensland and South Australia. It is characterised by drought tolerant spinifex (Triodia and Plectrachne) and Cassia, Eremophila, Acacia and Solanum (tomato family) shrubs.

Widespread and severe summer wildfires occur occasionally and can degrade the environment. Erosion of roads and seismic gridlines also pose localised minor threats.

Large conservation reserves such as the Great Victoria Desert Nature Reserve (2.5 million hectares) and Rudall River National Park (1.5 million hectares) exist in the region, and incorporate representative areas of most vegetation communities and landforms.

GOLDFIELDS

The Goldfields region is flat to gently undulating with laterite breakaways and salt pans cut by major drainage lines.

The vegetation ranges from the eucalypt woodlands to mulga communities. Many of the drainage lines are poorly defined and poor drainage permits broad flooding to occur. The eucalypt woodlands are of international significance as nowhere else do trees grow as woodlands in so arid an area. Most groundwater is naturally saline and in mining areas it is used extensively to process minerals.

Pastoralism is the most extensive land use in the central and northern parts of the region; the southern part is mostly vacant Crown land. Gold mining has occurred throughout the region for over 100 years, and nickel mining has also become important since the 1960s. Vehicle-based tourism has become increasingly widespread in the past 30 years.

Vegetation in the region is mainly in good condition, except in some pastoral or mining areas. Vegetation on pastoral leases is mostly in good to fair condition but some areas have extensive vegetation loss and associated widespread erosion. Early gold mining operations harvested large amounts of timber, but the native woodlands of the region are now recovering. Many old exploration and mining sites have not been rehabilitated as they were not subject to the environmental standards now required of exploration and mining operations.

Groundwater, although saline, is in good condition. In limited areas it has been contaminated by mine tailings containing substances such as cyanide.

Air quality is generally excellent throughout the region. However, at Kalgoorlie an Environmental Protection Policy has been implemented to reduce sulphur dioxide emissions from mineral processing plants.

The fauna of the Goldfields is quite well known by Western Australian standards because of extensive biological survey work conducted between 1978 and 1982. It is a 'blended fauna' of arid zone and south-west species with relatively few endemic species. The Goldfields region has lost most of its medium sized mammal fauna through the effects of changed fire regimes and introduced species. However, the area is rich in reptiles and the woodlands support diverse bird faunas.

The flora of the region is less well known, but exhibits a similar blending of species from adjacent zones. Declared threatened species often live in deep sands, granite outcrops or the greenstone landform areas, some of which are subject to mineral exploration and mining activities.

Potential threats to biota include inappropriate grazing management, feral predators and herbivores, particularly rabbits and goats, and infrastructure developments, such as roadworks, which can affect cross-country drainage flow.

Dundas Nature Reserve (78 000 hectares) which supports eucalypt woodland typical of the southern part of the Goldfields and Wanjarri Nature Reserve (53 000 hectares) are the major conservation reserves in the Goldfields region. The Yellowdine Nature Reserve (3200 hectares) was recently established to improve representation of the interzone, that is, the area comprising a mixture of both arid and south-west flora and fauna. However, poor representation of mulga woodlands in the north Goldfields in the conservation reserve system is of major concern. Eucalypt woodlands representation has improved with the recent acquisition of two pastoral leases for conservation purposes. Additional conservation reserves are proposed to meet this deficiency.

NULLARBOR

The Nullarbor is a flat plain, the largest expanse of arid karst (limestone) topography in the world, with high vertical cliffs on the region's central coast and extensive dunefields on the western and eastern margins. The region extends into South Australia.

Its climate is mostly arid with rainfall from passing cold fronts during the winter and the remnants of tropical cyclones during summer. No rivers occur, as surface water seeps into the shallow porous soils and underlying limestone. Extensive cave systems often containing fossilized animals are a notable feature of the Nullarbor.

Vegetation ranges from mallee woodlands on the coastal fringe to treeless grasslands in central, southern and eastern areas that extend northward through mulga and myall woodlands to the extensive dunefields of the Great Victoria Desert. Vegetation is mainly in natural condition except in pastoral areas where its condition ranges from fair to poor. However, the decline of the Western Myall *Acacia papynocarpa* is of concern. Vegetation degradation caused by rabbits, fire and sheep is apparent in the north of the region beyond the fringes of pastoral settlement.

Groundwater has not been affected by human activity and ranges in quality from fresh to saline. The little information available about the region's marine systems indicates that they are in excellent condition.

Uncontrolled access by an increasing number of tourists is causing some damage from vehicle tracks, and threatening some endemic cave dwelling species and the repository of fossil history.

The region's flora and fauna are quite well known through extensive biological surveys. Both flora and fauna have been adversely affected by weeds and feral animals. The previous richness of the mammal fauna of this region is known from historic accounts and recently discovered bone deposits in cave entrances. Thirty-two mammal species were present at the time of European settlement. However a 1984 survey did not record 10 of the species known to be present before 1940. Changes to the vegetation through the effects of rabbits and stock in parts of the Nullarbor, combined with introduced predators, have caused the loss of mammal species. Bird and reptile faunas are relatively intact in the region. A small but significant endemic fauna occurs, including rare species such as the Nullarbor Quail Thrush. Many endemic, troglodytic (cave dwelling) invertebrates inhabit the Nullarbor caves.

Owing to the lack of natural barriers and its extreme aridity, the Nullarbor has particular problems with introduced plants and animals. For example, Myxomatosis fails to control rabbits because of a lack of fresh water for its host (mosquitoes). Ward's weed is also spreading dramatically, possibly as a result of comparatively uncontrolled vehicle access. Conversely, the Nullarbor has been a relatively good buffer to exotic bird species invading from the east, for example starlings.

The region's biodiversity is not well represented in national parks and nature reserves, except for the near coastal zone. Cave systems and surface karst landforms are particularly poorly presented in the conservation estate and need to be protected, mainly from human use. Unalienated Crown lands in the region provide opportunities to improve the system of conservation reserves significantly and to protect the surface karst and caves. Two large reserves in the region are proposed, one south-east of Balladonia, and the other north of Madura.