

8 Regional performance – environment

Environmental accounting is generally well developed in Australia. In part this has been driven by formal national and state commitments to a range of environmental requirements including sustainable development, biodiversity conservation and prevention of desertification. Regional reporting of environmental outputs and outcomes needs to be aligned with these commitments.

8.1 Background

As presented in *Australia: State of the Environment 1996* (Commonwealth of Australia 1996), sustainable development requires the maintenance of the following three key components of the environment:

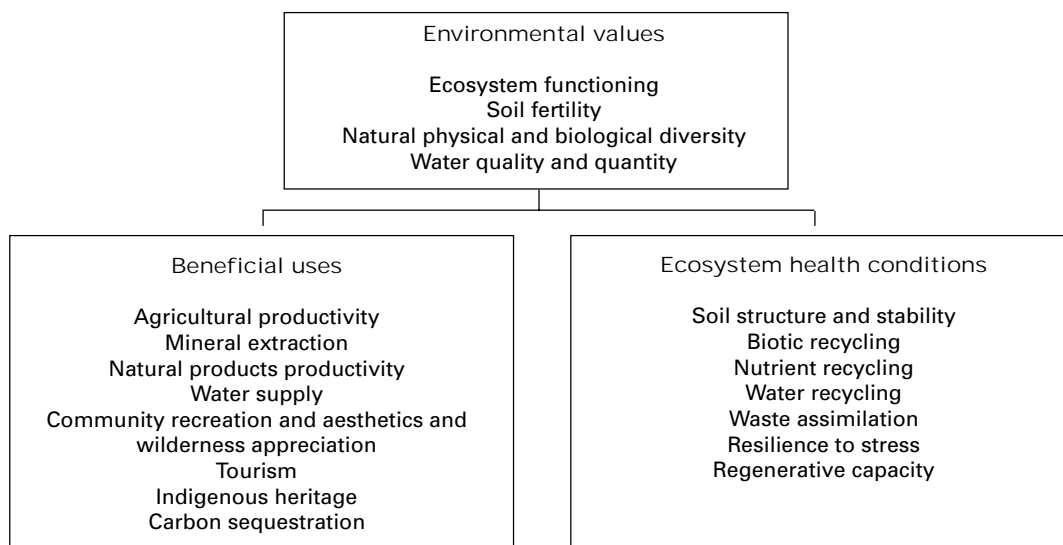
- Biodiversity – the variety of species, populations and, habitats and ecosystems.
- Ecological integrity – the general health and resilience of natural systems, including their ability to withstand stresses and assimilate waste.
- Natural capital – the stock of land, air, water and biotic resources that support essential ecological processes and sustain human existence.

In Western Australian parlance, the terms to describe the environment are those used by the Environmental Protection Authority, being:

- *'environmental value'* which is formally defined as 'particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharges and deposits' (ANZECC and ARMCANZ 1994). The fundamental environmental values contribute to forms of 'services' to life on earth, as follows:
 - those that support economic and social services are termed *'beneficial uses'*, while
 - the values that maintain the environment's own productivity are described as *'ecosystem health conditions'*.

The relationship between these three components is shown in Figure 29.

Figure 29: Environmental components



8.2 Environmental goal for regions

The goal for environmental management in the regions is:

*Developing a valued,
healthy and protected
environment*

8.3 Key result areas

Table 87 presents the key result areas for environmental management in the regions.

Table 87: Key result areas for environmental management

Key Result Area	Context		Management (response)
	Use (pressures)	Stocks (state)	
Land	Agriculture, mining, urban development etc	Current condition and trends of • Land	Environmental governance – investment in ameliorative activities – new technology, quality of reserve systems, and management plans.
Water	Water consumption etc	• Water resources	
Marine	Fishing, shipping,	• Ocean environments coastal developments	
Air	Airborne emissions,	• Atmosphere greenhouse gases	
Biodiversity	Pressures on habitats,	• Biodiversity feral predation etc	

8.4 A framework for indicator development

Both the Australian and Western Australian *State of the Environment Reports* have used the pressure-state-response model originally developed by the OECD. Use of this model is reflected in the Key Result Areas. This model can be used to develop indicators across the environmental domains of land, water resources, marine environments, atmosphere, and biodiversity.

Pressures – natural resource management

- The demand placed on the environment to provide beneficial uses, including resource use, waste discharge and emissions.

State – the stocks and value of natural resources

- The state of the natural resources can be measured at a given point in time, but it is more valuable if trends over time can be detected and reported.
- The stocks of the natural capital within the region – land, water, air, biota and mineral resources (state - quantity).
- The ability of that natural capital to contribute to ecological health conditions, including ecological processes, biodiversity, the ability to recycle nutrients and water and assimilate waste (state - quality).
- The ability of that natural capital to deliver beneficial uses (state – quantity and quality).

Response – Mechanisms and management

- Actions taken in maintaining stocks and capacity to provide services – legislation, administration, market instruments, public and private investment, recycling, waste minimisation, education and awareness, and carbon and salinity trading (response).

8.5 Regional environmental indicators

8.5.1 Land use

Land resources support mining, agricultural, pastoral, industrial and urban developments, and linear infrastructure. In the regions, the dominant uses are mining and agriculture, with a relatively small area devoted to urban development relevant to the metropolitan area. The presentation of environmental indicators for land resources considers the area of land used for mining, the level of land clearing activity and the condition of the land resources used for agriculture and pastoral grazing.

8.5.1.1 Land use for mining

Indicator: Area of land used for mining

Background

Mining is an important and very high value land use in Western Australia. It occurs across all regions, with the most extensive activity occurring in the Goldfields-Esperance, Mid West and Pilbara regions. A sensible indicator of the impact of mining on land resources is the area of land subject to mining or intensive mineral exploration.

Current situation

A total of 100,000 hectares in WA is currently used for mining. An indication of the regional level of activity is the value of Rehabilitation Bonds held by the Department of Minerals and Energy (now Department of Industry and Resources) at February 2002. These figures, shown in Table 88 remain relatively constant throughout the year and are calculated on a per hectare value.

Table 88: Estimated area of mined lands, February 2002

Region	Mining Bonds (\$'000)	Estimate of mined area (km ²)	Percentage of total State mining area	Area of region (km ²)	Percentage of region mined
Gascoyne	154	0.5	0.1	136,110	Insig.
Goldfields-Esperance	166,961	580	57.8	771,276	0.07
Great Southern	3,479	120	1.2	38,917	0.03
Kimberley	3,126	11	1.1	421,451	Insig.
Mid West	71,811	249	24.8	470,000	0.05
Peel	1,023	4	0.4	5,500	0.07
Pilbara	17,276*	59*	6.0*	505,000	0.01*
South West	6,306	21	2.2	23,970	0.09
Wheatbelt	18,296	63	6.3	154,862	0.04
Regional WA	288,433	996	99.8	2,527,086	0.04
Perth	614	2	0.2	5,387	0.04
WA	289,047	998	100.0	2,532,473	0.04

Source: Department of Minerals and Energy.

* an under-estimate, as many of these mines are covered by State Agreement Acts

For example, exploration attracts a Bond of about \$1,000 per hectare, disturbance by location of a waste rock dump about \$5,000 per hectare and a large tailings dam will have a Bond of about \$10,000 per hectare.

The Bonds are held by Government and released on completion of rehabilitation. Assuming an approximate value of \$3,000 per hectare, the Department of Minerals and Energy (2000) suggests that a total of 99,600 hectares or 996 square kilometres are being used for mining across the regions. Most of this activity is occurring in the Goldfields-Esperance, Pilbara and Mid West regions, with lesser activity in the Wheatbelt and Kimberley regions. The area used for mining in the Pilbara is underestimated in Table 89, as many of the mining operations in the region have been established under State Agreement Acts and therefore do not attract Rehabilitation Bonds.

Comment

Compared to the total area of the regions, as shown in Table 88 mining is a very small land user. While the total area of mined land – 998 square kilometres in total appears large, it represents about 0.04 per cent of the total land area in WA, or an area equivalent to 60 per cent of the built up area in the Perth region.

Indicator: Quality of environmental management in the mining industry

Background

Exploration, extraction and processing of the State's minerals is regulated through resources development, mining and environmental protection legislation. Through this legislation, Government establishes environmental standards for the industry and for individual mining operations. Environmental performance conditions are attached to individual operations.

Current situation

Mining companies are provided with regulatory, technical and policy advice services, mainly through the Department of Industry and Petroleum Resources. Mining companies compete for the State administered *Golden Gecko Awards* for quality in environmental management. Mining companies act on environmental requirements established in their licenses to mine, and also through their own policies and procedures.

Comment

An increasing number of major mining companies that are active in regional WA, including Alcoa World Alumina, Anglo-Gold, BHP Billiton, Placer Dome, Rio Tinto and WMC Limited produce external reports describing their environmental performance.

8.5.1.2 Land use for agriculture and pastoralism

Indicator: Land use for agriculture and pastoralism

Background

A significant area of Western Australia, concentrated mainly across the south west corner has been cleared of native vegetation for agricultural use, mainly broadacre cropping and grazing. Agriculture on the cleared land in the south west of the State contributes significantly to the State's economy, with gross product being about \$5 billion per annum, and growing at a rate of about 3 per cent per annum.

East and north of a line extending from Kalbarri to east of Esperance, about one third of the land is used for grazing sheep and cattle on pastoral leases (termed 'pastoralism') with small areas of intensive irrigated agriculture at Kununurra, Broome and Carnarvon.

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A much smaller area of the State has been cleared for industrial and infrastructure purposes, with the areas and changes in these areas being insignificant at regional scale.

Table 89 shows the area used for agricultural and pastoral use in each region.

Table 89: Agricultural and pastoral land use

Region	Area of region (km ²)	Agricultural use		Pastoral use	
		Use (km ²)	Percentage	Use (km ²)	Percentage
Gascoyne	136,110	20	0.01	113,000	83.0
Goldfields-Esperance	771,276	16,300	2.1	154,000	20.0*
Great Southern	38,917	28,000	71.9	Insig	Insig
Kimberley	421,451	150	0.04	230,000	54.6
Mid West	470,000	41,400	8.8	274,000	58.3*
Peel	5,500	614	11.2	Nil	Nil
Pilbara	505,000	Insig	Insig	134,734	26.7*
South West	23,970	11,300	47.1	Insig	Insig
Wheatbelt	154,862	107,000	69.1	Insig	Insig
Regional WA	2,527,086	204,784	8.1	905,734	35.8
Perth	5,387	na	na	0	0
State Total	2,532,473	na	na	905,734	35.8

Source: Adapted from the Economic Perspectives Reports – Department of Local Government and Regional Development.

* most of the remainder of the region is unallocated crown land

Current land clearing activity

Land clearing in the past has been managed by a number of different departments and regulatory bodies. Land clearing data is subsequently difficult to collate and summarise at both State and Regional levels. In the Department of Agriculture Annual Report 2000-2001, the Commissioner for Soil and Land Conservation issued an annual statement which noted the downward trend in notified clearing continued in response to changing community attitudes and the progressive tightening of controls. The Environmental Protection Amendment Bill 2002 currently before Parliament aims to simplify the land clearing approval process through a permit system.

Table 90 shows recent clearing activity across the whole State. It is evident that the rate of land clearing for agricultural and industrial/infrastructure purposes has slowed substantially as a result of policy changes in Government. These data show that the rate of clearing is about 12 square kilometres per annum, with about 57 Notices of Intent (NOIs) being lodged annually. About half of the applications are rejected on environmental grounds.

Table 90: Area of land cleared 1998-2001

Approval Stage	1998/99	1999/00	2000/01
Number of NOIs received by the Commissioner for Soil and Land Conservation*	ND**	58	57
Area proposed for clearing (ha)	ND	2,897	2,722
Area of no objection to clearing for agriculture (ha)	617	89	535
Area of no objection to clearing for infrastructure (ha)	759	289	499
Area referred by the Commissioner to the EPA (ha)	ND	1,124	366
Area of no EPA objection to clearing (ha)	ND	0	0
Area referred to the Water and Rivers Commission (ha)	ND	70	93

Source: Department of Agriculture.

* a Notice of Intent (NOI) is required if the proponent wants to clear more than one hectare

** ND – no data

Comment

This level of activity compares to a total cleared area for agriculture alone of 197,000 square kilometres. As such, clearing activity is likely to be of little value as an indicator of pressure on land resources. Better indicators, which are defined in following sections will relate to the condition of the land resources used for agriculture and pastoralism.

Indicator: Environmental management in allocating land for agriculture and pastoralism

Background

Ultimately, the Crown has responsibility for how all land is used and will establish uses and tenures as required to meet policy objectives. The use of land for agricultural, industrial, pastoral, urban and infrastructure uses is regulated under a range of statutes, including the *Land Act 1903*, the *Soil and Land Conservation Act 1945*, the *Environmental Protection Act 1986* and planning statutes.

Current situation

The area held under pastoral leases is contracting slowly as land is re-allocated into higher priority uses. These include irrigated agriculture, Indigenous habitation, mining, recreation and conservation. Statistics on the extent of this change are difficult to determine as in many situations although the effective land use has changed, the tenure (pastoral lease) has not. This is in part due to restrictions on tenure change required under the *Native Title Act 1993*.

At the operational level, recent policy and administrative decisions by Government have increased the environmental requirements to be satisfied before allowing significant land use change within a given tenure type, particularly in respect of clearing of native vegetation for broad-acre agricultural use. For example, the Commissioner of Soil and Land Conservation requires proponents to demonstrate that the environmental impacts of clearing can be managed satisfactorily for all projects where more than a hectare will be cleared. These requirements to be addressed for agricultural clearing are now approaching those which have applied in respect of land for mining or linear infrastructure over recent decades.

Comment

As demonstrated in Table 90, the level of clearing of native vegetation is now very low, and will remain so except for specialist needs where the planned land use is of sufficient value to be able to address environmental requirements (e.g. the planned Ord Stage 2 Project to expand irrigated agriculture in the East Kimberley).

8.5.1.3 Management of agricultural land

As noted in Section 8.5.1.2 agriculture is the dominant land use across the south west of Western Australia. Of a total of 26.7 million hectares in the south western corner of the State (the agricultural zone), 19.7 million hectares are farmed. In the areas with average rainfall of less than 500 mm, the dominant activity is broadacre annual cropping of cereals, pulses and oilseeds. In areas with between 500 and 700 mm, grazing for sheep and cattle production dominates. In higher rainfall areas in the South West region, agricultural use is very diverse, with intensive horticulture, viticulture, dairying and agro-forestry as important uses.

Three impacts of agricultural land use are:

Rising groundwater levels – on-site and off-site impacts

Rising groundwater levels are evident across much of the farmed land in the agricultural zone. This effect, due to the replacement of high water using perennial vegetation with low water using annual crops and pastures is a consequence of the farming systems that have been developed for WA conditions. The impact of rising ground water levels on the area at risk of shallow water tables and secondary salinity effects is shown in Table 91.

Acidifying processes on agricultural lands – an on-site impact

The incorporation on leguminous crops and pastures, and the use of nitrogenous fertilisers, both of which are essential for the productivity of WA farming systems, result in a slow process of soil acidification. This process, a natural consequence of the nature of our farming systems, will if severe enough, result in depressed yields of crops and pastures. Recovery of acidified terms require addition of lime, which will be an added cost of production. The extent of acidified land is shown in Table 92.

Nutrient losses from agricultural lands – an off-site impact

Applications of phosphorous (P) and nitrogen (N) fertilisers are essential for the maintenance of agricultural productivity on Western Australia's generally infertile soils. Leakage of these nutrients from agricultural lands, combined in some places with nutrients from intensive animal industries can accumulate in water bodies and wetlands, resulting in a process called 'eutrophication', which can damage the environmental values in these areas. In extreme situations, raised nutrient levels in water bodies can result in harmful algal blooms as seen following heavy summer rains in January 2000. The impact of nutrient losses on riverine health is shown in Table 103.

Indicator: Land resource condition

Background

Two sub-indicators are presented that address on-site impacts. The first is the area affected by shallow water tables, now and in the future. The second is the extent and severity of soil acidity that is sufficient to impact crop and pasture yields, and which will require treatment in the future.

Current situation

Area of land threatened by shallow or rising water tables

In Table 91, the areas of land threatened by shallow water tables are estimated for the six regions that cover the agricultural zone. The predictions, which were developed for the National Land and Water Resources Audit suggest that the increase in land area at high risk of shallow water tables will be most pronounced in the Wheatbelt, and along the south coast. Losses of production will occur in these areas, especially where the presence of shallow water tables leads to enhanced secondary salinity. Off-site impacts will be more serious, with predicted loss of biodiversity in areas at risk, increased salinisation of streamflows, and damage to rural infrastructure.

Table 91: Estimated areas of land threatened by shallow water tables, 2000

Region	Total area in agric zone	Area at high risk of shallow water tables in 2000 (% of total area)**	Area at high risk of shallow water tables in 2050 (% of total area)**
Mid West	4.9 m ha	1.0 m ha (20%)	1.2 m ha (24%)
Wheatbelt	10.7 m ha	2.0 m ha (19%)	3.2 m ha (30%)
Goldfields-Esperance	3.9 m ha	0.5 m ha (13%)	1.1 m ha (28%)
Great Southern	2.8 m ha	0.1 m ha (4%)	0.5 m ha (18%)
Peel	0.6 m ha	minimal	minimal
South West	3.8 m ha	0.06 m ha (1%)	0.2 m ha (5%)
Total for agricultural areas	26.7 m ha*	3.6 m ha (13%)	6.5 m ha (24%)

* Total area. Area farmed is 19.7 million ha

** Regional breakdown for areas at risk are estimates only as the data have not been collected at RDC scale.

Source: Short, R. and McConnell, C. (2001).

Soil condition – areas affected by high soil acidity

Soil acidity already constrains yields on 3 million hectares in the agricultural zone – representing 15 per cent of the 19.7 million hectares farmed. Its impact on economic outcomes from agriculture is higher than is dryland salinity.

Table 92 presents available estimates of the areas at risk of sub-surface acidity in the six regions covering the agricultural areas. The total area at risk of lowered plant yield due to soil acidity in the future is shown, which equates to the area that will require treatment to lower the degree of soil acidity. These data highlight the extent of soil acidification as an issue affecting agriculture in these region.

Table 92: Impacts of soil acidity, 2002

Region	Agricultural land holdings (million ha)	Areas requiring treatment for soil acidity in 2000	Percentage requiring treatment (million ha)
Goldfields-Esperance	1.63	0.69	42%
Great Southern	2.79	1.61	58%
Mid West	4.14	2.98	72%
Peel	0.15	0.13	83%
South West	0.67	0.62	93%
Wheatbelt	10.19	6.84	67%

Source: Department of Agriculture.

Indicator: Environmental management in agriculture

Background

Government provides research, advice and regulatory services to support sustainable use of agricultural land. Major initiatives relevant to the impacts presented above are the implementation of the State Salinity Strategy, the Soil Acidity ('*Time to Lime*' campaign) Program, regional and local strategic planning, and direct investment in improved land use and management. Regulatory activities are mostly undertaken under the *Soil and Land Conservation Act 1945*. The Commonwealth is a significant investor in agricultural land use and management, through the Natural Heritage Trust, which between 1996 and 2001 invested about \$30 million per annum in the WA agricultural areas.

Current situation

Adoption of desirable practices is increasing. Under the impetus of the *Time to Lime* campaign, the initial target of 450,000 tonnes of lime applied by 2002 has been exceeded and a new target of 750,000 tonnes has been set. Using data from surveys commissioned by the Department of Agriculture, Table 93 shows the percentage of farmers in the wheat-sheep and high rainfall areas that have adopted selected sustainable land management practices. Generally, the responses show that a high proportion of farmers use some of the desirable sustainable land management practices, with others much less adopted.

Table 93: Percentage of farmers who use selected sustainable land management practices

Selected management practice	98/99	99/00	00/01
Use of perennial pasture species	46 (64)*	58 (50)	54 (59)
Stubble retention or mulching to minimise degradation	73 (24)	68 (27)	69 (33)
Manage crop rotation to minimise degradation	87 (32)	85 (42)	83 (47)
Tree/ shrub planting	67 (44)	64 (59)	53 (43)
Preserve or enhanced areas of conservation value	57 (77)	60 (75)	82 (48)
Working to the contour (to minimise soil loss)	75 (36)	72 (33)	71 (41)
Excluded stock from areas impacted by land degradation	78 (66)	43 (69)	75 (37)
Protected river or creek frontages from grazing animals	37 (43)	45 (40)	54 (32)
Regular soil testing or monitoring	65 (42)	64 (54)	68 (60)
Regular monitoring of the watertable	40 (30)	47 (25)	40 (29)
Regular monitoring of pasture/ vegetation cover	61 (61)	81 (74)	77 (77)
Surface water control through level banks	56 (26)	53 (28)	44 (14)
Surface water control through grade banks	57 (21)	51 (22)	57 (22)

* figure mentioned first is for the wheat-sheep area; figure in parentheses is for the high rainfall area

Source: Department of Agriculture.

8.5.1.4 Management of pastoralism

Rangelands cover 70 per cent of the State's land surface, located north and east of the agricultural areas. As defined in the *National Principles and Guidelines for Rangeland Management* (Commonwealth of Australia 1999), rangelands 'comprise the low rainfall and variable climate arid and semi-arid areas, and north of the Tropic of Capricorn, some seasonally high rainfall areas'. Rangelands have been grazed for sheep and cattle production since the 19th century, with approximately 95 million hectares held as pastoral leases within 450 pastoral businesses. Rangeland grazing is a significant land use in the Kimberley, Pilbara, Gascoyne, Mid West and Goldfields-Esperance regions.

Indicator: Level of grazing use

Background

The State Government, through the Pastoral Lands Board establishes estimated potential carrying capacities for pastoral leasehold land. These figures assume that all parts of the pastoral lease are within grazing distance of permanent water, and that the rangelands are all in good condition. Livestock pressure as reported by lessees annually. However, they do not need to declare how the domestic stock were distributed spatially on the leasehold area, and thus the ratio of actual to potential carrying capacity (livestock pressure) is limited in its interpretative value.

The overall level of grazing use is low, which reflects the limits to the productivity of these lands. In the southern shrublands that occur within the Gascoyne, Mid West and Goldfields-Esperance regions, grazing intensities vary between 4 and 8 dry sheep equivalents (DSEs) per square kilometre. The Pilbara pastoral lands are grazed at about 8 DSEs per hectare, while the more productive grasslands in the Kimberley are grazed at about twice this rate.

Current situation

Livestock pressure is consistently high in parts of the southern rangelands (Pilbara, Mid West, Gascoyne regions, fluctuating around 100 per cent of estimated potential carrying capacity. In other pastoral areas, livestock pressures are between 40 and 90 per cent. Areas in which stocking pressure is low tend either to be:

- those with poor economic potential for grazing use, and/ or
- those in which livestock production is no longer the most important source of income to the lessees – these include situations where pastoral leases are held by mining companies, Indigenous communities and private conservation bodies.

For example in the Goldfields region, the ratio of actual to potential livestock rarely exceeds 70 per cent.

Comment

Trends over time to 1998 suggest little change in livestock pressure in the southern rangeland areas. In the Kimberley, livestock pressure has declined from a high of about 100 per cent in 1985 to a low in the mid-1990s of about 60 per cent (Source: Department of Agriculture Report to the Pastoral Lands Board, July 1999).

Indicator: Range condition and trend

Background

The Western Australian Government commenced a program of describing the nature and condition of the rangelands leased for grazing in the late 1960s. Most of the land area has been surveyed, as shown in Table 94, with investigations underway in areas not covered in the Pilbara and Goldfields-Esperance regions. At the same time, Government also began developing techniques for measuring trend in the lands leased for grazing.

Table 94: Range condition in Western Australia

Region	Rangeland survey (and year commenced)	Survey area (sq km)	% of region under pastoral use	Range condition (percentage)		
				Good	Fair	Poor
Kimberley*	West Kimberley (1972)	89,600	55	19	51	30
Pilbara*	Ashburton (1976)	61,128	27	64	51	27
	Roebourne Plains (1987)	10,200		27	9	22
Gascoyne	Gascoyne (1969)	68,700	83	6	45	65
	Carnarvon Basin (1980)	74,489		32	29	23
Mid West	Murchison (1985)	85,890	58	21	45	37
	Sandstone-Yalgoo (1992)	94,713		32	42	23
Goldfields-Esperance*	North-eastern Goldfields (1988)	110,570	20	39	33	28

* incomplete coverage

Source: Department of Agriculture.

The term 'range condition' is used to describe the state of the perennial vegetation and soil, relative to the undisturbed state. The term is controversial, given that it is generally assessed in the context of the use of the land for grazing. The results of the surveys show that the landscapes used for grazing have been changed from their original state, with areas having lost vegetation and soil resources.

Current situation

The information in Table 94 represents a 'snapshot' of the range condition at the time of survey. Trends in perennial vegetation and soil characteristics are being captured through the Western Australian Rangeland Monitoring System (WARMS), which is managed by the Department of Agriculture.

In the Kimberley region of a total 369 fixed monitoring sites installed on grazing land by 1998, 100 were re-assessed in 1998 for changes that had occurred in the period 1995 to 1998. Positive range trend was found on 19 sites (19%), no change was observed 74 sites (74%) and declining range trend was found on 7 sites (7%) (Source: Department of Agriculture Report to the Pastoral Lands Board, July 1999).

More recent information for 223 fixed sites in areas within the Gascoyne and Mid West regions shows that through the 1990s, a period of generally above average rainfall, the population of perennial plants, mainly shrubs has grown by an average of 47 per cent. If most of these new plants survive, this will be a significant and generally desirable pulse of increased shrub density in the southern rangelands. Canopy size for perennial plants increased on 96 per cent of the sites by an average of 81 per cent. Species richness by site increased an average of 15 per cent. Observations in the Kimberley rangelands also suggest recruitment of perennial grass species through the 1990s, with the frequency of these species increasing from 77 to 81 percent across all sites.

Comment

Although it is important to treat these sample results with caution, the observed trends, which occurred over a run of favourable seasonal conditions suggest that the grazed rangelands have the capacity to improve quite markedly given the right conditions (Source: *pers comm.* Department of Agriculture 2002).

Indicator: Environmental management in the pastoral industry

Background

The State has a *Managing the Rangelands* policy statement, and the Environmental Protection Authority is developing a Position Statement for the rangelands. Rangelands leased for grazing are administered by the Pastoral Lands Board, with input and advice from other Government departments. Pastoral lessees are required to meet set environmental management standards, with regular inspections to ensure that these standards are being met. The Gascoyne-Murchison Strategy (1998), which operates in the Gascoyne and Mid West regions was established with federal government support to address structural, environmental and industry development issues. The strategy has invested funds in industry and community development, and environmental protection and management.

Government places considerable effort in promoting adoption of sustainable management practices in pastoral areas. Table 95 reports results from surveys which examined the extent of adoption of desirable practices. These data, presented for the whole pastoral area, show that most primary producers in the rangelands maintain sustainable practices, with a small trend to increased adoption over time.

Table 95: Percentage of pastoral leaseholders who use selected sustainable land management practices

Selected management practice	98/99	99/00	00/01
Permanent control methods on stock water supplies	91	67	67
Rotational pasture spelling during plant growth season	56	50	57
Specifically spelled pastures for subsequent use by export cattle	23	23	32
Fencing to land systems	56	64	57
Excluded stock from areas impacted by land degradation	60	56	66
Protected river or creek frontages from grazing animals	25	36	36
Conducted a prescribed burn for management purposes	32	24	36
Preserve or enhanced areas of conservation value	49	50	66
Formal monitoring of vegetation/ pasture condition	77	82	83

Source: Department of Agriculture.

8.5.1.5 Forest management

Indicator: Forest condition

Background

The vast majority of timber harvesting occurs in the Peel and South West regions of WA, with lesser activity in the Great Southern region where the creation of new National Parks has greatly reduced the areas available for harvest. Minor timber harvesting also occurs in the Goldfields-Esperance, Wheatbelt and Kimberley regions.

Current situation

Historically the timber industry has relied on pine plantations and native forests for sawlogs with woodchips produced as a by-product. Over the last 10 years there has been significant investment in short rotation eucalypt plantations, established in high rainfall (>600mm) agricultural areas. These plantations are now maturing and are destined for the production of fine writing paper and packaging material.

Table 96 presents the total picture for the timber industry across the south west of the State. These predicted data show a reduction in the harvest of sawlogs from the native forests, with a ramp-up of production of 'chiplogs' from the tree plantations that have been established over the last decade.

Table 96: South West WA - Wood supplies and trends to 2013

Year	Native Forest Jarrah		Native Forest Karri		Plantation Chiplog (m ³)*
	Sawlog (m ³) Logs (m ³)	Other Bole	Sawlog (m ³) Logs (m ³)	Other Bole	
2001	273,000	ND	124,000	ND	650,000
2002	190,000	ND	65,000	ND	1,000,000
2003	170,000	ND	55,000	ND	2,151,000
2004	106,000-164,000	499,000	31,000-62,000	80,000+	2,151,000
2005	106,000-164,000	499,000	31,000-62,000	80,000+	2,151,000
2006	106,000-164,000	499,000	31,000-62,000	80,000+	3,226,000
2007	106,000-164,000	499,000	31,000-62,000	80,000+	4,036,000
2008	106,000-164,000	499,000	31,000-62,000	80,000+	4,310,000
2009-2013	106,000-164,000	499,000	31,000-62,000	80,000+	4,310,000

Source: Conservation Commission (2002) and URS Forestry (2002)*.

Table 97 breaks the production of hardwood timber down to regions scale. Most of the State's hardwood timber harvest comes from the South West region, based on the stands of jarrah and karri located in those areas. An exception to this is the sandalwood harvesting industry, which has provided export income to Western Australia since the very earliest days of European settlement.

Most of the sandalwood now comes from the Goldfields-Esperance region. This is a very high value product, worth about \$4,000 per tonne.

Table 97: Hardwood production from the regions (1999/00)

Region	Quantity (tonnes)	Value (\$m)
Goldfields-Esperance*	2,000	7.5
Great Southern	insig	0.04
Peel	136,500	9.4
South West	1,300,000	64.5
Total	1,500,000	81.44

Source: Australian Bureau of Statistics (2002).

* Sandalwood production

Table 98 focuses on the plantation industry which has grown rapidly over the last decade. Commercial blue gum production commenced in the early 1990s, as a result of direct investment through private and public sectors. Land has been acquired in a number of ways including purchase, long-term lease, or payment of annuities to landholders. There are now about 1,960 square kilometres of commercial tree plantations in this area, and industry growth has the strong support of the State Government.

Most tree plantations grow Tasmanian blue gums (*Eucalyptus globulus*) mainly located in areas where annual rainfall exceeds 650 mm per annum. The area used for commercial blue gum production has previously been cleared for grazing or dairying. In these higher rainfall areas, increasing diversity of land use is occurring, with wine grapes, commercial timber, horticulture, aquaculture and farm-based tourism emerging as significant land uses in recent years. In some localised situations, tree plantations have become a dominant land use. In the lower rainfall areas, incentive schemes are promoting the establishment of eucalypt sawlog species and maritime pine (*Pinus pinaster*).

Table 98: Eucalypt plantation areas

Region	Area (ha)	YIYO ¹ production (m ³)
Goldfields-Esperance	7,000	154,000
Great Southern	127,000	2,793,000
Peel	3,000	66,000
South West	59,000	1,297,000
Total	196,000	4,310,000

Source: URS Forestry data (2001).

¹ YIYO = Year In Year Out

Also a significant sector is the already established softwood plantations. Within Western Australia there are 97,591 ha of industrial plantations and 850 ha of farm forestry, totalling 98,441 ha of softwood plantations. Forestry resources are either within the industrial plantation sector or farm forest plantations. Within the industrial plantation sector, 32 per cent are softwood, however, there has been a significant shift from predominantly softwood plantations to hardwood plantations. Within farm forest plantations, 13 per cent of total plantations are planted to softwoods. Softwood plantations exist in the Mid West, Perth, Wheatbelt, Peel, South West and Great Southern regions, encompassing the south west section of the State.

Indicator: Environmental management in forestry

Background

The current Forest Management Plan is due to expire in 2003. Due to the high level of public interest in forest management the State Government has brought forward the plan's review process. Further, in August 2002 it released the draft Forest Management Plan for 2004-2013.

Current situation

The State Government is currently committed to making available 804,000 ha of Jarrah forest and 61,000 ha of Karri forest for timber harvesting. This area is expected to meet contracted sawmill supply volumes over the period of the new management plan and beyond. In order to support adjustment to the reduced supply levels, the State Government has allocated \$137.9m towards the restructuring of the timber industry and for exit assistance. Expenditure to the end of September 2002 totals \$58.8m.

Environmentally, the establishment of tree plantations on grazing land has been beneficial. Replacement of the annual crops and pastures farming system by perennial farming systems, including plantation timber will result in higher *in situ* water use, lowering of groundwater levels and reduced stream and land salinisation. For example, there is evidence that the extent of tree-farming in the Denmark River Catchment has been sufficient to reverse the salinising trend which is a very favourable public outcome. Public land and water managers are actively promoting tree establishment to improve the hydrological situation in those catchments identified as being possible future domestic and industrial water resources.

Treefarm establishment is seen as having a positive impact on nutrient pollution, with less nutrient loss into water bodies than with annual crops and pastures. For example in the Torbay catchment in the Great Southern region, grazing and dairying collectively contribute over 70 per cent of the P and N in the inlet, whereas tree plantations contribute less than 2 per cent. Similarly, tree plantings adjacent to water-logged or excessively inundated wetlands can reduce the hydrological threats to these environmental assets. Many treefarms include areas of remnant bushland and wetland, of varying value to the regional conservation objectives and in varying condition. Removal of grazing from these areas as part of normal treefarm management will be very beneficial in improving the condition of these remnants.

Comment

While the environmental benefits are clear, land use change at this scale has caused some tensions in rural communities, who have expressed concern about a loss of traditional farming landscape, reduced resident population in rural areas and reduced critical mass for sporting, community service and recreational activities. These concerns, which were most keenly expressed in the period of rapid growth in the mid 1990s, have reduced as timber companies have matured and have become recognised more for their contribution to local investment, employment and community development.

Research into sandalwood recruitment and survival is establishing the basis for a more sustainable industry in native harvesting, plus the development of commercial sandalwood plantations.

8.5.2 Water resources

Indicator: Use:availability of divertible supply

Background

At a national scale, only 32 per cent of the surface water in Australia can be diverted from streamflow by pumping or storage in dams. After considering environmental needs, about 20 per cent of the total run-off can be sustainably diverted for human uses. In WA, many of the south west streams are saline which prevents their use for domestic and irrigation supplies which further reduces this percentage. It is significant too that many of the river basins with large divertible flows are located a very long distance from potential water uses.

Current surface water development

Table 99 presents the level of water surface development for the major catchments in the regions.

Table 99: Indicative surface water development

Region	Catchments	Surface water development
Gascoyne	Gascoyne, Wooramel, Lyndon-Minilya	Low development (less than 30%)
Goldfields-Esperance	Internally drained areas South coast streams	Low development (less than 30%)
Great Southern	South coast streams	Low development (less than 30%)
Kimberley	Ord, Fitzroy, Drysdale, North Kimberley Rivers, Dampier Peninsula	Low development (less than 30%)
Mid West	Murchison, Greenough, Chapman, Hill Moore*, Internally drained areas	Low development (less than 30%)
Peel	Peel-Harvey Inlet	Medium development (30 to 70%)
Pilbara	De Grey-Oakover, Coastal Rivers, Ashburton	Low development (less than 30%)
	Fortescue	Medium development (30 to 70%)
South West	Blackwood*, Geographe Bay, Warren-Tone	Low development (less than 30%)
	Collie	Medium development (30 to 70%)
Wheatbelt	Avon*	Low development (less than 30%)
Metropolitan area	Helena, Canning	Medium development (30 to 70%)

Source: National Land and Water Resources Audit (2001).

* saline streams

Current water resources, flows and yields

In respect of those resources that have been developed, water use over the last 15 years has roughly doubled and groundwater use has increased threefold, primarily in the Perth sedimentary basin. Surface water use has risen by 40 per cent over the same period principally due to increased use in the Ord River irrigation scheme. Water use is expected to double again over the next 20 years placing pressure on available resources in those areas where water use is currently approaching

unsustainable limits, including Peel, the Wheatbelt and Perth. Programs to develop additional resources and reduce demand are in place. Table 101 illustrates the extent of surface water availability and use and Figure 30 highlights the current water use as a percentage of sustainable yield for groundwater.

Table 100: Water resources, flows and yields, 2000

Regions	Total Surface Water					Total Fresh / Marginal Water Only					
	MAF (GL/yr)	CY (GL/yr)	CU (GL/yr)	DY (GL/yr)	SY (GL/yr)	MAF (GL/yr)	CY (GL/yr)	CU (GL/yr)	DY (GL/yr)	SY (GL/yr)	CU/SY (%)
Gascoyne	751.0	0.0	0.0	249.8	199.8	751.0	0.0	0.0	249.8	199.8	0%
Goldfields- Esperance	136.0	0.3	0.3	5.3	5.3	136.0	0.1	0.1	1.2	1.2	8%
Great Southern	914.8	7.1	5.9	364.7	150.7	914.8	6.2	5.0	122.1	81.7	6%
Kimberley	33,000.0	323.3	272.4	11,272.7	3,158.6	33,000.0	323.3	272.4	11,272.7	3,158.6	9%
Mid West	257.0	1.7	1.7	108.4	39.4	257.0	0.1	0.1	16.0	1.0	7%
Peel	897.0	127.4	82.0	148.4	142.8	897.0	117.8	72.4	138.8	133.2	54%
Pilbara	3,601.0	25.0	10.8	381.9	201.9	3,601.0	25.0	10.8	381.9	201.9	5%
South West	3,795.0	251.5	164.4	2,072.1	1,036.4	3,795.0	250.9	163.8	1,713.8	964.7	17%
Wheatbelt	359.0	4.8	4.7	65.8	31.2	359.0	4.2	4.1	10.7	8.8	47%
Regional WA	43,710.8	741.0	542.2	14,669.1	4,966.0	43,710.8	727.6	528.7	13,907.0	4,750.8	11%
Perth	683.0	114.2	115.7	279.1	241.7	683.0	112.6	114.0	129.5	125.4	91%
WA	44,393.8	855.2	657.8	14,948.1	5,207.7	44,393.8	840.1	642.8	14,036.5	4,876.3	13%

Source: Water and Rivers Commission.

Note: MAF Mean annual flow – the amount of water that on average is generated by a catchment each year.

CY Current developed yield – the amount of water that can be used using current infrastructure.

CU Current use – the amount of water currently used from a water resource each year (based on 1996/97 figures data).

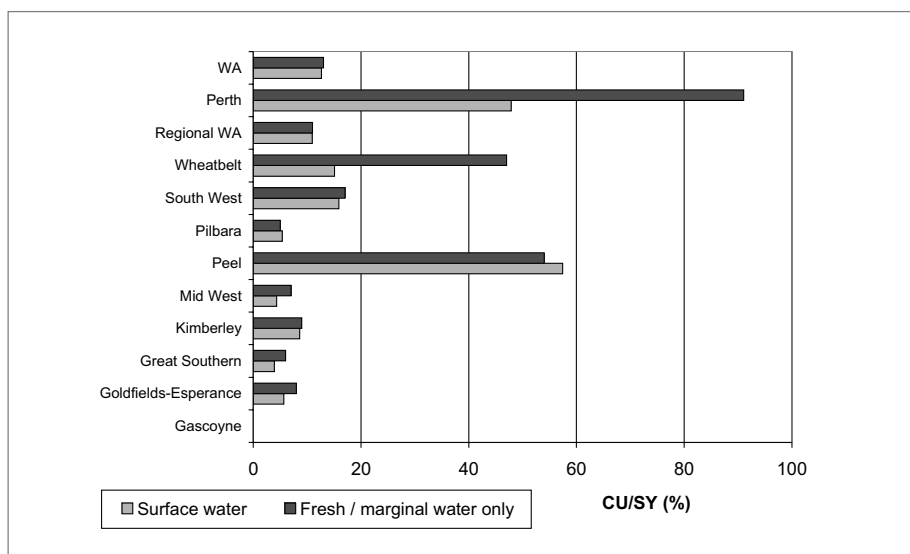
DY Divertible yield – the amount of surface water that can economically be diverted from the catchment each year.

SY Sustainable yield – the amount of water that can be sustainably harvested each year from a water resource after making provisions for environmental and social values.

The data is based on a number of assumptions which have not been specifically investigated, including management objectives and environmental allocations. Figures are for review purposes only and should not be taken as forming part of a plan.

Table 101 shows the extent of groundwater availability and use and Figure 31 highlights the current water use as a percentage of sustainable yield for groundwater. Generally speaking, regional WA, and the metropolitan area have enormous groundwater resources, with the level of use within sustainable limits. Again, the location of many of these supplies is remote from potential uses which has limited development. Exceptions occur in the metropolitan area where groundwater now supplies over half Perth's domestic requirements, and in the more closely settled areas of the South West and Peel, where groundwater supplies are important. There is a large use of water for mining and mineral processing in the Pilbara, Mid-West and Goldfields-Esperance regions, with the level of development in some areas well above the regional level. Significant development of artesian supplies for stock water occurred in the West Gascoyne early in the 20th Century. Government and landholders are currently investing in bore capping and piping of water supplies to reduce the level of water use.

Figure 30: Current water use as a percentage of sustainable yield, surface water, 2000



Source: Water and Rivers Commission.

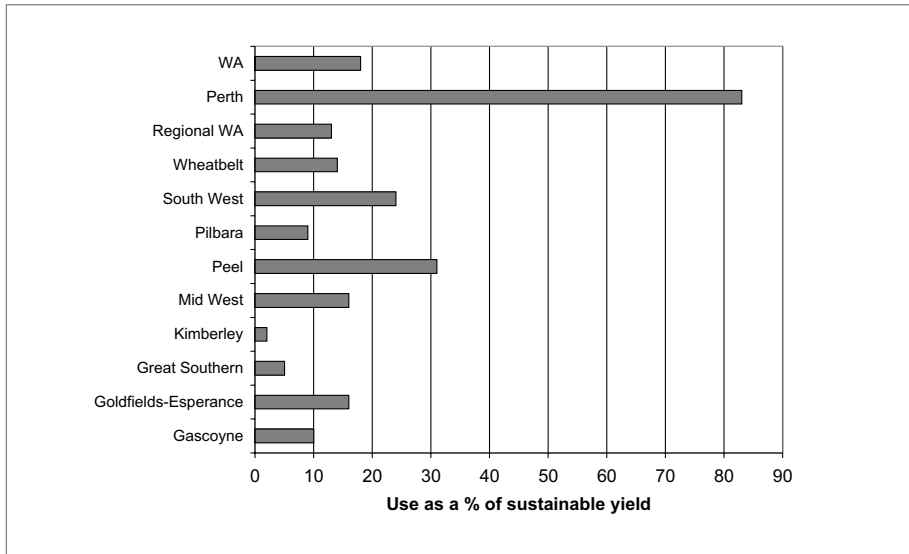
Table 101: Groundwater yields, use and sustainability, 2000

Regions	Groundwater			Total Use (GL/yr)	Use as % of Sustainable Yield
	Sustainable Yield (GL/yr)	Licensed Use (GL/yr)	Unlicensed Use (GL/yr)		
Gascoyne	314.1	17.2	15.0	32.2	10%
Goldfields-Esperance	821.7	134.5	0.0	134.5	16%
Great Southern	98.7	4.9	0.0	4.9	5%
Kimberley	1,227.5	25.0	0.6	25.6	2%
Mid West	677.2	108.1	0.0	108.1	16%
Peel	253.8	66.0	12.6	78.6	31%
Pilbara	928.5	87.5	0.0	87.5	9%
South West	494.2	117.8	0.9	118.7	24%
Wheatbelt	994.0	134.7	3.7	138.4	14%
Regional WA	5,809.7	695.7	32.8	728.5	13%
Perth	494.2	332.6	76.7	409.3	83%
WA	6,303.9	1,028.3	109.5	1,137.8	18%

Source: Water and Rivers Commission and National Land & Water Resources Audit (2001).

Figure 31 illustrates the current water use as a percentage of sustainable water use for groundwater in Western Australia.

Figure 31: Current water use as a percentage of sustainable yield, groundwater, 2000



Source: Water and Rivers Commission.

8.5.3 Waterways health

Indicator: Environmental pressures on rivers

The pressures on the State's rivers across the different regions are shown in Table 102. Careful management of these pressures is required to ensure that the condition of the rivers is not affected by factors such as excessive nutrients, sedimentation, loss of natural habitat and feral weeds and pests.

Table 102: Pressure on rivers, 2000

Pressure	Gascoyne	Goldfields - Esperance	Great Southern	Kimberley	Mid West	Peel	Pilbara	South West	Wheatbelt	Perth
Waterway Pressure	Grazing	Broad acre farming and grazing	Residential & rural development	Grazing Feral animals	Broad acre farming and grazing	No Data Available	Grazing	Intensive agriculture	Broad acre farming	Urban development
			Broad acre farming					Broad acre farming	Aquaculture	Industrial activities
			Recreation /Tourism					Plantations		Recreation / Tourism
			Plantations					Increasing farm dam numbers		
Degradation Issue	Erosion	Loss of riparian vegetation	Loss of riparian vegetation	Erosion	No Data Available	Erosion	Loss of riparian vegetation	Loss of riparian vegetation	Loss of riparian vegetation	Loss of riparian vegetation
	Sedimentation	Weeds	Weeds	Sedimentation		Sedimentation	Weeds	Weeds	Weeds	Weeds
		Salinity	Salinity				Salinity	Salinity	Salinity	Salinity-
		Waterlogging	Waterlogging				Waterlogging	Waterlogging	Waterlogging	Flooding
		Eutrophication	Eutrophication				Flooding	Flooding	Flooding	Eutrophication
		Erosion	Erosion				Eutrophication	Eutrophication	Eutrophication	Contamination
		Sedimentation	Sedimentation				Contamination	Contamination	Contamination	Erosion
		Drainage	Drainage				Erosion	Erosion	Erosion	Erosion
		Flooding	Flooding				Sedimentation	Sedimentation	Sedimentation	Sedimentation
							Drainage	Drainage	Drainage	Drainage
							Change in flow/ water level	Change in flow/ water level	Change in flow/ water level	Change in flow/ water level
							Exotic fish	Exotic fish	Exotic fish	Exotic fish
						Blocked fish passage	Blocked fish passage			

Source: Water and Rivers Commission.

Indicator: Riverine health

Background

Nutrient pollution of rivers is an issue in the agricultural regions where streams carry nutrients sourced from adjacent farming lands. This becomes a significant problem when excessive nutrients lead to eutrophication and occasional algal blooms. The latter occur mainly in the shallow estuaries along the south and west coast, with a particularly severe event occurring in the Swan estuary in January 2000.

Current situation

Table 103 provides data on the relative health of rivers in respect of nutrient and sedimentation loads. Some level of sedimentation is acceptable, being a natural part of landscape forming processes. High rates of sedimentation resulting in silting of river systems and high turbidity is normally associated with disturbance in the catchment, such as river training, excessive grazing and cropping.

Table 103: Nutrient loads and sedimentation

Regions	Severity of nutrient loads (river length, km)			Severity of sedimentation (river length, km)		
	High	Medium	Low	High	Medium	Low
Gascoyne	NA	NA	NA	ND	ND	ND
Goldfields-Esperance	0	209	0	308	169	0
Great Southern	77	684	290	414	513	212
Kimberley	NA	NA	NA	716	3421	3893
Mid West	152	234	0	486	0	0
Peel	77	241	0	0	157	209
Pilbara	NA	NA	NA	ND	ND	ND
South West	95	270	523	378	397	0
Wheatbelt	350	311	0	155	359	81
Regional WA	751	1,949	813	2,457	5,016	4,395
Perth	67	0	29	0	43	43
WA	818	1,949	842	2,457	5,059	4,438

Source: State of the Environment Report (1998).
ND = not data available; NA = not applicable

Table 104 presents estimates for the probable extent of overall river modification as a result of human influences. The data, which are drawn from the National Land and Water Resources Audit are inadequate for the less closely settled regions, where the extent of landscape modification for agriculture and infrastructure has been much less. The data that are available across the south west corner of the State, suggest that the greatest degree of modification of river systems has occurred in the Wheatbelt, the Mid West and the Great Southern. Modifications have included increased salinisation, increased siltation, river training and loss of riparian habitat. In all of these regions, government and private investment is endeavouring to improve the condition of the rivers.

Table 104: Probable extent of river modification, 2002

Region	Probable state of river condition (km)			
	Largely Unmodified	Moderately Modified	Substantially Modified	Extensively Modified
Gascoyne	ND	ND	ND	ND
Goldfields - Esperance	ND	ND	ND	ND
Great Southern	185	2,590	62	0
Kimberley	ND	ND	ND	ND
Mid West	613	324	66	0
Peel	253	67	0	0
Pilbara	ND	ND	ND	ND
South West	1,396	307	0	0
Wheatbelt	737	520	105	0
Regional WA	3,184	3,808	233	0
Perth	130	31	82	0
WA	3,314	3,839	315	0

Source: URS, adapted from National Land and Water Resources Audit (2002).
 ND = no data available

Indicator: Water resource management

Background

The Water and Rivers Commission has developed a draft policy (Water and Rivers Commission 2000) stating its waterways management objectives and principles. Work is now progressing to develop related strategies and actions, including compiling data and building on waterways management plans already in place.

Current situation

The current status of management planning in the regions is shown in Table 105.

Table 105: Water resource management, 2002

Regions	Number of waterway management plans by scale			Primary management issues addressed in the plans
	Regional plans	Catchment plans	River action plans	
Gascoyne	ND	ND	ND	
Goldfields - Esperance	ND	ND	ND	
Great Southern	ND	ND	ND	
Kimberley	2	2	3	Exotic animal/plant invasion, vegetation degradation and point source pollution.
Mid West	3	8	2	Vegetation degradation, flooding and exotic animal/plant invasion.
Peel	ND	ND	ND	
Pilbara	1	3	2	Vegetation degradation and exotic animal/plant invasion.
South West	8	34	52	Vegetation degradation, exotic animal/plant invasion, nutrient enrichment and drainage.
Wheatbelt	10	42	73	Vegetation degradation, exotic animal/plant invasion and nutrient enrichment.
Regional WA	24	89	132	
Perth	8	11	57	Drainage, vegetation degradation, exotic animal/plant invasion and stream salinisation.
WA	32	100	189	

Source: Water and Rivers Commission Statewide Policy No. 4 and Supporting Information and 'Review of the extent and adequacy of existing waterways management in Western Australia', (2001).

8.5.4 Ocean environments

Environmental issues in the ocean environments that border all the regions relate to the sustainable use and management of the fish stocks, and the conservation of marine biodiversity within marine conservation reserves and parks. The stated government objective for these environments is 'conserving our marine and aquatic environments and the fish stocks which they support' (Fisheries Department Strategic Plan, 1999).

8.5.4.1 Fisheries

Indicator: Pressure on the region's fisheries

Growing urban and industrial development is putting pressure on marine environments, although the impact will be substantially less in the regions than in the Metropolitan area. Recreational fishing is an important use of the resource throughout WA, with an estimated 600,000 people over the age of 16 involved. Several of the regions are noted destinations for specialist fishing-based tourism – the Gascoyne, Mid West, Pilbara, South West and Great Southern. There is an increased demand for areas suitable for aquaculture too in response to the fully exploited or over-exploited status of most of the world's wild-stock fisheries. The impact of increasingly efficient fishing technology needs to be addressed through more careful planning for allowable catches. Finally an important threat is the risk of harmful aquatic species or diseases being introduced to WA through shipping or the importation of marine products.

Indicator: Fish stocks and allowable catches

Table 106 shows exploitation status, current catch and allowable catches for the major commercial fisheries in all regions.

Table 106: Stock exploitation status and catch ranges for major commercial fisheries – 2000

Fishery	Exploitation status	Previous acceptable catch (tonnes)	Catch (tonnes) current seasons	Future acceptable catch or effort (tonnes)	Comments
Kimberley RDC region (pt North Coast Fisheries Bio-region)					
Broome prawn	Under-exploited	King prawn 36-146 t	King prawn 76 t	King prawn 35-170 t	Fishing season managed to achieve high exploitation rate
Kimberley prawn	No assessment (NA)	301-645 t	236 t	240-500 t	Banana prawn catch showed limited response to higher rainfall
Pearl oyster	Fully exploited	617,700 oysters	568,191 oysters	572,500 oysters	Quota in Zone 1 not fully utilised
Kimberley gillnet and barramundi	Fully exploited for key species only	25-40 t (barramundi)	45 t (barramundi)	25-40 t (barramundi)	Higher barramundi catch although effort trending lower
Northern demersal	Fully exploited for key species only	600-1,000 t	470 t	60-1,000 t	Low catch due to low effort
North coast shark	NA	NA	103 t	NA	Developing fishery
Lake Argyle catfish*	Over-exploited	100-140 t	231 t	100-140 t	Catch well above historic levels
Pilbara RDC region (pt North Coast Fisheries Bio-region)					
Onslow prawn	NA	61-132 t	87 t	60-130 t	High summer rainfall gave improved banana prawn catches
Nickol Bay prawn	NA	Banana prawn 300-500 t	Banana prawn 467 t	90-300 all prawns	As above
Pilbara trawl	Fully exploited	2,100-2,400 t	2,075 t	1,900-2,200 t	Assessment only includes major species
Pilbara demersal trap and line	Fully exploited	300-400 t	316 t	150-300 t	Range for trap only as line not restricted
Spanish mackerel	NA	260-390 t	305 t	249-358 t	Range is estimate only, fishery yet to stabilise
Gascoyne RDC region (Gascoyne Coast Bio-region)					
Shark Bay prawn	Fully exploited	1,611-2,183 t	2,250 t	1,501-2,330 t	High catch reflects high catchability related to sea temps
Exmouth prawn	Fully exploited	771-1,276 t	565 t	771-1,276 t	Reduced tiger prawn recruitment
Shark Bay scallop	Fully exploited	1,500-2,750 t	1,345 t	1,250-3,000 t	Catch reflects negative environmental impacts on recruitment
Shark Bay snapper	Fully exploited	430-550 t	488 t	550 t	Reduced catch due to low effort
Shark Bay beach seine & mesh net	Fully exploited for key species only	95-140 t (whiting)	127 t (whiting)	95-140 t (whiting)	Whiting catch only

Mid West, Wheatbelt, Peel and South West RDC regions (West Coast Bio-region)					
Western rock lobster	Fully exploited	13,500-14,500 t	14,523 t	8,166-14,523 t	Above forecast catch
Roe's abalone	Fully exploited	116 t	108 t	108 t	New management plan in place
South-west trawl	NA	NA	Prawns 32 t Scallops 23 t	NA	Prawn catch is mainly king prawns
Abrolhos Is and Mid-West trawl	Fully exploited	250-400 t	429 t	50-600 t	Recruitment dependent on annual environmental conditions
West Coast purse seine	Fully exploited	260 t	14 t	NA	Reduced catch due to mortality factor
Estuarine fisheries	Fully exploited for key species only	NA	305 t	NA	Includes fish and crustaceans
Great Southern and Goldfields-Esperance RDC regions (South Coast Bio-region)					
Esperance rock lobster	Fully exploited	50-80 t	69 t	50-80 t	Catch figures for all 3 management zones
Abalone	Fully exploited	236 t	223 t	230 t	Two zones amalgamated into one fishery
WA salmon	Fully exploited	1,300-3,600 t	2,283 t	1,300-3,600 t	Environmental factors influence subsequent year's catch
Australian herring trap	Fully exploited	450-1,200 t	818 t	450-1,200 t	South coast catch only
Southern & west coast demersal gillnet and longline	Fully exploited for key species only	875-1,075 t for key species only	785 t	725-975 t for key species only	Key species only reported. Reduced breeding stocks in whiskery sharks
Estuarine fisheries	Fully exploited for key species only	200-500 t	252 t	200-500 t	Includes fish, molluscs and crustaceans
Albany/ King Geo. Sd purse seine	NA	0	NA	50-100 t	Fishery closed as a result of mortality. Research quota set for 2001
Bremer Bay purse seine	NA	0	NA	100-200 t	Fishery closed as a result of mortality. Research quota set for 2001
Esperance purse seine	Fully exploited	1,060 t	983 t	1,000-1,200 t	Quota set allowing for disease but recognising good recruitment

* Northern inland bio-region

Source: Department of Fisheries, State of the Fisheries Report (2001).

Indicator: Fisheries environmental management

The State's fish stocks are managed mainly through the *Fish Resources Management Act 1994* which is administered by the Department of Fisheries, which is represented in all regions. An essential role of the Department is to set management rules including, where relevant, 'allowable catches' for both commercial and recreational fisheries. The Department is supported by Management Advisory Committees. Specific Ministerial Policy Guidelines cover a number of matters, including rock lobster processing, aquaculture and recreational fishing stock, enhancement of non-endemic species, assessment of aquaculture and pearling applications in coastal waters, the pearl oyster fishery, abalone and marine eco-tourism.

Indicator: Marine conservation

Table 107 shows the nature and location of actions taken to conserve marine ecosystems. These measures include establishment of marine parks, exclusion zones for trawling, fish habitat protection areas (FHPAs), and reef protected areas (RPAs).

Table 107: Fish and fish habitat protection

Region	Fisheries	Action Bio-region
Kimberley	North Coast	Ashmore Reef National Nature Reserve
		Cartier Island Marine Reserve
		Gantheaume Point RPA
		Rowley Shoals Marine Park
		Permanent trawl closure ²⁴ along the West Kimberley coast
		Proposed Pilbara/Kimberley Regional Fisheries Environment Management Review.
Pilbara	North Coast	Proposed Montebello Islands Marine Park
		Proposed Dampier Archipelago Marine Park
		Proposed Pilbara/Kimberley Regional Fisheries Environment Management Review.
		Kunmunya and Samson II RPA
		Permanent trawl closure along entire coast
Gascoyne	Gascoyne Coast	Ningaloo Marine Park
		Proposed Miaboolya Beach FHPA
		Proposed Quobba FHPA
		Muiron Islands RPA
		Gascoyne Region Fisheries Environmental Management Review (FEMR) released in 2000/01
		Point Quobba RPA
		Shark Bay Marine Park (including Hamelin Pool Marine Nature Reserve)
Permanent trawl closure around Ningaloo Marine Park and North West Cape		
Mid West	West Coast	Abrolhos FHPA
		Extended seasonal trawl ban around Abrolhos Islands
		Permanent trawl closure along the coast
Goldfields-Esperance	South Coast	Sanko Harvest RPA
		Esperance Jetty RPA
		Permanent trawl closure east of 125° 00'E

²⁴ A statewide prohibition on trawling applies, unless specifically authorised under a management plan and the appropriate licence held. Refer to the Department of Fisheries *State of the Fisheries* report 2000-01 for further general information.

Wheatbelt	West Coast	Proposed Jurien Bay Marine Park
		Lancelin Lagoon FHPA
		Lancelin Island FHPA
		Permanent trawl closure along the coast
Perth	West Coast	Swan River Marine Park
		Proposed Perth RPA
		Cottesloe FHPA
Peel	West Coast	Shoalwater Islands Marine Park
		Permanent trawl closure along the coast
South West	South Coast	The Swan RPA
		Yallingup RPA
		Cowaramup RPA
		Permanent trawl closure along the coast to Cape Leeuwin
Great Southern	South Coast	Community evaluation of fish stock health in coastal habitats of Albany

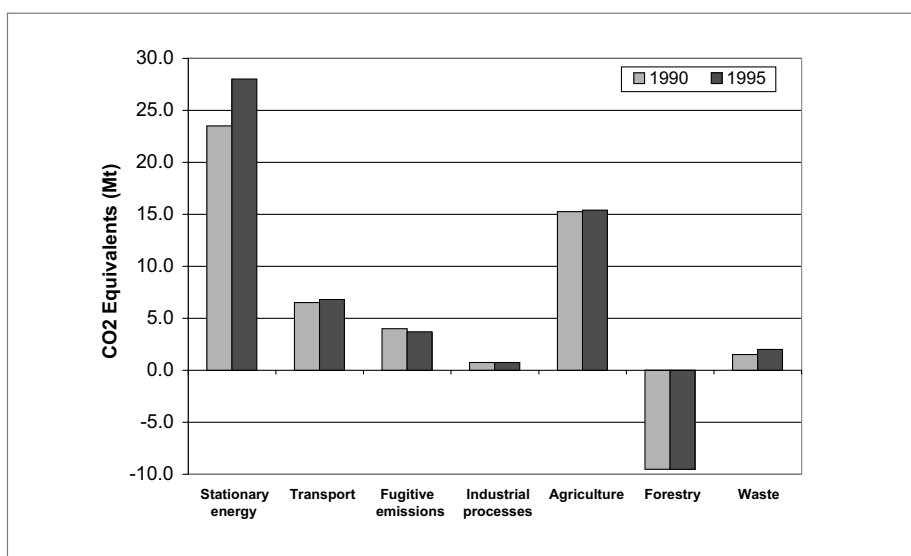
Source: Department of Fisheries, State of the Fisheries Report (2001).

8.5.5 Atmosphere

Indicator: Greenhouse gas emissions

Greenhouse gas emissions are not available at regional scale, with state scale being the smallest unit at which discreet measures are available. Figure 32 provides estimates of greenhouse gas emissions from different sectors and processes in 1990 and 1995. These data show that about 50 per cent of all emissions come from power generation, with agriculture responsible for 20 per cent of total emissions. The growth of plantation forestry in the south west of the State (see Section 8.5.1.5) has resulted in net sequestration of carbon through that use.

Figure 32: Western Australia greenhouse gas emissions, 1990 and 1995



Source: Office of Energy.

Greenhouse gas emissions are continuing to increase in Australia, and in WA. Nationally, there was a 16.9 per cent increase in emissions between 1990 and 1998. However, there is evidence that at national scale, economic growth is not necessarily directly linked to increased emissions. In 1999, the economy grew by 5.4 per cent while emissions only increased by 1.1 per cent (State of the Environment Report 2001).

Agriculture’s contribution has been reducing in the years since the mid 1990s by the rapid growth of the plantation forestry industry in the south west of the State which is resulting in reduced emissions and net sequestration of carbon through that use. Most of the 196,000 hectares of hardwood plantations were established after 1995, although the rate of further establishment is slowing. The change of land use from grazing to hardwood plantations on this land will result in a net reduction in emissions of 13 tonnes of CO₂ equivalents per hectare per annum, calculated over a 20 year period. This is made up of reduced emissions from grazing (1.4 tonnes CO₂ equivalents per hectare per annum) and net sequestration in the hardwood plantations (11.9 tonnes CO₂ equivalents per hectare per annum) established on agricultural land. Over the full area converted to this new land use, the outcome will be a net reduction in emissions of 2.6 million tonnes CO₂ equivalents per annum as a result of the changed land use on agricultural land.

Although the amount has not been calculated, the improving range trend recorded on monitoring sites throughout the pastoral areas as described in Section 8.5.1.4 which has occurred in the favourable seasons in the 1990s will have increased vegetative and soil carbon stores in those areas. However, current accounting rules for carbon measurement do not allow these stores to be included in national inventories and fluctuations in seasons may see some of this stored carbon emitted through periods of less favourable seasons.

Indicator: Greenhouse gas management

Background

WA is committed to initiatives that will limit greenhouse gas initiatives. These initiatives, which will impact in the regions are contained in the Government's State Sustainability Strategy (2002). They include:

- the development of a State Greenhouse Strategy;
- establishment of a Sustainable Energy Development Office;
- enactment of carbon rights legislation;
- a requirement for government agencies to reduce energy consumption by 12 per cent between 2001-02 and 2006-07 through the Energy Smart Government Program;
- reduced carbon intensity of power generated by Western Power, and
- encouragement of investment in carbon sequestration and renewable energy generation.

It is not possible to report on many of these initiatives at regional scale. However data are available on progress in renewable power generation in the regions.

Renewable power generation

The proportion of total energy use from renewable power cannot be determined by region. However the number of renewable energy power stations in each region and their capacity can be calculated (Table 108).

Table 108: Renewable energy electricity generation stations over 20 kW, May 2002

Region	No. of stations power	Type	Renewable capacity (MW)	Non renewable capacity (MW)	Renewable proportion of total capacity (%)
Gascoyne	1	wind	0.69	0	100
Goldfields-Esperance	1	wind	2	612	0.33
Great Southern	1	wind	22	0	100
Kimberley	2	hydro/ bagasse	36	60	37.5
Mid West	1	solar	0.02	253	0.01
Peel	-	-	-	193	0
Pilbara	-	-	-	551	0
South West	1	hydro	2	1,708	0.12
Wheatbelt	-	-	-	-	-
Regional WA	7	NA	62.31	3,377	1.81
Perth	2	landfill gas/biogas	12.6	1,700	0.74
WA	9	NA	74.91	5,077	1.45

Source: Office of Energy.

Table 109 illustrates the proportion of renewable energy that is distributed into the grid by Western Power and other suppliers, from 1997/98 to 2001/02.

Table 109: Proportion of energy use from renewable sources

Details	1997/98	1998/99	1999/00	2000/01	2001/02
Total electricity sent out (GWh)	12,143	12,427	12,626	13,038	13,123
Renewable sent out (GWh)	96	103	99	97	156
% Renewable	0.79	0.83	0.78	0.74	1.2

Source: Office of Energy.

Western Power has an initiative called *NaturalPower* in which households and businesses can sign up to ensure at least part of their supply is from renewable energy sources such as wind turbines or biomass, instead of traditional fossil fuel generators such as coal or gas. The renewable energy is not actually delivered to the customer but supplied to or purchased from external generators and inputted into the grid. *NaturalPower* is only available to Western Power customers connected to the South West Interconnected System (SWIS). The SWIS includes the major population centres in the South West of the State (to Kalbarri) but excludes the Esperance-Goldfields region.

8.5.6 Terrestrial biodiversity

The Western Australian regions support a rich suite of biodiversity, much of which is unique at regional and even local scale. The resources are internationally recognised – Australia is one of the 12 mega-diverse environments on the planet, and the south west section of WA – encompassing part or all of six of the nine regions has been identified as one of the 25 biodiverse ‘hot-spots’ in the world.

Biodiversity occurs at three levels.

- Genetic diversity – the variety of genetic information contained in all of the individual plants, animals and micro-organisms that inhabit the earth. Genetic diversity occurs within and between the populations of organisms that comprise individual species as well as among species.
- Species diversity – the variety of species on earth.
- Ecosystem diversity – the variety of habitats, biotic communities and ecological processes.

The basic unit for understanding the pressures on biodiversity, its state and how it is managed is the *bioregion*. There are 80 of these regions in Australia, with 27 of them represented in Western Australia. Each region having a unique set of climatic, landform, and vegetative characteristics. They are also known as ‘Bioregions’, after the Interim Bioregionalisation for Australia (IBRA) which established this system. The material presented in this section relies largely on information presented at Bioregion scale by the National Land and Water Resources Audit (2001) and the State of Environment Reports done by WA and the Commonwealth Governments. A summary description of each IBRA province in WA is provided as Annex C.

Indicator: Pressures on biodiversity

Background

The principal pressure on biodiversity is loss of habitat, which has occurred mainly through clearing for human purposes, and overgrazing of native vegetation in the pastoral areas. Other causes include pressures from feral weeds and pests, impacts due to secondary salinisation and soil acidity, exotic diseases and inappropriate fire regimes.

Current situation

The threats considered are the fragmentation of natural habitat and the impact of feral animals. Table 110 presents data on the percentage of the native vegetation remaining in the regions and assessment of the degree of fragmentation of the vegetation. The data show that the loss of native vegetation and fragmentation of that remaining is highest in the Wheatbelt, and in the agricultural areas in Goldfields-Esperance, Great Southern, Peel South West and Mid West regions.

Although the data show that the vegetation in the remote areas outside the south west part of the State is largely intact, the history of pastoralism in the areas will have put pressure on biodiversity resources. Some indication of the extent of the pressure can be inferred from the data in Table 94.

Table 110: Native vegetation fragmentation

Region	Percentage of native vegetation remaining	Degree of fragmentation
Gascoyne	More than 70%	Extensive use zone – very little clearing
Goldfields-Esperance	Between 30 and 70% on Esperance Plains and Mallee associated with major landscape	Extensive use zone north of Salmon Gums – no clearing High connectivity in the mallee More than 70% elsewhere Some connectivity features on the Esperance plains
Great Southern	Between 30 and 70%	Connectivity high in most areas Selective clearing in some areas
Kimberley	More than 70%	Extensive use zone – very little clearing
Mid West	Less than 30% in agricultural areas	Some connectivity associated with major landscape features More than 70% elsewhere Extensive use zone – very little clearing
Peel	Between 30 and 70%	Some connectivity associated with major landscape features
Pilbara	More than 70%	Extensive use zone – very little clearing
South West	Between 30 and 70% in	Connectivity high in most areas most areas Selective clearing in some areas More than 70% in State forests
Wheatbelt	Most less than 30%	Very little connectivity in most of the region. Some connectivity associated with major landscape features on margins of the region

Source: National Land and Water Resources Audit (2001).

Table 111 shows the number of invasive fauna species in each region that will impose pressure on the biodiversity. These data show that no region is without pressures due to feral animals.

Table 111: Invasive fauna

Region	Number of terrestrial non-Indigenous fauna species per Bioregion
Gascoyne	5 – 8
Goldfields-Esperance	5 – 16 (depending on location)
Great Southern	13 – 16
Kimberley	5 – 8
Mid West	5 – 12 (depending on location)
Peel	13 – 16
Pilbara	5 – 12 (depending on location)
South West	13 – 16
Wheatbelt	9 – 12

Source: State of the Environment Report (2001).

Comment

The extent of land clearing is unlikely to increase (see Section 8.5.1.2), with the major requirement being to reduce the impact of these pressures through actions such as expanding the area managed for conservation, using revegetation to reduce the degree of fragmentation in the agricultural lands and feral predator control.

Indicator: Condition of biodiversity in Bioregions

Background

As noted in previous sections, the essential unit of management is the Bioregion. Two measures of the condition of biodiversity in the region are presented. Firstly the area of native habitat cleared is a surrogate for the level of disturbance of habitat. Secondly, the number of threatened mammal species is a measure of the health of fauna.

Current situation

Table 112 presents data for the percentage of each Bioregion cleared, and the number of threatened fauna and the number of know and predicted occurrences of threatened plants in each.

Table 112: Condition of Bioregions

Region	Major Bioregions represented*	Area cleared (%)**	No. of threatened mammal species***	No. of threatened plants****
Gascoyne (G)	Carnarvon	0 (a)	2-3	<5
	Gascoyne	1 (a)	2-3	<5
Goldfields-Esperance (GE)	Esperance Plains (share with GS)	43	8 +	10 – 29
	Mallee (share with GS and W)	43	8 +	10 – 29
	Coolgardie	3 (a)	2-3	5 – 9
	Murchison (share with MW)	2(a)	0-1	5 – 9
	Great Victoria Desert	0	2-3	<5
	Nullarbor	0 (a)	0-1	<5
	Hampton	0	0-1	no records
	Central Ranges	0	2-3	<5
Great Southern (GS)	Gibson Desert	0	2-3	no records
	Warren (share with SW)	44	4-5	10 – 29
	Mallee (share with GE and W)	43	8 +	30 – 49
Kimberley (K)	Jarrah Forest (share with SW, GS and Pe)	44	8 +	>49
	Northern Kimberley	0 (a)	2-3	<5
	Central Kimberley	0 (a)	2-3	<5
	Dampierland	0 (a)	2-3	<5
	Ord-Victoria Plains	0 (a)	0-1	<5
	Victoria-Bonaparte	1 (a)	0-1	no records
	Tanami	0	0-1	no records

Mid West (MW)	Geraldton sandplain (share with W)	52	8 +	>49
	Yalgoo	2 (a)	0-1	5 – 9
	Avon (share with W and SW)	88	8 +	>49
	Murchison	2 (a)	0-1	<5
Peel (Pe)	Swan Coastal Plain (share with SW)	44	8 +	10 – 29
	Jarrah Forest (share with SW and GS)	44	8 +	30 – 49
Pilbara (Pi)	Pilbara	0 (a)	8 +	<5
	Great Sandy Desert	0	4-5	no records
	Little Sandy Desert	0	4-5	no records
South West	Swan Coastal Plain (share with Pe)	44	8 +	>49
	Jarrah Forest (share with GS and Pe)	44	8 +	30 – 49
	Warren (share with GS)	44	4-5	10 – 29
	Avon (share with MW and W)	88	8 +	>49
Wheatbelt	Avon (share with MW and SW)	88	8 +	>49
	Mallee (share with GE and GS)	43	8 +	30 – 49
	Geraldton sandplain (share with MW)	52	8 +	>49

* Source: Thackway and Cresswell (1995)

** Source: State of the Environment Report 1996

*** Source: State of the Environment Report 1998

**** Source: National Land and Water Resources Audit 2001

(a) Bioregions where grazing of native vegetation is a significant land use

The data show that biodiversity will be in better health in those remoter areas of the State where clearing has been limited and where grazing has not been carried out. However, even in these areas, such as the Great Sandy Desert, mammals are at risk due to a range of pressures including inappropriate fire regimes, predation from feral species and for other reasons that are not well understood.

In the closely settled agricultural areas of the State, biodiversity resources remain significant, but their persistence will be difficult in many situations due to the loss of habitat and pressures from impacts such as secondary salinisation.

Comment

Achievement of national and state objectives for conservation of the State's biodiversity at regional scale will be challenging for individual landholders and managers, regional governance and state agencies.

Indicator: Management of regionally significant biodiversity

Background

Conservation of biodiversity needs to occur at a Bioregional scale, with local actions supporting these regional outcomes. Biodiversity conservation depends on actions taken to conserve and manage available habitat, the control of stresses such as feral animal and weeds and the prevention of exotic diseases and pests. In respect of terrestrial biodiversity, most action focuses on the management of areas of natural habitat that contain important components of the Bioregion's biodiversity.

Current situation

The principal government agency with responsibility for achieving nature conservation outcomes is the Department of Conservation and Land Management. Table 113 shows the area of land in each region currently being managed by that agency for nature conservation. This area includes land held by the Conservation Commission such as national parks and nature reserves and land held by other public entities that is managed on their behalf by the Department.

Table 113: Land managed by government for nature conservation

Managed lands (km ²) in regions as defined by Department of Conservation and Land Management									
Tenure classification	Kimberley	Pilbara	Mid West	Wheat-belt	Goldfields	Swan	Central Coast	Southern Forest	South Coast
Approximate RDC Region	Kimberley	Pilbara	Gascoyne & Mid West	Most of Wheatbelt	Most Goldfields-Esperance	Perth & Peel	South West		Pt Goldfields-Esperance & all Gt Southern
National Park	8,298	23,966	5,048	13	1,510	451	2,717		8,918
Conservation park	4,602	1,493	37	3	335	566	6		
Nature reserve	8,098	2,506	7,323	10,424	63,044	506	426		15,854
Marine park	232	2,256	7,487			164			
Marine nature reserve			1,320			4,908			
State forest				281			12,036		40
Other managed land	1,153	4,300*	21,092*	7	12,447*	706	1,117		92
Total	22,383	34,521	42,307	10,725	77,336	7,301	16,296		24,904

Source: Department of Conservation and Land Management, Annual Report 2001.

* Mainly former pastoral leasehold & Section 33(2) managed land

As part of the requirement for nature conservation outcomes, the Department prepares and implements Management Plans for the properties in its control. Table 114 shows the status of management planning for conservation properties as at 30 June 2001.

The preparation of a management plan requires collation of scientific data on the physical and biological resources in the area, the determination of objectives for nature conservation and other uses that might occur

specific objectives, allocation of responsibilities and resources for strategic and day-to-day management, and a process for review and revision of the plan.

Table 114: Management Plans for land managed for nature conservation

RDC Region	Completed Plans at 30 June 2001	Final Plans being prepared at 30 June 2001
Kimberley	Purnululu NP and Nature Reserve	
Pilbara	Dampier Archipelago Nature Reserves Karijini NP Jarabi, Bundegi and Muiron Islands	Dampier Archipelago – Burrup Peninsula Millstream – Chichester NP – Mungarooona Range Nature Reserve Montebello/Barrow Island Marine Conservation Reserve (Indicative Management Plan) Dampier Archipelago/ Cape Preston Marine Conservation Reserve (Indicative Management Plan) <i>Kimberley Region</i> Rowley Shoals Management Plan (Indicative Management Plan)
Gascoyne	Cape Range National Park (NP) Ningaloo Marine Park Shark Bay Marine Reserves Shark Bay Terrestrial Reserves	Cape Range NP (revision) Ningaloo Marine Park (revision) Shark Bay World Heritage Area Strategic Plan
Mid West	Lesueur NP-Coomallo Nature Reserves Nambung NP, Wangarren, Nilgen and Southern Beekeepers Nature Reserves	Turquoise Coast Islands Nature Reserves Kalbarri NP
Goldfields-Esperance	<i>South Coast Region</i> (pt) <i>Goldfields Region</i> Wanjarri Nature Reserve Rowles Lagoon Conservation Park and Clear and Muddy Lakes Nature Reserve	Gibson Desert Nature Reserve Esperance Coastal Parks and Reserves
Wheatbelt	Nature Reserves, Shire of Wyalkatchem Nature Reserves in Shires of York and Northam Dryandra Woodland	Jurien Marine Park (Indicative Management Plan) <i>Wheatbelt Region</i>
Peel	<i>Northern Forest Region</i> Logue Brook Reservoir & Catchment Area Shoal Water Islands Nature Reserves Yalgorup NP Serpentine NP	Shoalwater Islands Management Plan Rockingham Lakes Regional Park Forest Management Plan (pt)
South West	Shannon Park, D'Entrecasteaux NP Benger Swamp Nature Reserve <i>Central Forest Region</i> Lane Pool Reserve <i>Southern Forest Region</i> Waroona Reservoir & Catchment Area Walpole-Nornalup NP Leschenault Peninsula Conservation Park	Perup Forest & Lake Muir-Unicup Nature Reserves Wellington Forest NP Leeuwin Naturaliste Ridge – Scott NP Shannon, D'Entrecasteaux NP (revision) Forest Management Plan (pt)
Great Southern	Fitzgerald River NP <i>South Coast Region</i> (pt) West Cape Howe NP Two Peoples Bay Nature Reserve Stirling Range and Porongorup NPs	

Comment

The information provided documents actions by government only. Adequate biodiversity conservation will require action to be taken to manage biodiversity wherever it occurs, such on private land holdings. Government and private sectors are encouraging this approach, through the following actions.

- Development of approaches for ecologically sustainable management of grazing enterprises on pastoral leasehold land.
- Support for private conservation reserves through projects that establish special management arrangements for remnant vegetation on private land, and through support for entities such as the Australian Wildlife Conservancy.
- Support through schemes such as the Natural Heritage Trust for community volunteers who are managing biodiversity at local scales.
- Research into the identification, management and rehabilitation of WA's biodiversity being undertaken by government, universities and mining companies.

Indicator: Number of vegetation types in the conservation reserve system

Background

An assessment of the comprehensiveness, adequacy and representativeness (CAR) of the reserve system in each region was undertaken by using the Interim Biogeographic Regionalisation of Australia (IBRA). These classifications were used as a surrogate measure of vegetation types. Note, this analysis was undertaken on the basis of representation of IBRA provinces in the total conservation estate and not within areas specifically gazetted as conservation reserves. In the southern regions the conservation estate includes State forest reserves, these may not provide the same level of nature conservation security as national parks and other dedicated conservation reserves. Results for these regions are likely to be an overestimate of the level of representation within a CAR conservation system.

Current situation

'Representation' and 'Comprehensiveness' is assessed by the per cent area of each IBRA province that is held within the CALM estate in each region. 'Adequacy' of representation in each region is summarised by Table 115 where the number of IBRA provinces with representation at 0%, and less than 5%, 10% and 15% by area is shown. There is still ongoing debate as to what adequate representation is, early arguments were for comprehensive representation at 10% by area. As conservation estates have improved and better knowledge obtained this may now have shifted to a goal of 15% or more.

Results show that some 8.6% of WA is within the conservation estate (inclusive of State forests). The level of representation varies greatly across regions. The Pilbara, Kimberley, and Mid West regions have a representation of near to 5%. Other non-forested regions are Gascoyne (13.1%), Goldfields-Esperance (11.6%), Great Southern (15.3%), and Wheatbelt (9.6%). Representation in regions with forests (and with the CALM estate likely to include greater areas of State forest reserves) are much higher: Peel (47.2%), Perth (24%), and South West (59.2%). As there is variability between regions there is also great variability of representation with each region.

Table 115 summarises the average level of representation of IBRA provinces in each region, but also breaks this down by showing the number of provinces in each region, and the number with representation below a range of "Adequacy" thresholds. For example, the Pilbara has an average representation in the CALM estate of 5.6%. There are 16 different IBRA provinces in the Pilbara, and of those provinces seven are not represented in the CALM estate at all and 10 of the 16 are represented at a level of less than 5% by area. Similarly for Gascoyne, Goldfields-Esperance, Great Southern, Kimberly, and Mid West, more than a quarter of the IBRA provinces in those regions are poorly represented in the conservation estate (less than 5% by area).

Table 115: Adequacy of Bioregion conservation in each Region

Region	% CALM	# IBRA	0%	<5%	<10%	<15%
Gascoyne	13.1	8	1	3	4	5
Goldfields-Esperance	11.6	20	4	6	11	15
Great Southern	15.3	7	-	2	2	4
Kimberley	5.0	14	5	7	10	12
Mid West	5.2	16	5	9	12	13
Peel	47.2	2	-	-	1	1
Pilbara	5.6	16	7	10	14	15
South West	59.2	4	-	-	1	1
Wheatbelt	9.6	11	-	2	4	5
Perth	24.0	3	-	1	1	1

Source: Department of Conservation and Land Management.

Comment

An important objective for government will be to continue to acquire land for the conservation estate, with the objective of having a comprehensive, adequate and representative reserve system. For example, government is currently establishing 30 new national parks in the old growth forest areas (in the South West region), and is purchasing pastoral leases in the Gascoyne and Mid West regions to add to the conservation estate in those areas.

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- Western Power (www.westernpower.com.au).
- Women in the WA Labour Market. Fact Sheet No. 4/00, Women's Economic Policy Analysis Unit, Curtin Business School, December 2000.

9.2.3 Government agencies

- Department for Community Development – Youth Affairs.
- Department of Agriculture.
- Department of Communications, Technology and the Arts.
- Department of Conservation and Land Management.
- Department of Consumer and Employment Protection.
- Department of Culture and the Arts.
- Department of Education.*
- Department of Employment and Workplace Relations.
- Department of Environmental Protection.
- Department of Fisheries.
- Department of Health.
- Department of Housing and Works.
- Department of Immigration & Indigenous & Multicultural Affairs.
- Department of Indigenous Affairs.
- Department of Industry and Technology.**
- Department of Justice.
- Department of Local Government and Regional Development.
- Department of Mineral and Petroleum Resources.***
- Department of Planning and Infrastructure.
- Department of Sport and Recreation.
- Department of Training and Employment*

Department of Treasury and Finance.
 Forests Products Commission.
 Gascoyne Development Commission.
 Goldfields Esperance Development Commission.
 Great Southern Development Commission.
 Kimberley Development Commission.
 Main Roads Western Australia.
 Mid West Development Commission.
 Office for Children and Young Peoples Policy (now Department for Community Development – Youth Affairs).
 Office of Energy.
 Office of Multicultural Interests.
 Peel Development Commission.
 Pilbara Development Commission.
 Police Department.
 Productivity Commission.
 Small Business Development Corporation.
 South West Development Commission.
 Valuer General's Office, Department of Land Administration
 Water and Rivers Commission.
 Western Australian Tourism Commission.
 Wheatbelt Development Commission.
 Women's Policy Development Office (now Department for Community Development – Youth Affairs).

* now Department of Education and Training

** activities now incorporated into Departments of Industry and Resources, Premier and Cabinet and Treasury and Finance.

*** now Department of Industry and Resources

