STATE OF THE ENVIRONMENT REPORT Western Australia 2007

Theme 9

TOWARDS SUSTAINABILITY

INTRODUCTION

The 1998 *State of the Environment Report* documented the progress of the natural resource sectors towards achieving ecologically sustainable development. However, the broad concept of sustainability has significantly evolved since then and Western Australia now has a *State Sustainability Strategy*. In the words of the strategy, sustainability is an aspirational goal of 'meeting the needs of current and future generations through an integration of environmental protection, social advancement and economic prosperity' (Government of Western Australia, 2003a, p. 24).

Although sustainability is a relatively new concept, it has been widely embraced by many nations, states, businesses and communities as a powerful means of realising a better future. This concept requires us to challenge the normal way of doing things and to look for opportunities that improve the environment, society and economy without accepting trade-offs. The concept of sustainability is sometimes described in business decision making as the 'triple bottom line' of economic development, environmental integrity and social and cultural wellbeing. True sustainability, however, is a much broader concept and should be expressed through the unification of the three bottom lines, when all are considered as one. 'Sustainable development' is also a term often used to describe the application of sustainability principles to development projects. Again, the concept of sustainability is broader than just being considered in relation to development.

The Towards Sustainability theme focuses primarily on the 'environmental integrity' component of sustainability. Environmental integrity aims to ensure that our State's '… natural resources are conserved, managed, protected and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). Other components of sustainability, notably the social and economic aspects, have not been addressed in detail as it falls outside the scope of this report – although many inter-linkages have been recognised herein.

Each major natural resource sector has reported its progress towards managing, conserving, protecting and/or using natural resources in a sustainable manner:

- Managing natural resources sustainably refers to maintaining or enhancing natural resources, while providing for beneficial uses. Often environmental management systems or accreditation schemes are used to ensure a coordinated, logical approach to managing the natural resource. This approach usually requires establishing a vision and setting environmental values, objectives and criteria/targets through a community consultation process. It includes best practice, strategic planning and natural resource management for delivering on-ground environmental improvements.
- Conserving natural resources means preserving highly valued parts of the environment for the long term. This is often achieved by placing environmental assets in the conservation reserve system or other informal protection mechanisms.
- Protecting natural resources refers to ensuring the health of natural resources by maintaining key ecosystem services including soil, water and vegetation health, habitat provision, carbon sequestration, climate regulation and cultural values, amongst others. Inadequate protection of ecosystem services will impact natural cycles that humans often take for granted. This approach includes pollution control, environmental harm and planning mechanisms.
- Using natural resources refers to consuming natural resources to provide economic and social benefit. This requires the determination of sustainable yield or allocation limits for natural resources to ensure that resources aren't consumed beyond acceptable means. Adoption of eco-efficiency practices should also be considered for the sustainable use of natural resources (e.g. waste minimisation, efficient resource use).

The sectors covered in 'Towards Sustainability' are agriculture, conservation, energy, fisheries, mining and petroleum, pastoralism, tourism, water supply and wood production. Each report represents a sector-wide collaboration with input from government agencies, industry, business, universities, research institutions and special interest groups (where appropriate). Therefore, it should be noted that the content of the Towards Sustainability chapter does not necessarily reflect the views of the Environmental Protection Authority. The EPA has used this information to assess each sector's environmental performance and integration of sustainability (see '*Overview*').

9.1 AGRICULTURE

Mixed agricultural land use in the State's South West near Lowden (Tourism WA).

Description

The agriculture sector in this report is defined as the management, protection and use of land for broadacre crop production, livestock and intensive industries. It focuses specifically on agriculture practices within the South West part of the State, an area of about 25 million hectares (or 15% of the State).

The Wheatbelt, situated in the State's South West, supports broadacre, rain-fed crop and stock farming across a variety of soil and landscape types. Common crops include wheat and other grains, oil seeds and pulse crops. Livestock industries are more commonly found in the higher rainfall areas, primarily involving cattle and sheep husbandry for meat and wool production. Intensive agricultural industries including horticulture, dairying, piggeries and feedlots are scattered throughout the State, but mostly closer to Perth and regional centres. Alternative agricultural activities are increasing in popularity and include silviculture (trees), viticulture (table and wine grapes) and hobby farms. The sector significantly overlaps with other natural resource sectors, particularly pastoralism, fisheries, wood production and water supply. these are addressed in separate chapters as they have different environmental impacts from agriculture.

Agriculture plays a major role in the economy of WA, representing the largest renewable resource sector. In 2005–06 the gross value of agricultural production was estimated to be $5.7 billion, with the value of agricultural exports being $4.3 billion (including production from pastoral areas). This represents 9% of the value of the State's total exports and approximately 16% of national agricultural exports, second only to the mining sector (Department of Agriculture and Food, 2006a). Fifty per cent of Australia's wheat exports come from WA. The agriculture sector also has direct flow-on effects to other sectors of the economy, with the WA agri-food industry contributing more than $10 billion to the State's economy in 2003–04. Agriculture also supports approximately 17% of WA's workforce (Australian Farm Institute, 2005).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The WA agriculture sector has proposed a sustainable vision of '… ensuring profitable agricultural systems that conserve our environment whilst contributing to the economic and social wellbeing of rural Western Australia' (Government of Western Australia, 2003a, p. 115). The objectives for sustainable agriculture reflect these vision statements:

- Promote the adoption of adaptive management practices that mitigate on-site and off-site environmental impacts while achieving agricultural profitability and social responsibility.
- Protect or enhance land, water, biodiversity, and atmospheric resources used or impacted by agriculture.
- Ensure effective and efficient use of resources and management of waste.

Headline indicators

Indicator TS1: Per cent of farmers certified through formal assessment of their farm management systems under accredited processes such as codes of practice, quality assurance or environmental management systems.

Farming for the Future is a Department of Agriculture and Food initiative that is developing farm sustainability practice standards to assist industry meet demands to demonstrate sustainable practice. A self assessment tool based on current recommended practices has been made available to farmers. The Department is now working with industries and representatives of the supply chain to further refine this, and related tools, to meet their particular needs. An annual telephone survey conducted by the department asked the question: 'Have you used a Quality Assurance, Environmental Management System or Code of Practice to guide your management decisions?' In 2006, just over one-third (35%) of farmers undertook a formal assessment, which was marginally higher than the 31% in 2005 (Department of Agriculture and Food, 2006b). Surveys indicate that the farmer participation rate was nearly double for farms in high rainfall areas compared to those in lower rainfall areas. Further refinement of the question is needed to reflect more clearly the intent of this indicator.

Indicator TS2: Proportion of natural resource base used by agricultural sector covered by regional natural resource management plans, and the extent of progress made towards resource condition targets specified under these plans.

This indicator includes natural resource management plans and biosecurity plans incorporating risk assessment, targets, asset prioritisation and processes for evaluation and

monitoring. Regional natural resource management groups have accredited regional strategies based on continuous improvement. Investment plans focus investment on achieving resource condition targets in the regional strategies. Targets will be refined and validated as part of the continuous improvement process. The plans offer a long-term approach to investment in resource protection and the development of agreed targets, and will assist the integration of effort across the sector.

Indicator TS3: Trends in efficiency of resource use by key agricultural industries as measured by regular assessments (every 3–5 years) using techniques such as life cycle assessment.

Techniques such as life cycle assessment take a whole-of-lifecycle view of a product or industry to help identify processes that are resource inefficient or where environmental impacts are likely to occur. To date, the grains, dairy and piggery industries have undertaken life cycle assessment. However, this would need to be applied to a broader range of industries and redone regularly to reveal trends and identify where process improvement is needed throughout the supply chain. The approach will require some development and will be refined as research needs are identified and new or improved technologies emerge for different stages of the industry cycle.

Status

MANAGEMENT OF AGRICULTURAL RESOURCES

The agriculture sector has a major role in natural resource management and a responsibility to ensure continuous improvement and adaptive management. Recent research has shown that the most important influences on the adoption of sustainable farming practices in Australia include participation in natural resource management programs, managerial skills and economic factors such as farm profitability, farm size, off-farm income and level of farm equity (Nelson et al., 2004).

Since the 1998 State of the Environment report (Government of Western Australia, 1998a), there has been a substantial increase in participation in management systems that identify and manage the environmental impacts of the farm business and improve production efficiencies. Such approaches – including environmental management systems, various industry codes of practice and relevant quality assurance systems – include tools such as best management practices (Table TS1.1), the development of property management plans, hazard analysis and critical control points. While there are no long-term measures of the rate of involvement, recent surveys show that 35% of farmers in the surveyed sample participated in a systematic assessment of their management practices (Department of Agriculture and Food, 2006b).

Table TS1.1: Per cent of farmers adopting best practice, 2002–06.

Practices	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)
Agronomy practices					
Planted non-irrigated perennial pasture species	34	33	39	39	42
Planted saltland pasture species (agriculture region only)	23	15	21	17	32
Stubble retention or mulching practices (agriculture region only)	62	48	71	60	64
Land conservation management					
Tree/shrub planting	62	56	56	59	70
Preserved or enhanced areas of conservation value	60	57	62	58	75
Excluded stock from areas impacted by land degradation	60	58	65	60	62
Protected river/creek frontages from grazing animals	42	48	43	47	48
Resource monitoring					
Regular soil testing for nutrient levels	70	59	72	67	73
Regular soil testing for pH	70	61	72	66	73
Regular monitoring of pasture/vegetation cover on sandy/light soils	56	48	58	66	54
Surface water management					
Water on sloping lands (e.g. grade banks)	54	43	59	47	64
Water on valley floors using surface drains (agriculture region only)	32	29	41	31	49
Water on valley floors using deep drains	16	12	15	12	27

Data sources: Department of Agriculture and Food, 2006b.

Profitability can be a key indicator of agricultural sustainability. It highlights the likelihood of a business remaining viable and its capacity to spend surplus income on natural resource conservation and management. In the last three years the WA broadacre and grains industries were more profitable than their eastern states counterparts and in a better position to adopt best management practices (Table TS1.2)

Table TS1.2: Farm business profit for agricultural industries in Western Australia and Australia.

	2003–04 $	2004–05 $	2005–06 $ (preliminary)
Broadacre industries (WA)	88 682	26 285	3 099
Broadacre industries (Australia)	4 537	3 693	8 620
Dairy industry (WA)	687	1 532	51 550
Dairy industry (Australia	–14 158	19 967	19 260
Grains industry (WA)	164 137	50 938[a]	–12 706[a]
Grains industry (Australia)	59 446	23 300[a]	11 100[a]

Data sources: Australian Bureau of Agricultural and Resource Economics (2006a & 2006b). (a) represents estimates, pers. comm. ABARE.

Protection of natural resources

Profit-at-full-equity represents the economic return to land, capital and management after the value of labour provided by managers has been deducted (eds Hajkowicz & Young, 2002). It provides an indicator of capacity of businesses to adapt to variable weather conditions, environmental pressures and market conditions. Farms in the South West have a wide spread of profit-at-full-equity (Figure TS1.1). The extensive areas of low profit represent pastoral areas of the southern rangelands. Excluding rangelands, it is estimated that 80% of profit-at-full-equity came from less than 3% of agricultural land (eds Hajkowicz & Young, 2002; National Land and Water Resources Audit, 2002). This significant inequity in profitability suggests some structural problems that may warrant intervention through public policy.

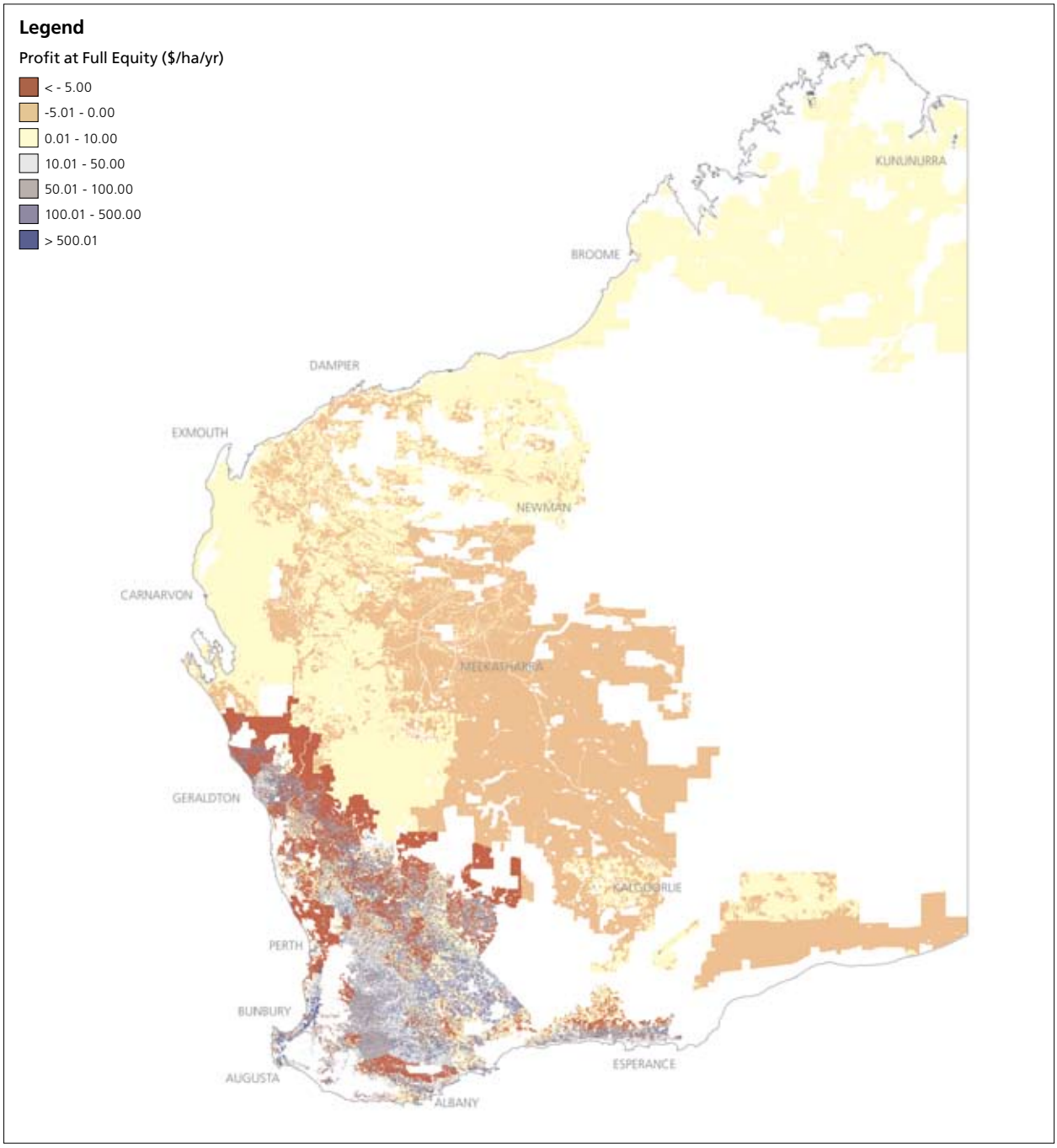


Figure TS1.1: Profit-at-full-equity, a five-year average for 1992–96.

Data source: CSIRO [ver.1997]; Analysis: CSIRO; Presentation: EPA.

Not only can diseases, weeds and pests damage native environments, they can lead to a decline in agricultural production and affect trade in international markets (see '*Introduced animals*' and '*Weeds*'). Western Australia has one of the world's most pest and disease-free agricultural production environments (Agriculture Protection Board of Western Australia, 2004). As well as preventing new animal pests, diseases and weeds from arriving, biosecurity involves getting rid of, and controlling, those that are already here. The sharp decrease in the number of animal diseases identified on WA farms is in part due to the reduction in the list of notifiable diseases. The decrease in the interceptions of significant pests, diseases and weeds is a positive result for the State (Table TS1.3). Biosecurity plans have been developed to protect agricultural industries. These include Grainguard, Hortguard (i.e. horticulture), Stockguard (i.e. livestock) and Beeguard.

Table TS1.3: Biosecurity statistics for Western Australia.

Service measures	2002–03	2003–04	2004–05	2005–06
Identification of notifiable animal diseases	23	22	23	3
Interceptions of significant pests, diseases, weeds	278	367	297	192
Removal of properties from quarantine	122	119	106	101

Data source: Department of Agriculture and Food, 2006c.

Table TS1.4: Number of farmers involved in major Western Australian covenanting programs and the area of protected native vegetation.

	Hectares	Number of farmers
National Trust of Australia (since 1999)	8 882	95
Soil and Land Conservation Council (since 1988)	180 000	2 500
Department of Environment and Conservation (since 1999)	4 605	66

Data sources: National Trust of Australia (Western Australia), Department of Agriculture & Department of Environment and Conservation.

Protection mechanisms such as covenanting programs are used by farmers to voluntarily protect and manage native vegetation on their property. Covenants are available through the National Trust of Australia, Soil and Land Conservation Council and Department of Environment and Conservation programs. Covenants restrict clearing and grazing of native vegetation and may help establish management arrangements. Fencing may be required to ensure livestock do not intrude into a covenanted area. Nearly 200 000 ha of native vegetation (affecting 2700 landholders) has been protected since 1988 through these three programs (Table TS1.4).

USE OF NATURAL RESOURCES

It is generally recognised that many forms of agriculture are not sustainable. Over the long term this will require major changes for some agricultural landscapes. In the short to medium term, sustainable use of natural resources can be achieved by improvements in eco-efficiency, that is, the production of goods that use less energy and fewer raw materials, leading to less waste, less pollution and reduced cost. Technological innovation informed by life cycle assessment will be a key to this.

Life cycle assessment is an emerging technique for assessing the eco-efficiency of agricultural industries. It examines the efficiency of production processes that help to transform raw agricultural materials into finished product, and the associated production of waste. Life cycle assessments can focus on specific areas of inefficiency or environmental degradation on the production line. Policy measures, including targeted research, can be implemented to rectify these problems.

RECENT EXAMPLES OF LIFE CYCLE ASSESSMENTS INCLUDE:

1. The Western Australian grains industry found the following areas for improvement in the pre-farm and farming stages of bread production: global warming, human toxicity, terrestrial ecotoxicity and eutrophication (Narayanaswamy et al., 2002).
2. The Australian dairy industry found the following areas for improvement in the production of milk on farm: water use, eutrophication and greenhouse gas emissions (Nicol, 2005).

Efficiency of resource use can also be determined from the amount of production per unit area of farm land. Land use and production efficiencies vary across agricultural industries. For example, wheat yields in WA are improving by 20–50 kg/ha per year, depending on the location. On average, this has resulted in a doubling of yields over the last 20 years, a doubling of water-use efficiency and a three- to four-fold increase in the proportion of the crop qualifying for premium payments related to quality. This improved crop production was due to plant genetics, adaptation to environment and crop management, and has helped farmers remain profitable in the face of relentlessly declining terms of trade (increased costs with reduced returns).

Total factor productivity growth represents increases in outputs relative to resource inputs. The State's agricultural sector growth is estimated to be 4.2% per annum, which is among the highest in Australia. Within WA, the wheat–sheep zone has the highest total factor productivity growth of 6.6% per annum: sheep (4.1%), beef (3.5%), mixed sheep–beef (4.7%) and mixed crop–livestock (3%) (Islam, 2000). Given that crop yields are still improving despite recent low rainfall years, it is believed that the growth in yield is due to improved technologies and better use of rainfall. A significant component of doubling wheat yields per hectare, often in the face of declining rainfalls, has been improved water use efficiency through reduced losses of rainfall to soil evaporation and drainage (Anderson et al., 2005).

While increased water scarcity within the agricultural sector will motivate farmers to improve their irrigation practices and reduce their water consumption per output unit, agriculture is among the highest water users in the State, consuming an estimated 40% of supplied water (see '*Water supply*'). There is a wide range of returns on water use within the agriculture sector. The Department of Agriculture (2004a) estimated that returns per unit of water used varied from highs of around $13 000/ML and $9 300/ML for potatoes and apples respectively, to a low of $600/ML or less for flood-irrigated dairy or beef production. From 1990 to 2000, an increase in the use of more efficient irrigation methods occurred. For example, drip or micro spray use went from 18% to 38%, and there was a corresponding decrease in less efficient methods including

furrow or flood irrigation (which decreased from 48% to 35%), and spray/sprinkler methods, which decreased slightly (Australian Bureau of Statistics, 1991 & 2001).

Water resource allocation and management policies that facilitate a shift in water use towards activities with the highest economic returns is predicted to result in investment in water management and more efficient systems that will support improved sustainability outcomes. Western Australia uses less energy per dollar product than the Australian average, probably due to the comparatively low use of irrigation (Figure TS1.2). The State efficiency is not as high as for Australia generally, but usage is decreasing more rapidly (Department of Agriculture, 2005a).

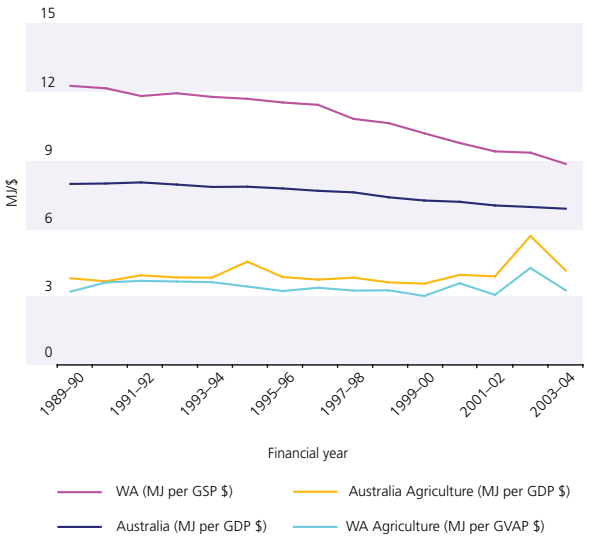


Figure TS1.2: Comparison of energy use in Western Australia and Australia for the agricultural sector.

Data source: Department of Agriculture (2005a).

In contrast, efficiency of fertiliser use in WA (Figure TS1.3) decreased from 1990 to 2003 for wheat and barley (Department of Agriculture, 2005a). The reason for this requires further analysis. It may reflect a significant shift from sheep to grain production that has opened up areas for grain growing where farmers typically do not achieve the efficiency levels of 'traditional' cropping areas (i.e. those with high rainfall and fertile soils). The trend to increased use of nitrogen fertiliser is also likely to be a factor.

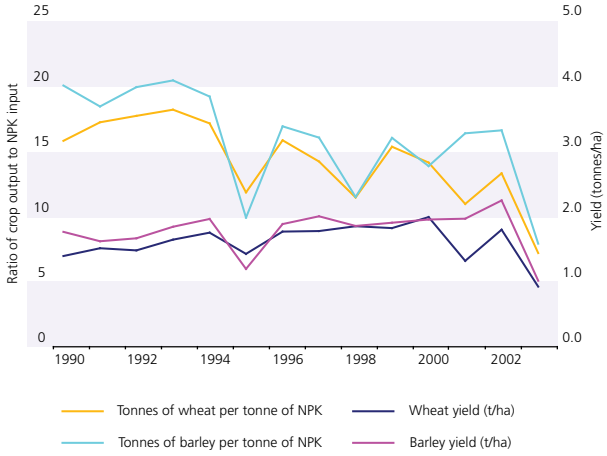


Figure TS1.3: Fertiliser (NPK) use efficiency for wheat and grain farms in Western Australia, 1990–2003.

Data source: Department of Agriculture.

Pressures

LAND AND INLAND WATER PRESSURES

Public awareness of environmental issues has meant that farm practices are increasingly influenced by environmental quality and landscape amenity concerns. Many of the key issues affecting land and water resources associated with agriculture (e.g. salinisation, nutrient run-off causing eutrophication, soil acidification, waterlogging, loss of soil health) are discussed elsewhere in this report. Other land degradation issues include water repellence of some soils, waterlogging, soil erosion and deterioration in remnant vegetation.

BIODIVERSITY PRESSURES

Pests, weeds and diseases regularly threaten the productivity of agricultural systems. As global trade has increased, so has the risk of introduction of exotic pests and diseases. Agricultural industries are continually challenged by exotic disease and pest threats (e.g. anthracnose in lupins, apple scab, Queensland fruit fly and skeleton weed in broadacre crops). Exotic vermin (e.g. foxes, rabbits and wild cats) and weeds (e.g. bridal creeper) once established greatly threaten native wildlife and natural habitats. Surveillance and control of pests and diseases will have ramifications not only for farm businesses but also for natural environments.

CLIMATE CHANGE

Climate change is likely to pose a long-term challenge for the agricultural sector through a reduction in growing season rainfall, on-farm water availability, animal health, and extreme weather conditions. It could also affect soil stability, human health and the risks from insect pests and weeds (see '*Climate change*'). Rising wheat yields over the past 30 years in the South West (despite reduced rainfall in the growing season) illustrates the importance of farming technology changes and suggests that improvements in farming systems and technology have been able to cope with the climate trends to date. Whether this will continue in the future remains uncertain and will be a challenge for adaptation and planning for the future of the industry.

WATER SUPPLY

Irrigation water use will come under increasing pressure from competing uses such as public water supply and industrial use. Agricultural industries will also be under scrutiny in regards to the efficiency of water use, water allocations, receipt of cross-subsidised water supplies and impacts on water quality through salinisation and nutrient export.

SOCIAL AND ECONOMIC PRESSURES

A pressure on sustainable agriculture is the depopulation of rural areas and subsequent reduction of services in rural towns. Rural employment is decreasing with increased mechanisation, comparatively lower wages for rural workforces and the low diversity of job opportunities. Rural communities are also becoming a declining political force.

Some of the economic pressures on sustainable agriculture are the declining terms of trade, the declining importance of agriculture in the nation's economy, the weakening relationships between farm and food prices, the deregulation of markets and the spread of quality assurance schemes requiring farmers to rapidly learn new skills.

Fertiliser use efficiency for wheat and grain farms has been declining (Tourism WA).

Current responses

Research, development and extension: Research, development and extension in agriculture are vital to the sector's performance. Current activities include developing standards and better management practices; developing more sustainable land management systems; productive use and rehabilitation of saline lands; climate science and adaptation; recycled organics; and exploring new opportunities such as bio-energy production and carbon sequestration through revegetation (e.g. trees, saltland pasture) to offset agricultural greenhouse gas emissions. Much of this work involves collaborative programs across a range of research organisations and government departments. For example, the Future Farm Industries Cooperative Research Centre is at the forefront of research, development and extension with programs covering the fundamentals of plant-based solutions to salinity.

Integrated planning: Regional natural resource management groups have developed regional plans in partnership with Commonwealth, State and local governments and regional communities in order to gain accreditation through the National Action Plan for Salinity and Water Quality (Council of Australian Governments, 2000) and the Natural Heritage Trust. These programs and processes have built on the previous Landcare movement. The regional natural resource management strategies involve resource risk assessments, identification of priority assets, setting targets for natural resource management indicators, and establishing local/farm-level practices to help meet desired outcomes at regional and State levels. Integrated land use planning is being used in a number of areas to manage potential threats to agriculture and to identify and promote new land use opportunities aligned with land suitability or improvements to existing agricultural practices. These developments indicate a positive move towards strategic and integrated planning for investment of public and private funds for sustainable use of agricultural land.

Economic instruments: Investigations are being undertaken of economic incentives and innovative instruments as drivers of land use change towards more sustainable use of agricultural land. They include biodiversity offsets, integrated ecosystem services trading, tax incentives and environmental stewardship rebates as well as land purchase.

Education and training: Substantial work is underway in education and training programs by the Department of Agriculture and Food, regional natural resource management groups, research organisations, private grower groups and programs such as FarmBis.

Industry management programs: Trials are being conducted in WA as part of the Environmental Management Systems National Pilot Program. These projects are now being built upon by a number of broader industry environmental management systems pathways projects. Most agricultural industries and their supporting service industries have established or are establishing codes of practice which promote quality assurance (including best practice farm management and production of safe food and fibre products). Innovative producer groups like the Mingenew–Irwin Group, Blackwood Basin Group and the Fitzgerald Biosphere Group are integrating sustainability principles into production through the environmental equivalent of quality assurance programs. Many agricultural industries are introducing programs to ensure sustainable production for the future, for example, the national Dairying for Tomorrow program with Western Dairy, Horticulture for Tomorrow, and Grain and Graze.

Industry biosecurity management plans: Hortguard and Grainguard are examples of industry management plans which address roles and responsibilities, risk assessment and processes for joint decision-making and cost sharing based on public versus private good. They focus on prevention through border protection, preparedness by the agriculture sector, and response to incursions of exotic pests, weeds and disease.

Implications

Agricultural industries and farming communities have a responsibility to ensure that natural resources are maintained or improved for future generations and that associated impacts are not transferred to the wider catchment. Unsustainable agricultural practices may result in loss or decline in native vegetation, reduced biodiversity, introduction and invasion of weed and feral species, altered water regimes, salinisation, soil erosion, acidification, sedimentation, eutrophication and contamination of waterways and wetlands.

Unsustainable agricultural land use also results in reduced production and decreased economic profitability. It may render the land unsuitable for other potential uses that could be better suited to the land including tourism, silviculture, aquaculture, water supply catchments, conservation and potentially carbon trading. Market access for some industries required to meet triple bottom line accountability and performance standards may also be affected.

Unsustainable agricultural practices may result in a net migration of people away from farms that become less profitable or degraded. A decreasing population base will generally result in reduced local development opportunities and business interest, a fall in employment and a gradual loss of community services that support the agricultural sector.

SUGGESTED RESPONSES

9.1 Develop a Climate Change Adaptation Strategy for agriculture in WA in a partnership between the relevant government and non-government organisations. This would include alternative farming systems that enable adaptation to climate change and promote sustainable industries and technologies that are profitable as well as environmentally beneficial, such as bio-fuels or carbon sequestration.

9.2 Establish strategic land use analysis and planning capacity to advise land managers and industry about the sustainability of current and alternative land uses.

9.3 Develop economic incentive packages and market-based schemes to drive land use changes where necessary.

9.4 Accelerate adoption of schemes such as 'Farming for the Future', quality assurance, environmental management systems and life cycle assessment. Incentive programs and innovative extension and environmental education methods need to be developed to ensure a critical mass of adoption of these initiatives and to encourage the establishment of new behaviour norms for the agriculture sector.

The piggery industry has been incorporating sustainability principles into its operations (Department of Agriculture and Food).

CASE STUDY – THE PIG INDUSTRY

The pig industry provides a very good example of an industry that has incorporated triple bottom line sustainability principles into its operations. It has achieved this through modifying various production processes and the continued enhancement of Codes of Practice to address environmental issues associated with pig production including odour, nutrient enrichment of ground and surface waters, and erosion and land degradation associated with poorly run operations. For example, the industry increased the efficiency of pig diets by altering the proportions of phosphorus and nitrogen in pig food. Straw-based housing systems were introduced for grower/finisher pigs that retained waste in the straw instead of transferring it to traditional large effluent ponds. This reduced the risk of nutrient pollution in local groundwater and streams. Water use efficiency was also improved, with water now only being used for drinking and not for cleaning and washing down pig pens. Changes were also made industry-wide, including uptake of a quality assurance program and the development of environmental codes of practice. As a result, the industry has reduced its environmental impacts and improved export opportunities.

CASE STUDY – THE MINGENEW–IRWIN GROUP

The Mingenew–Irwin Group began investigating the applicability of environmental management systems to broadscale agriculture in 2000, and in 2003 developed an environmental management systems workbook and best management practice guidelines. They then started work on a new research project to look into the widespread adoption of environmental management systems, ensuring practical application and benefit testing, as part of a national environmental management systems pilot program (funded by the Natural Heritage Trust). The group continues to train local producers and support them in developing individual business environmental management systems through workshops and individual support.

The environmental management systems approach is based on the principles of the internationally recognised code ISO 14001, and also includes some of the techniques from quality assurance code SQF 1000. These deal with major environmental factors such as chemical usage, salinity, erosion, groundwater contamination, eutrophication of waterways and the introduction of genetically modified crops.

Some of the benefits are improved environmental and whole-of-business management by farmers, which leads to overall improvements in land management. It is seen as a proactive approach to environmental management and provides benefits by:

- assuring the farmer that they are producing their goods and managing their natural resources in the best way possible;
- assuring the consumer that goods produced by that farmer were grown following well-defined sustainable principles; and
- assuring the WA public and regulators that farmers are using the State's natural resources productively and responsibly.

9.2 CONSERVATION

Karri forest walk in Beedelup National Park (Tourism WA)

Description

The 'conservation sector' in this report refers to those parts of WA's environment that form part of the National Reserve System and the National Representative System of Marine Protected Areas, or included in complementary off-reserve conservation areas managed for nature conservation. The conservation sector differs from the other sectors in this theme because it does not relate to extractive use of natural resources. The sector aims to protect biodiversity, including highly valued and representative ecosystems, native flora and fauna (especially rare and threatened species), and important landscapes in many instances.

The formal conservation reserve system has the highest levels of long-term (statutory) protection and their management is open to public accountability. This public terrestrial and marine protected area system is considered a major strategic component to conserving biodiversity in situ and meeting sustainability objectives. In WA, the following categories under the *Conservation and Land Management Act 1984* are collectively considered part of the National Reserve System and National Representative System of Marine Protected Areas: national parks, nature reserves, conservation parks, marine parks, marine nature reserves and marine management areas. The management of formally reserved areas under the Act is the responsibility of Department of Environment and Conservation.

Informal (or off-reserve) conservation is provided by a range of instruments to complement the objectives of the formal conservation reserve system. These instruments generally do not meet the standards of the National Reserve System, but are also important for achieving conservation outcomes. They include private protected areas, Commonwealth Indigenous Protected Areas, covenanting schemes (such as Nature Conservation Covenants) and non-binding management agreements (such as Land for Wildlife and Woodland Watch). Some have a level of legal protection, e.g. private land covered under accredited Nature Conservation Covenants. Other areas are managed for conservation purposes by local governments or State agencies other than Department of Environment and Conservation. Commonwealth Indigenous Protected Areas are set aside for biodiversity conservation and preservation of cultural heritage (e.g. the Ngaanyatjarra Indigenous Protected Area covers 9 812 900 ha and contains all of WA's Central Ranges bioregion, an area the size of Tasmania).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The conservation sector objectives that reflect this vision aim to:

- Establish a formal conservation reserve system that captures the full range of biodiversity (through being comprehensive, adequate and representative) ensuring its protection into the future and the long-term security of tenure for management.
- Provide a network of off-reserve conservation areas that complement the formal conservation reserve system in maintaining the State's biodiversity.

Headline indicators

Indicator TS4: Per cent of terrestrial biogeographical regions that meet the 15% reservation target.

The benchmark of at least 15% reservation has been increasingly recognised for terrestrial bioregions (Department of Conservation and Land Management, 2003). It originates from the *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia* (ANZECC & MCFFA National Forest Policy Statement Implementation Sub-committee, 1997), but has been expanded to include other ecosystems as well as forests. The *National Objectives and Targets for Biodiversity Conservation* (Environment Australia, 2001b) required that a representative sample of each bioregion be protected by 2005 within the National Reserve System or network of Indigenous Protected Areas, or as private land managed for conservation under a conservation agreement. As of June 2005, only 20% of the terrestrial subregions (defined by the Interim Biogeographic Regionalisation of Australia) met the objective 15% or more of the area reserved; 11% of the subregions did not contain any formally reserved areas (Table TS2.1; Figure TS2.1). To date, no formal evaluation against the target has been undertaken.

Two Peoples Bay Nature Reserve on the South Coast (Tourism WA)

Indicator TS5: Per cent of marine biogeographical regions with no formal reservation.

The *National Objectives and Targets for Biodiversity Conservation* (Environment Australia, 2001b) requires that progress be made towards the establishment of a comprehensive, adequate and representative system of marine protected areas. However, no specific targets of percentage per marine region or ecosystem type have been set. The State Government has developed the strategy *New Horizons – The Way Ahead in Marine Conservation and Management* to develop a marine conservation reserve system that manages the biological and recreational resources to take into account other essential and sometimes competitive activities (Government of Western Australia, 1998b). Most marine bioregions have a very low level of reservation with 65% of bioregions having no marine reservation (at June 2005) (Table TS2.1; Figure TS2.1). In contrast, the Ningaloo bioregion has the highest level of reservation at 82% of its area.

Table TS2.1: Terrestrial subregions and marine bioregions in Western Australia that meet various levels of reservation, as of June 2005.

Level of reservation	Number of terrestrial subregions	Per cent reserved	Number of marine bioregions	Per cent reserved
0%	6	11%	11	65%
0.1–5.0%	20	37%	2	12%
5.1–10.0%	9	16%	0	0%
10.1–15.0%	8	15%	0	0%
More than 15.1%	11	20%	4	23%
Total	54		17	

Data source: Department of Conservation and Land Management [ver. 2006]. Note: Includes the formal conservation reservation system only. Data from Indigenous protected areas and private land is not included. Terrestrial subregions are defined by the Interim Biogeographic Regionalisation of Australia, marine bioregions are defined by the Interim Marine and Coastal Regionalisation of Australia.

Wildflowers in Kalbarri National Park (Tourism WA)

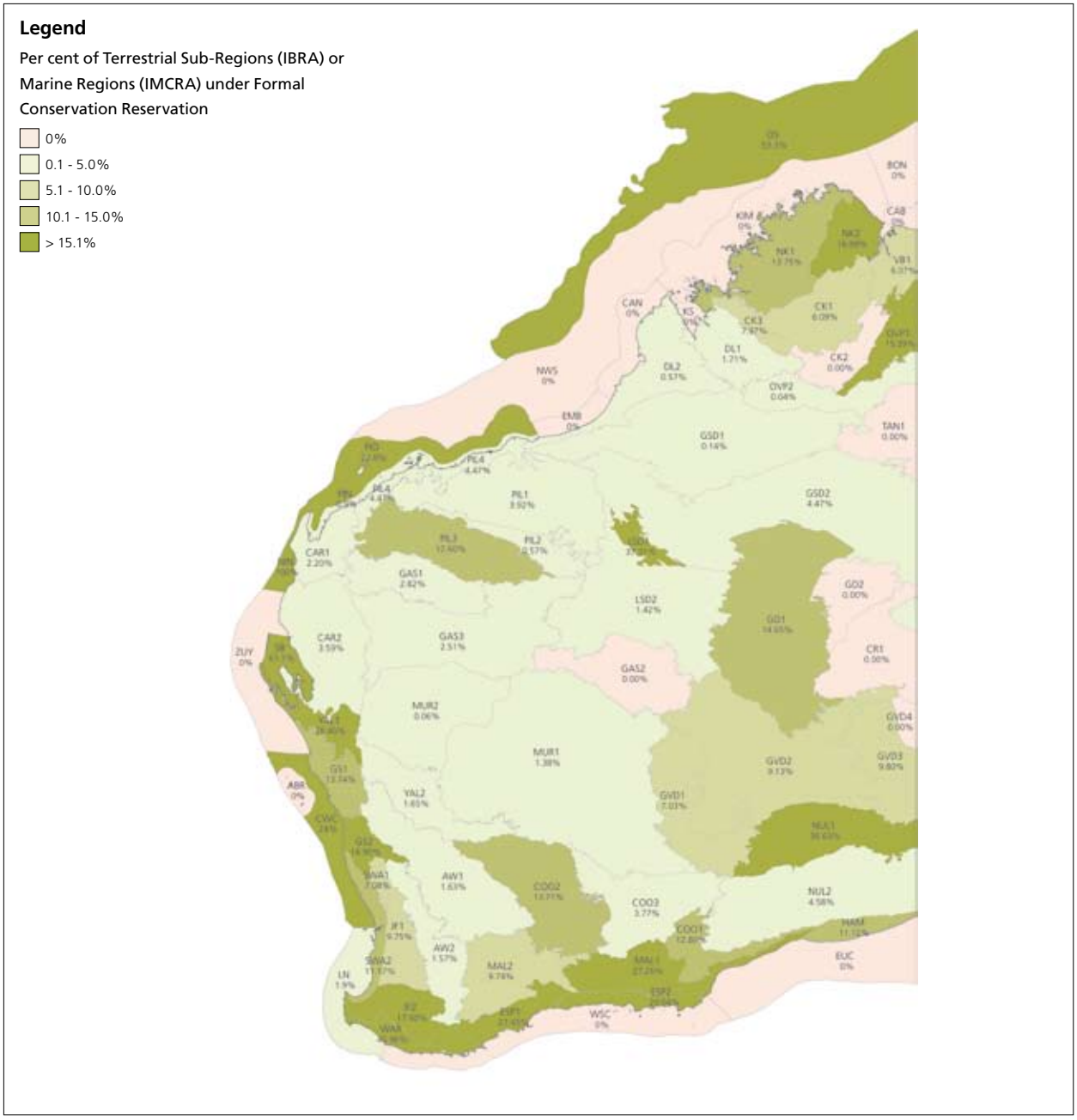


Figure TS2.1: Per cent of terrestrial and marine subregions in Western Australia's formal conservation reserve system, as of June 2005.

Data source: Department of Conservation and Land Management – Marine Conservation Reserves [ver. 2005], CALM managed land [ver. 2005]; Department of Environment and Heritage – IBRA [ver. 2005], IMCRA [ver. 1997]; Analysis: CALM; Presentation: EPA. Note: Figures in brackets show the area that will be reserved when outstanding *Forest Management Plan* reserve proposals and pastoral acquisitions are added.

Status

CONSERVATION OF NATURAL RESOURCES

At 30 June 2006, WA had a formal terrestrial conservation reserve system comprising national parks (97 parks, covering 5 593 536 ha), conservation parks (843 155 ha), nature reserves (10 860 832 ha) and miscellaneous conservation reserves (285 832 ha) under the *Conservation and Land Management Act 1984*. The total area of 17 583 355 ha equates to 6.95% of WA's land area. In addition, 5 265 201 ha of former pastoral leasehold land has been acquired for conservation reserves as at 30 June 2006 but has not yet been formally reserved. Under the *Forest Management Plan 2004–2013*, approximately 195 000 ha of land tenure was marked for addition to the conservation reserve system (Conservation Commission of Western Australia, 2004). Reservation of these areas will increase the total area of the formal conservation reserve system to around 22.85 million ha, or 9% of WA's land area. Furthermore, a total of more than 1.4 million ha of land in the rangelands has been identified for exclusion from pastoral leases when the leases expire in 2015, and will be incorporated in the formal conservation reserve system.

Principles for the formal conservation reserve system rely on 'representativeness', which requires different vegetation types to be distinguishable from each other and mapped to be included in the conservation reserve system. There are many different ways of mapping vegetation, but to be consistent with other states WA has adopted the National Vegetation Information System methods. A 'vegetation association' is a discrete identifiable set of species that occur together, and usually includes information about vegetation structure. As at June 2005, 19 vegetation associations had been extensively cleared to at least 90% of pre-European settlement occurrence, and were not represented in the formal conservation reserve system. This included seven associations with 2% or less remaining native vegetation. About 39% of vegetation associations were not protected in the formal conservation reserve system (Table TS2.2). Thirty-one per cent of vegetation associations had greater than 15% of their occurrence represented in the formal conservation reserve system.

Table TS2.2: Proportion of vegetation associations protected in the formal conservation reserve system, as an indicator of representativeness as at June 2005.

Per cent formally reserved	Per cent of National Vegetation Information System vegetation associations (total = 818)
0%	39%
0.1 – 5%	16%
5.1 – 15%	14%
>15%	31%

Data source: Department of Conservation and Land Management [ver. 2006]; Department of Agriculture – National Vegetation Information System data [ver. 2003]. Data analysis: Department of Conservation and Land Management. Note: Calculations include areas proposed for reservation under the *Forest Management Plan* and former pastoral lease areas that have been acquired, but are yet to be reserved.

The comprehensive, adequate and representative reservation system has been largely defined by vegetation and geological features. Although some protected areas contain inland water systems, these are not usually the focus of reservation. As a result, waterways and wetlands are often not reserved as whole functioning systems. The Natural Resource Management Ministerial Council (2004) aims to amend the National Reserve System scientific guidelines to ensure that freshwater ecosystems are appropriately incorporated into the formal conservation reserve system (with a particular focus on planning so that ecosystems reduced to less than 30% and less than 10% of original areas can be identified).

There are currently 12 internationally recognised Ramsar Convention listed wetland sites (covering 35 005 ha and including some marine areas) and 120 Directory of Important Wetlands of Australia (nationally-listed wetlands) in WA, but listing does not provide legal protection for the wetlands (unless included on reserved land). The *Environmental Protection (Swan Coastal Plain lakes) Policy 1992* covers some wetlands on the Swan Coastal Plain due to specific conservation values. These have legal protection but are not formally reserved.

Table TS2.3: Growth of two off-reserve conservation programs administered by the Department of Environment and Conservation in Western Australia since 2000.

Year	Land for Wildlife (wildlife habitat only)		Nature conservation covenants	
	Area (ha)	Number of properties	Area (ha)	Number of properties
1999–2000	77 795	478	0	0
2000–01	92 431	636	119	9
2001–02	102 691	807	380	20
2002–03	115 635	981	606	33
2003–04	227 628	1 090	2 852	46
2004–05	236 778	1 218	4 605	66
2005–06	244 398	1 380	5 786	70

Data source: Department of Conservation and Land Management [ver. 2006]; Department of Conservation and Land Management (2006) Note: The two Indigenous protected areas (Ngaanyatiarra and Paruku) cover a total of 10 247 500 ha and form a significant part of the State's off-reserve conservation areas.

At 30 June 2005, WA's marine conservation reserve system comprised nine marine parks, two marine management areas and one marine nature reserve, covering a total area of around 1.54 million ha, or 12.2% of the area covered by marine bioregions. Currently, 2.5% of State marine waters are afforded the highest level of protection in marine nature reserves or sanctuary zones of marine parks, with other marine protected areas allowing other beneficial uses (Figure TS2.1).

Marine parks are created to protect natural features and aesthetic values while at the same time enabling sustainable recreational and commercial use where these activities do not compromise conservation values. There are four types of management zones applicable to marine parks: recreation zones, general use zones, sanctuary zones and special purpose zones. Sanctuary zones afford the highest level of protection for environmental values in marine parks, and only allow passive recreational uses consistent with the protection of those values.

There have been some significant achievements in the establishment of the marine conservation reserve system in WA, with the creation of the Jurien Bay Marine Park, the Montebello Islands Marine Park, the Barrow Island Marine Park and the State's first marine management areas, the Muiron Islands Marine Management Area and the Barrow Island Marine Management Area in 2003 and 2004. In 2005, two existing marine parks were also significantly extended: the southern portion of the Ningaloo Reef was added to the Ningaloo Marine Park and all of the surrounding State waters were added to the Rowley Shoals Marine Park, significantly increasing the ecological integrity of both reserves.

Of the 18 marine regions in WA, 11 have no marine reserves and a further two have less than 3% of their area reserved (Figure TS2.1). Planning is underway for the establishment of new marine conservation reserves for Dampier Archipelago to Cape Preston, the 'Capes' (Geographe Bay and Cape Leeuwin to Cape Naturaliste and Hardy Inlet), Walpole–Nornalup inlets and extensions to the Shark Bay and Shoalwater Islands marine parks. Gaps remain in the marine conservation reserve system, particularly in the Kimberley and South Coast regions. The Recherche Archipelago and Roebuck Bay have been identified as high priorities for future reservation consideration.

MANAGEMENT OF CONSERVATION AREAS

The *Directions for the National Reserve System – A Partnership Approach* (Natural Resource Management Ministerial Council, 2004) provides a common approach and framework to establish and manage the National Reserve System. It sets minimum standards which must be met for protected areas to be included in the National Reserve System, and targets for reservation. The National Reserve System Program under the Commonwealth's Natural Heritage Trust assists the states and territories, non-government organisations and private land managers to establish and manage Australia's National Reserve System through financial incentives and best practice standards for management.

Management plans and interim management guidelines form the basis for conservation practices and actions in the conservation reserve system. At present, WA has 56 current final management plans for the conservation estate covering 2 080 574 Ha (9% of the total conservation estate in WA). The approach to management has changed over time, and some areas have had management plans superseded by different management frameworks over time (e.g. Three Forest Region regional management plans were superseded by the Regional Forests Agreement process and then by the subsequent *Forest Management Plan 2004–2013*). In addition, there are 23 management plans in preparation, covering another 4 158 001 ha.

Western Australia's *Forest Management Plan 2004–2013* (Conservation Commission of Western Australia, 2004) implements government policy for Protecting our Old-growth Forests (Australian Labor Party Western Australian Branch, 2001). It extends the conservation commitments made under the South West Regional Forest Agreement of 1999 and nominates further areas for inclusion in the formal conservation reserve system. The agreement was based on national criteria to reserve 15% of the pre-European forest ecosystems, increase reservation level for vulnerable ecosystems to 60% of remaining extent, and increase the reservation level of rare and endangered forest ecosystems to 100% of remaining extent.

The 2015 pastoral lease exclusion program has resulted in more than 1.4 million ha of land with high biodiversity conservation value in the rangelands being identified for addition to the conservation estate when pastoral leases expire on 30 June 2015. Early surrender of some of these pastoral leases has commenced. Bush Forever (Western Australian Planning Commission, 2000) identifies regionally significant bushland within the Perth metropolitan area of the Swan Coastal Plain. It aims to formally protect at least 10% of the 26 original vegetation complexes.

Two important objectives in the *National Strategy for the Conservation of Australia's Biological Diversity* (Department of Environment, Sport and Territories, 1996) are the need to strengthen biodiversity conservation outside of formal conservation areas and the need for bioregional planning. Areas managed for nature conservation on private land are most prevalent where land has been significantly modified, and where comprehensive, adequate and representative reserve system objectives cannot be met through formal reservation. Private land ownership is highest in the State's South West. Significantly, there has been continual growth of off-reserve conservation networks in the Swan Coastal Plain, south coast, northern agricultural and Wheatbelt regions. Other types of reserves, such as waterway reserves and roadside corridors that are not managed for the purpose of biodiversity conservation, may form important corridors between the formal conservation reserve system and off-reserve conservation areas.

Public interest in conservation on private land has grown over the last five years, and consequently the number of properties and areas subject to various types of agreements or where management advice is offered has increased over time (Table TS2.3). Nature conservation covenants and management agreements may provide incentives for management (such as fencing of significant areas), provide guidance on management and place conditions under nature conservation covenants that endure on the title of properties through changes in ownership. There are other notable programs (such as the National Trust of Australia's nature conservation program and the WWF–Australia Woodland Watch) that have also become popular in some areas.

Weano Gorge in Karijini National Park (Tourism WA)

Pressures

Pressures are threats to the health and ecological integrity of conservation areas can be divided into two main types: those involving biological processes, and pressures that stem from institutional issues.

ENVIRONMENTAL THREATS

There are many specific threats that have been addressed elsewhere in this report. The spread of invasive species (environmental weeds, introduced animals, introduced marine species and diseases such as Phytophthora dieback) are biological pressures that disrupt ecological processes, resulting in a decline or loss of biodiversity. The decline in or loss of habitat values and ecosystem function can be due to a number of impacts including changed fire regimes, salinisation of land and water, off-site pollution and contamination, and soil erosion. Often these pressures are a legacy of former land uses that initiated degrading processes and these continue to impact on conservation values. Climate change impacts on biodiversity also represent a significant threat.

LAND RESOURCE USE CONFLICT

Current State Government policy through the *Mining Act 1978* allows for exploration mining tenements and mining titles over some forms of existing conservation reserves. During economic booms, there is increased demand for natural resources in WA (e.g. minerals, petroleum, wood products, water supplies), which may impact on the State's biodiversity. Population growth also has potential to impact valuable biodiversity assets. As the Perth metropolitan region expands and becomes more consolidated, property reserved for conservation purposes becomes more economically valuable and more attractive for development. Irresponsible behaviour of people (such as illegal rubbish dumping, vandalism, poaching of native species and illegal land clearing activities) also affect conservation areas.

MANAGEMENT ISSUES

Benign neglect or inadequate management which fails to respond adequately to developing threats will result in further decline of conservation areas . Of the total conservation estate in WA, 9% is covered by a management plan. Agencies responsible for management of all conservation estate areas have the responsibility to maintain biodiversity values. However this can be very difficult when managing landscape level threats.

KNOWLEDGE GAPS AND SHORTFALLS

Society's failure in the past to adequately value biodiversity has resulted in its continued decline. The lack of biodiversity knowledge further impedes the identification of representative ecosystems and species for conservation. Small reserved areas in fragmented or largely modified landscapes are effectively islands subject to problems due to small and genetically isolated populations, and are vulnerable to environmental change. The long-term security of legal instruments such as conservation covenants and management agreements is largely untested. There is a lack of public scrutiny of contract formation, circumstances under which they can be dissolved and any potential action that could be taken if contravention of a covenant or management agreement occurs.

Current responses

Legislation: The principal State legislation providing for the establishment and management of the public terrestrial and marine conservation reserve systems is the *Conservation and Land Management Act 1984*. Reserves are vested in the Conservation Commission (terrestrial) and the Marine Parks and Reserves Authority (marine). The Department of Environment and Conservation manages reserved lands and waters on behalf of the people of WA.

Formal conservation reserve system: has the highest levels of long-term (statutory) protection and its management is open to public accountability. This public terrestrial and marine protected area system is considered a major strategic component to conserve biodiversity in situ and in meeting sustainability objectives. The Department of Environment and Conservation is responsible for the design and establishment of the formal terrestrial and marine conservation reserve system in WA. The State's biological survey program provides a basis for the selection of areas for the terrestrial conservation reserve system. To date, about 25–30% of the State has been systematically assessed to determine biodiversity patterns and components, and conservation status. This is complemented by a number of local scale biological surveys and assessments.

Forest Management Plan 2004–2013: implements government policy for *Protecting our Old-Growth Forests* (Australian Labor Party Western Australian Branch, 2001). It extends the conservation commitments made under the South West Regional Forest Agreement of 1999 and nominates further areas for inclusion in the formal conservation reserve system.

Indigenous Protected Areas: The Indigenous Protected Areas Program is a Commonwealth initiative under the Natural Heritage Trust to develop agreements with Indigenous communities regarding the management of biodiversity and cultural assets on their lands, in order to further complement the formal conservation reserve system. The program helps develop Indigenous protected areas.

Environmental protection policies: The *Environmental Protection (Swan Coastal Plain lakes) Policy 1992* was established to protect wetlands on public and private land in the Swan Coastal Plain. The *Wetlands Conservation Policy* (released in 1997) outlines principles and actions for wetland conservation and management. The policy is currently being reviewed and updated. In contrast to terrestrial vegetated areas, no national program exists to specifically develop a system of representative freshwater reserves.

Land for Wildlife: is a voluntary property registration scheme for landholders who wish to manage areas of wildlife habitat on their property. The program encourages and assists landholders to include nature conservation along with other land management objectives.

Nature Conservation Covenants: The Department of Environment and Conservation offers landowners the opportunity to use conservation covenants to protect the nature conservation values of their properties. It is a voluntary, legally binding document that has provisions restricting activities that might threaten the land's conservation values. Every conservation covenant is individually negotiated between the Department and the landowner, and aims to maintain the conservation values of the bushland whilst allowing for flexibility to reflect the landowner's wishes for the land.

Strategic plan for marine protected areas: *The Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for action by Australian governments* (ANZECC & MCFFA Task Force on Marine Protected Areas, 1999) outlines 34 actions to be implemented by the Commonwealth, state and territory governments to advance the establishment of marine protected areas.

Implications

The conservation of biodiversity is fundamental for the long term protection of the State's natural capital and the achievement of sustainability goals. Biodiversity and associated ecosystem services underpins many of the State's economic sectors, such as tourism, and the health and wellbeing of most Western Australians. Despite many of the environmental issues identified in this report, some parts of WA are considerably less-degraded than other parts of Australia and the world, so a significant opportunity exists to systematically consolidate them in the formal conservation reserve system for the benefit of current and future generations. Despite the proclamation of a number of conservation reserves in recent years, the target of more than 15% reservation of each terrestrial bioregion has only been met in 20% of terrestrial subregions. The reservation levels for marine ecosystems are also inadequate. Reservation alone does not ensure the protection of biodiversity in perpetuity – ongoing management and control of environmental threats is still necessary.

SUGGESTED RESPONSES

9.5 Accelerate the establishment of the formal conservation reserve system, particularly in priority terrestrial subregions and marine regions.

9.6 Progressively implement a protected area plan for each priority subregion and region, and provide adequate management.

9.3 ENERGY

Electricity transmission lines (Department of Environment and Conservation).

Description

The energy sector comprises the extraction and conversion of energy (from primary fuel sources into useful energy), the consumption of energy and energy used for transportation. Resource extraction of fossil fuels has been discussed elsewhere (see '*Mining and petroleum*'). Sustainable energy may be broadly defined as energy which is replenished on a time scale comparable to its utilisation, and where its use causes no adverse inter-generational social, economic or environmental impact. This usually involves increased utilisation of renewable energy, improved generation efficiency, fuel substitution to less environmentally damaging sources (as an interim measure) and energy efficiency initiatives. More recently, resource depletion and security of energy supply has also come under the umbrella of sustainable energy.

Western Australia has an energy-intensive, export-oriented economy with a significant primary industry sector. The State has an abundance of energy resources comprising fossil fuels such as coal, oil and natural gas, and renewable sources including wind, solar, wave, geothermal and biomass. Western Australia is a net exporter of energy with large contracts for the sale of natural gas to China, Japan and Korea. The State also has significant reserves of uranium. The State's large area, relatively small population, economic structure and heavy reliance on fossil fuels pose particular challenges to improving the sustainability of energy use and conversion in WA.

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The energy sector objectives that reflect this vision aim to:

- Reduce reliance on fossil fuels and increase reliance on renewable energy.
- Improve the efficiency of energy use in the Western Australian community.
- Improve awareness of the environmental, economic and social benefits of renewable energy and energy efficiency among Western Australians.

Headline indicators

Indicator TS6: Primary energy use by fuel type.

Primary energy use represents the total consumption of each primary fuel. It includes fuel used directly in 'end-use' sectors as well as fuel used in the conversion of primary fuels to electricity and petroleum products. In 2003–04, total primary energy consumption in WA was approximately 760 petajoules (PJ) (Figure TS3.1). The State is reliant on fossil fuels: 98% of WA's primary energy needs are supplied from fossil fuels. Nearly half of all fuel use is from natural gas, followed by oil (32%) and coal (17%). Renewable energy sources constitute 2% of primary energy in WA and include wood used for heating and solar water heaters.

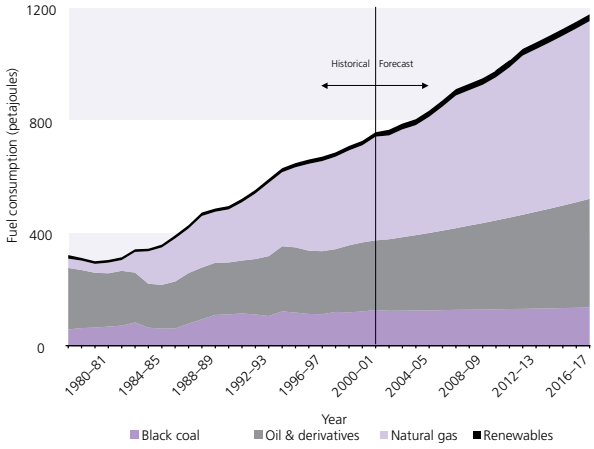


Figure TS3.1: Western Australia's primary energy usage (historical and forecast) by fuel type.

Data source: Office of Energy estimate, based on Australian Bureau of Agricultural and Resource Economics (2005a); Akmal & Riwoe (2005).

Indicator TS7: Primary energy consumption per dollar gross state product (energy intensity).

Primary energy consumption per dollar of gross state product is a measure of the intensity of energy use in the WA economy. Energy intensity is often used as a proxy indicator for how efficiently energy is used. Energy intensity decreased by 18% between 1998 and 2004 to 8.75 PJ per billion dollars gross state product (Figure TS3.2). Although energy intensity is decreasing (improving), changes in fuel mix, levels of production and the structure of the economy can mask real trends in energy efficiency. For example, a change in the structure of the economy away from energy intensive

Woodside's onshore gas processing plant. Nearly half of WA's primary energy comes from natural gas (Woodside).

industries, such as from ore refining to office based service industries will reduce energy intensity. However, energy use per unit output within those sectors may not have changed. Analysis by the Australian Bureau of Agricultural Resource Economics suggests that after accounting for these factors, energy efficiency has not changed significantly since the late 1990s (cited in Tedesco & Thorpe, 2003).

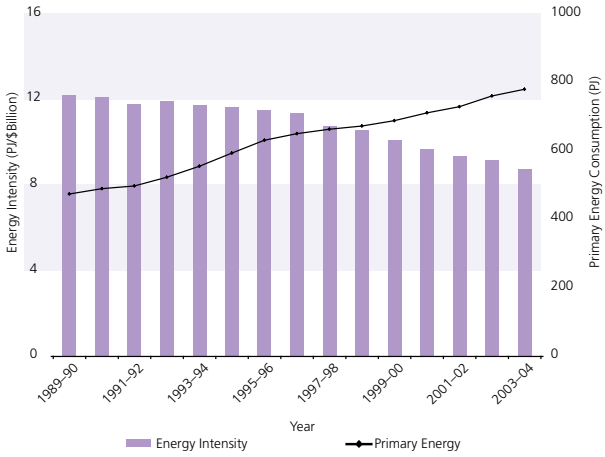


Figure TS3.2: Primary energy consumption per real dollar gross state product (2004 prices).

Data source: Australian Bureau of Agricultural and Resource Economics (2005a); Australian Bureau of Statistics (2004). Note: Energy consumption is measured in petajoules (PJ).

Status

ENERGY USE

Primary energy consumption has grown by 3% per annum since 1998 and is forecast by the Australian Bureau of Agricultural and Resource Economics to grow by 3.8% in the medium term (Akmal & Riwoe, 2005). This growth rate includes the effect of several new liquid natural gas projects, such as the Gorgon Venture.

Manufacturing is the largest sector in terms of primary energy use, accounting for 29%, followed by electricity generation at 28%, transport at 18% and mining at 16% (Figure TS3.3). Bauxite refining, iron ore, nickel, mineral sands and silica processing are energy-intensive industries that collectively consume over two-thirds of the primary energy used in the manufacturing sector.

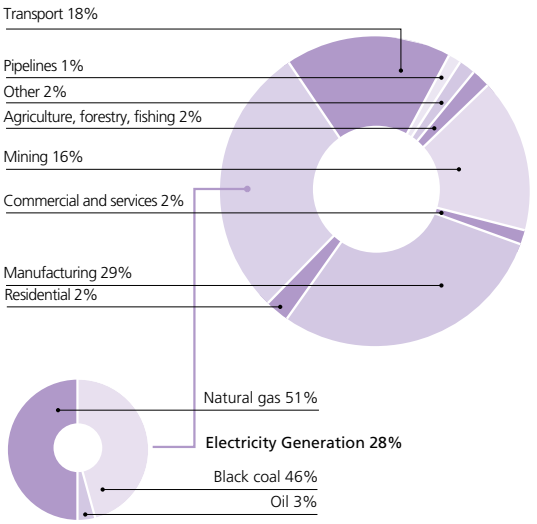


Figure TS3.3: Western Australian primary energy use by sector and fuel use in the electricity generation sector, 2003–04.

Data source: Office of Energy estimate, based on Australian Bureau of Agricultural and Resource Economics (2005a).

Over 80% of energy used in WA is used for stationary (non transport) purposes. Of energy used for these purposes, natural gas remains the most significant fuel comprising around 60% of stationary energy use, followed by coal (21%) and oil and its derivatives (17.5%). Renewable energy sources supply approximately 2.5% of stationary energy use. Since 1998, the stationary energy sector has increased by 3.6% per annum in primary energy terms.

Electricity is the main product from energy sources used for stationary purposes. Natural gas has become the dominant fuel source for electricity generation in the State, with growth in electricity demand supplied by natural gas-fuelled power stations (Figure TS3.3). Coal use for electricity generation has remained stable since 1998. Electricity generated from renewable sources remains a small proportion (approximately 3.2% in 2005–06) of total electricity generation in WA. Historical and forecast electricity consumption by end-use sector shows continuously increasing growth (Figure TS3.4). The forecast electricity usage does not reflect current changes to government policy and approvals for new electricity generation infrastructure. Specifically, the forecast excludes the NewGen Power natural gas-fired power station, the Bluewaters 1 coal-fired power station, the retirement of Muja A and Muja B power stations, and the State Government's 6% renewable energy target for 2010.

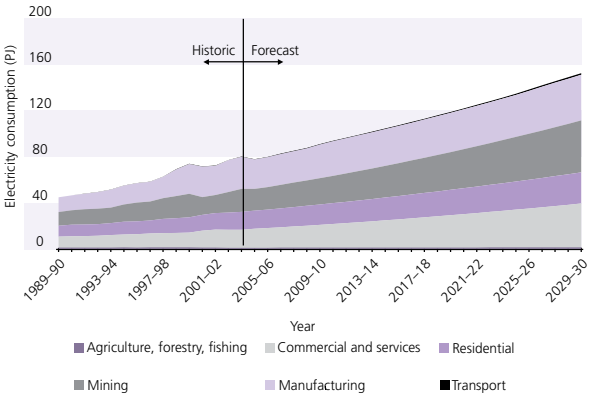


Figure TS3.4: Historic and forecast electricity consumption by sector, 1989–2030.

Data source: Office of Energy estimate based on Australian Bureau of Agricultural and Resource Economics (2005a); Akmal & Riwoe (2005). Note: Energy consumption is measured in petajoules (PJ).

A number of new renewable energy projects have been developed in recent years, particularly by the private sector, assisted by legislative and structural changes to WA's electricity system. Electricity market reforms have also allowed new retail entrants to become established. Since 1998, approximately 125 megawatts (MW) of new renewable energy plant greater than 0.5 MW capacity has been constructed, with 80 MW of wind farms committed or under construction. Wave and geothermal energy sources are also emerging as potential new sources of renewable energy.

Electricity consumption is forecast to grow at an average rate of 2.7% per year (Australian Bureau of Agricultural and Resource Economics, 2005a). The most significant growth in average electricity demand is forecast to come from the mining and commercial sectors. To meet growth in average electricity demand, a new combined cycle natural gas-fired power station will partly replace the aging coal-fired Muja power station (Muja A and Muja B), scheduled for decommissioning in 2008. A new 200 MW coal-fired power station at Collie has also been approved and is under construction. Peak electricity demand is forecast to increase at a rate approximately 25% higher than average electricity demand due to weather-sensitive loads such as air-conditioning (Independent Market Operator, 2005).

Cogeneration, or the combined generation of electricity and heat energy for industrial processes, will become more significant in the State. A cogeneration plant has a much higher efficiency than stand alone electricity or heat generation. Currently 890 MW of full or partial cogeneration capacity is installed in WA, with a further 280 MW of new gas-fired cogeneration systems under construction.

Transport energy comprises 18% of primary energy use. Petroleum products (including liquid petroleum gas) supply nearly all transport energy demand. The rate of growth of transport energy use in the State has declined since 1998, with little net change in road transport energy consumption. The data suggest the robust growth in transport energy consumption experienced in the mid 1990s has slowed. A trend for increased oil prices may have impacted on travel behaviour. The Australian Bureau of Agricultural Resource Economics (2005a) forecasts that between 2001–02 and 2029–30, primary and final road transport energy consumption in WA will continue to rise.

MANAGING ENERGY RESERVES

Although WA is a net exporter of energy resources it imports significant quantities of liquid transport fuels. Estimates of fuel reserves are often conflicting and reserves are only 'proven up' as needed. A Ministerial Council on Energy study found that Australia possessed sufficient primary energy resources to meet demand for the next thirty years (Strategic Energy Supply and Security Working Group, 2004). However, the WA transport sector's reliance on liquid fossil fuels increases vulnerability to price rises due to supply disruptions. Sustained high oil prices (due to supply constraints or political instability in oil-producing regions) may act as a driver to improve energy efficiency and investment in alternative vehicle fuels. Sustained higher oil prices could also make the conversion of gaseous to liquid fuels economically viable.

Western Australia has large reserves of fossil fuels including coal and natural gas. Natural gas is the cleanest burning fossil fuel and whilst non-renewable, there are still significant reserves around the world. Estimates indicate that the State holds around 80% of Australia's natural gas reserves, with production around 65% of the nation's gas production (Department of Industry and Resources, 2005b).

The State also has significant reserves of uranium, but current State Government policy prohibits uranium mining. The possible adoption of nuclear power would need to consider community concerns about the long-term storage of radioactive waste, the cost of electricity generation and the safety of the technology. The inter-generational impacts of nuclear energy would also need to be balanced against the inter-generational impacts of greenhouse gas emissions and climate change.

Western Australia has good wind, wave, tidal, geothermal and solar renewable resources. Geothermal and biomass resources (in the form of landfill gas, organic wastes and vegetative biomass) are currently receiving more attention from renewable energy generators. Unlike wind, solar and wave energy, output from geothermal and biomass plants are not intermittent and its output can be managed. This has advantages for network operation and stability.

Pressures

CLIMATE CHANGE

Climate change poses a significant challenge to the energy sector in terms of infrastructure and potential economic impacts. The energy sector is the single largest contributor to greenhouse gas emissions in WA, which are a major contributor to human-induced climate change. Emissions from fossil fuel combustion constitute two-thirds of the State's emissions. To date, the environmental costs associated with climate change and greenhouse gas emissions have remained largely external to the price of energy. Energy supplies from less greenhouse-intensive sources of energy are typically more expensive than from conventional fossil fuels, partly because of these costs are not factored in to energy prices. The lack of recognition in economic terms of the environmental cost of greenhouse gas emissions from energy sources is also impeding the investment impetus for cleaner technologies.

Cogeneration plant at Alcoa's Pinjarra alumina refinery. Cogeneration systems for industrial processes have much higher efficiency than stand alone electicity or heat generation (Alcoa).

PEAK ELECTRICITY DEMAND

Increasing peak electricity demand places pressure on WA's electricity infrastructure. Installing new electricity generation and network infrastructure upgrades (wires and poles) to meet the disproportionate growth in peak demand can be economically inefficient. Peak demand occurs for only a small period of the year and electricity plant to supply this load may only operate for one to two days a year. As a consequence, peak electricity generation is very expensive. Reducing peak and overall electricity demand will reduce the need for new power stations and upgrading of electricity networks. Collectively termed 'demand management', this can involve shifting electricity demand to off-peak periods, and improving energy efficiency and energy conservation. It is important to note that not all demand management options save energy (load shifting, for example).

TRANSPORT

Western Australia is Australia's largest state geographically, with consequent implications for transport energy use. There are constant and increasing pressures for increased mobility, driven by economic and social factors, e.g. increasing industry activity and associated freight transport, and increasing movement of people for work and other activities.

It will be a significant challenge to address greenhouse gas emissions from the transport sector. Our cities are based around inexpensive personal motor transport, relative to some other economies. This urban model encourages increased travel by motor vehicles and discourages more sustainable forms of transport such as public transport, walking and cycling. The State's freight network is also dominated by the motor vehicle and considerable investment has been made in infrastructure that supplies transport fuel. There is also a general lack of understanding in the community of the environmental impact of transport energy. As with stationary energy, the environmental costs of climate change are excluded from transport fuel pricing. Current financial models in Government and the private sector for vehicle pricing, fuels and transport systems encourage growth in the number and use of environmentally harmful vehicles and fuels.

Current responses

State Government energy supply initiatives: The State Government has set a target of 6% of electricity sold on the South West Interconnected System (the main electricity grid in WA, servicing Perth and surrounding regions) to come from renewable sources by 2010 (Australian Labour Party Western Australian Branch, 2001) and is working with other states and territories on options for implementing this requirement through a multi-state scheme. Electricity generated from renewable energy sources on the grid has quadrupled in recent years and is currently 4.2% of all electricity generation on this system. A longer-term renewable energy strategy that will include a target for 2020 is under development. A bioenergy strategy is being developed with a focus on Landcare benefits. A handbook to guide development of renewable energy projects has been developed.

The State Government has committed to purchasing 20% of its electricity needs from renewable energy sources by 2010. A solar schools program is being established that will see the installation of 100 photovoltaic systems in State schools. The government is also funding an urban renewable energy demonstration plant and providing support for the Kalgoorlie–Boulder Sun Farm that proposes to use concentrating solar dishes. The Narrogin Integrated Wood Processing plant has demonstrated the Landcare potential that biomass can offer and represents the first Australian biomass gasifier to generate electricity into an electricity grid. Consumers can also choose to purchase renewable energy through the Green Power program.

The joint State–Commonwealth Remote Renewable Power Generation Program reinvests diesel excise funds paid by the State in renewable energy projects in remote areas. The terms of the agreement with the Commonwealth have been renegotiated to fund renewable energy projects on the fringes of the electricity grid as well as off-grid energy efficiency initiatives. As of 2005, the program has funded 1.2 MW of small scale solar projects and 5.4 MW of larger wind energy projects.

Electricity market reforms: Major reforms have been made to the electricity market in WA, making it easier for intermittent renewable sources (e.g. solar and wind) to participate in the market. An Independent Market Operator has been established to ensure fair access to the transmission and distribution system (wires). The Independent Market Operator is also required to investigate the potential for demand management options when new generation capacity is required. Following the separation of Western Power into four separate businesses, the 'new' Western Power (which manages the electricity network) is required to consider alternatives to new network infrastructure, including demand management and embedded generation.

Energy efficiency initiatives: Energy efficiency is generally agreed to offer the least-cost means to address climate change. Energy efficiency offers positive economic benefits and frees up resources for investment elsewhere. The State Government has implemented the Energy Smart Government program which seeks to reduce energy consumption in government buildings and services, and achieve a cultural shift in how energy is consumed in the public sector. Results for the 2005–06 financial year show the program has reduced the energy consumption of participating agencies by 7.8% towards a final target of 12% by 2007. The program has reduced associated greenhouse emissions by 3.6%.

Western Australia participates in the National Appliance and Equipment Energy Efficiency Program. This program implements and coordinates product energy efficiency initiatives nationally. The program sets minimum energy performance standards for appliances and equipment, administers a testing program, and coordinates appliance energy labels. By 2020 the cumulative savings in WA are estimated to be 65.7 PJ in final energy terms and 15.7 million tonnes of greenhouse gas emissions. The program is estimated to have a greenhouse gas abatement cost of –$23 per tonne of carbon dioxide.

The State Government in collaboration with the Commonwealth and other state and territory governments has developed the *National Framework for Energy Efficiency*. The framework aims to capture the potential of energy efficiency and is currently being implemented. The program has established improved standards for energy efficiency in residential and commercial buildings and energy efficiency reporting for larger energy users.

Transport initiatives: There are a number of State Government programs underway to decrease the impact of transport energy use on the environment. These measures include restricting the number of 6-cylinder vehicles in the government fleet, promoting alternative fuels such as liquefied petroleum gas and hybrid vehicles, and trialling alternative fuels in the form of hydrogen and biodiesel.

Measures to improve the public transport system include converting the bus fleet from diesel to compressed natural gas and extending the current public transport network, for example the Mandurah to Perth railway. Urban design measures include promoting 'mixed use' urban centres with convenient access to public transport and cycling and walking infrastructure, such as Subiaco and East Perth.

Australian vehicle emission standards generally follow European standards. Some American standards have been adopted for heavy-duty vehicles, where compliance costs are lower. Typically Australia lags behind Europe in adopting equivalent emission standards. *The Fuel Quality Standards Act 2000 (Commonwealth)* now provides a national framework for Australia's fuel standards. The first set of standards for petrol and diesel was introduced in 2002. Western Australia has been proactive in regulating fuel quality standards with regulations enacted in 1999 for petrol and diesel. Standards are currently under development for liquefied petroleum gas and biodiesel. Compressed natural gas standards are likely to be developed in the near future (Motor Vehicle Environment Committee, 2003).

Implications

Climate change has a number of implications for the stationary and transport energy sectors that affect the economic drivers of the industry as well as raising technical challenges. It is widely acknowledged in Australia and overseas that major reductions in global greenhouse emissions are required to manage the potential environmental impacts of climate change. In effect, the energy sector will become 'carbon constrained' in the future if the negative environmental outcomes of climate change are to be avoided. It is foreseen that major changes in how the State generates and uses energy will be necessary. Domestic and foreign demand for WA's extensive reserves of natural gas are likely to increase considerably in the transition to a 'low emission' economy where natural gas is seen as an important interim alternative to coal. However, increased production of natural gas for export will increase greenhouse gas emissions from this sector. Power stations require large capital expenditure and are constructed to last for decades. Constructing power plant in the near term using conventional technologies and greenhouse-intensive fuel sources could have implications for meeting greenhouse emissions reductions in the longer term.

Unchecked growth in electricity demand is likely to bring forward the need for new electricity generation infrastructure. Without pricing systems that reflect environmental costs, there is little incentive for investment in more sustainable forms of generation including renewable energy. Geosequestration (long-term underground storage of carbon dioxide) has been proposed to manage greenhouse gas emissions from fossil fuels. While carbon dioxide reinjection is a proven technology within the petroleum industry, the technology required for carbon dioxide capture and storage from stationary energy sources is still under development. There are examples of commercial geosequestration projects globally, but it is still to be proven on a commercial basis in Australia.

Approximately 3% of WA's electricity is generated from renewable resources such as wind power (Tourism WA).

SUGGESTED RESPONSES

9.7 Require new generators to meet world's best practice, as adapted to Australian conditions, for generation technology for the chosen fuel type and operational mode.

9.8 Introduce incentives for owners of existing plant to improve energy efficiency by retrofitting new technology as it becomes available.

9.9 Facilitate the expansion of WA's renewable energy industry.

9.10 Increase the diversity or capacity of fuel supply infrastructure for cleaner fuels.

9.11 Expand measures to facilitate improvements in consumer energy efficiency.

9.12 Introduce incentives to encourage greater uptake of fuel efficient and alternative fuel vehicles.

9.13 Introduce a fuel efficiency target for government fleets.

CASE STUDY: DEPARTMENT OF LAND INFORMATION

The Department of Land Information is a state government agency responsible for land and property information and a proven leader in energy efficiency.

In 1994, the department started an energy management program for its head office in Midland. Between 1998 and 2002 the program achieved a 24% reduction in energy use and a 25% reduction in energy costs.

Seeking to capitalise on gains made under this program the department entered into an energy performance contract in 2003. The contract manages investment risk through linking expert knowledge with day-to-day operations. It guarantees a 15% reduction in energy and cost savings over the duration of the contract. To date, the energy performance contractor has exceeded these targets. In 2005, the department achieved energy savings of 1 349 157 kilowatt hours (kWh) against the baseline for the Midland building, which is an excess savings over the guarantee of 510 317 kWh.

Between 2003 and 2005 upgrades were made to the lighting, building control systems and water heating systems. An additional reduction in energy use of 23% was achieved between 2003 and 2005. Over the last seven years the department has also realised energy cost savings of $1.3 million. This is an outstanding example of what can be achieved when motivated staff work with industry experts to implement innovative approaches to energy management.

The Department of Land Information has been widely recognised for the innovative energy efficiency strategies introduced by its Midland staff more than a decade ago. The department has also received the prestigious Premier's Sustainable Environment Award and the WA Environment Award for Energy Efficiency in 2003.

9.4 FISHERIES

Fishing boats at Fremantle Harbour (Tourism WA)

Description

The fisheries sector includes the harvesting of fish and other marine organisms from marine or inland waters for consumption. It includes the harvesting of natural stocks and organisms artificially grown in inland waters and marine farms (e.g. pearling, aquaculture). Western Australia's unique oceanography determines the productivity and diversity of species. The Leeuwin Current transports warm, nutrient-poor tropical water southwards along the continental shelf and heavily influences coastal waters. As a consequence, WA's oceanic waters are relatively unproductive and nutrient-deficient when compared with the west coasts of other continents. Benthic primary producers (namely seagrasses and algae) predominate, whereas in many other marine systems phytoplankton are the major primary producers.

By world standards WA's take of seafood in terms of tonnage is very small, amounting to less than 0.4% of the world catch by weight (Australian Bureau of Agricultural and Resource Economics, 2005b). Western Australia's catch of all species for 2002–03 was slightly less than 34 000 tonnes; in 2002–03 it constituted less than 14% of the total weight of seafood taken in Australian waters (Australian Bureau of Agricultural and Resource Economics, 2005b). However, despite the relatively small catch, the State's fisheries are economically significant, contributing 25% of the total value of Australia's fisheries (Department of Fisheries, 2005a). Commercial wild-caught fisheries and aquaculture are now established throughout the State and directly contribute between $500 and $750 million to WA's economy each year.

Recreational fishing is a popular activity that involves about 34% of the State's population and an increasing number of tourists. Along with aquatic ecotourism, it contributes $500 million in annual economic activity to WA, and is important to regional economies. Marine farming of South Sea Pearls is the longest established, largest and most successful marine aquaculture industry in WA. There were 16 pearling licensees in 2003 in an industry valued at $120.5 million. Other WA aquaculture activities include the marine farming of pearls (other than South Sea), beta carotene production from salt fields, and mussel, oyster, barramundi, trout, marron and yabby farming. Generally these are relatively small aquaculture businesses valued at $6.5 million in 2003–04 (Department of Fisheries, 2005a).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The environmental objectives for good fisheries management are set out in a number of international standards and guidelines (e.g. United Nations Convention on the Law of the Sea 1982; Food and Agriculture Organisation Code of Conduct for Responsible Fisheries; Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem 2001) as well as in National and State legislation. The key objectives for fisheries management in Western Australia are:

- Ensure that fisheries are managed sustainably.
- Protect and conserve habitats and ecosystems that support fisheries production, and ensure that fishing does not cause irreversible ecological change.

Headline indicators

Indicator TS8: Proportion of fish stocks managed sustainably.

Sustainability indicators for the fisheries sector are still in development. However, interim measures examine criteria for adequate breeding stocks and acceptable catch (or effort) levels. Both criteria are needed to sustain a fishery for the long term. The number of fisheries under formal management plans is slowly growing over time and in 2005–06, 35 fisheries were reviewed. About two-thirds of fisheries were assessed by Department of Fisheries as being sustainable, having both adequate breeding stock and acceptable catch levels (Table TS4.1). Unfortunately, information was not available for 17% of fisheries to assess both criteria.

Table TS4.1: Per cent of assessed WA fisheries meeting both adequate breeding stock levels and acceptable catch (or effort) levels.

	2004–05	2005–06
Number of fisheries	35	35
% of sustainable fisheries	62.9%	65.7%

Data source: Department of Fisheries, 2005b and 2006.

Spangled emperor are taken in the Pilbara trap fishery (Tourism WA)

Indicator TS9: Certification of the ecologically sustainable management of fisheries.

The focus of fisheries management has broadened in recent years, from managing stock levels, to also considering the wider ecological impacts of fisheries. Since January 2002, all Commonwealth Government managed fisheries and state export fisheries are subject to an independent assessment under the *Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)*. An assessment is conducted by the Department of the Environment and Heritage against the *Guidelines for the Ecologically Sustainable Management of Fisheries* (Environment Australia, 2001a). This assessment determines if fisheries are being managed in an ecologically sustainable way and promotes continuous improvement in environmental performance. It takes into account effects on habitats, marine communities and ecological interactions, as well as bycatch and undesirable impacts on endangered and protected species. Through this process the department assesses the management arrangements in place to ensure the ecologically sustainable management of the fishery. The assessment process is limited to Commonwealth and State fisheries that export their catch; there is currently no ecological assessment of minor domestic fisheries or recreational fishing, although this is planned for the future.

Status

USE OF FISHERIES

Traditionally, fisheries management has focused on managing a fishery so that the catch of fish does not exceed the maximum sustainable yield, i.e. sufficient numbers of fish should remain within the population to ensure ongoing breeding success and the maintenance of fish stocks at the desired level. A more recent recommended approach to measuring fishery sustainability has been to use assessment of breeding stock together with trends in catch and fishing activity.

In total, WA has 35 managed commercial fisheries, with an additional 15 under other forms of management arrangement (overseen by the Department of Fisheries under the *Fish Resources Management Act 1994*). Of the 35 fisheries reviewed, 94% had breeding stock assessments available for major species. Insufficient data was available for the remainder but catch histories indicate that harvested stocks are relatively stable using a precautionary approach. Of assessed fisheries, 88% had adequate breeding stocks in 2005–06 (Figure TS4.1). Fisheries with inadequate or uncertain breeding stocks include the Shark Bay snapper fishery, northern shark fishery, the southern and west coast demersal gillnet and longline fishery (southern shark), and the south coast crustacean fishery (Department of Fisheries, 2006). Trends in the level of adequate breeding stocks have been similar in recent years, but higher compared to the late 1990s (Figure TS4.1)

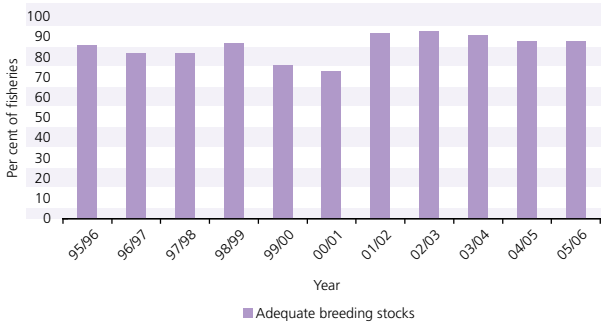


Figure TS4.1: Per cent of fisheries where breeding stocks of the major target species are both assessed and adequate to ensure catches are sustained at maximum levels within the range expected under typical environmental conditions.

Data source: Department of Fisheries (2006).

A target catch or fishing effort (limits on fishing, gear, or number of operators) is determined for each of the fisheries. This indicator provides an assessment of the success of management plans and regulatory activities in keeping fish catches from each of the managed stocks at appropriate levels. When the plan is operating effectively, the catch by the fishery should fall within a projected range. The catch range reflects the variability of environmental conditions that influence the recruitment of juvenile fish that can't be controlled by a management plan. Some fisheries are quota based, which restrict the volume of harvested stock. If quotas are not met, it may indicate insufficient industry activity or that the abundance of stock is significantly lower than when the quota was set.

Comparisons of the catch or effort level were available for 30 of the 35 fisheries in 2005–06. Inadequate data were available for some fisheries, but others (such as the pilchards fisheries) were recovering from exotic viruses and rebuilding stock levels. Of the four fisheries with catch quotas, 3 (75%) operated within their catch targets and one (the Shark Bay snapper fishery) exceeded its target and requires a review. Of the 26 effort controlled fisheries, 21 (81%) had catches that were within acceptable limits of their catch targets.

Five fisheries (19%) exceeded their allowable catch targets including the northern shark fishery, Pilbara trap and line, northern demersal scalefish fishery, south coast crustacean and the Cockburn Sound crab fisheries (Department of Fisheries, 2006). In summary, 80% of assessed fisheries were considered to have acceptable catch levels (Figure TS4.2). Trends in the acceptability of the catch or effort level appear to be declining (Figure TS4.2).

Figure TS4.2: Per cent of fisheries where the catch or effort reported is acceptable relevant to the target management range being applied.

Data source: Department of Fisheries (2006).

Over-fishing may result in the fish caught being less than optimal size and may also result in the average number of recruits declining due to insufficient parental biomass. Alternatively, the targeted removal of a particular size of animals can affect the overall health of the ecosystem. Whole of ecosystem requirements have been implemented in the Southern and Western purse seine fisheries because other animals (such as seabirds and sharks) are dependent on the same size or class of fish that humans take. This reflects a broadened approach to fisheries management, by considering the wider ecological impacts.

Both current breeding stock assessment and current catch levels are needed in the context of assessing the sustainability of a fishery (Table TS4.2). About 66% (23 out of 35) of WA managed commercial fisheries are known to be currently sustainable, having both adequate breeding stock and acceptable catch levels. About 17% of fisheries have insufficient information to assess either one or both criteria. Another 17% of fisheries do not meet one or both criteria. About 8–9% of fisheries were considered to be unsustainable in 2005–06 (did not meet both criteria), including the Shark Bay snapper fishery, the northern shark fishery, and the south coast crustacean fishery. Management of these fisheries (amongst others) are under priority review.

Table TS4.2: Per cent of WA managed commercial fisheries meeting breeding stock and catch level criteria.

Year	% fisheries meeting both criteria	% fisheries meeting only 1 of 2 criteria	% fisheries meeting no criteria	% fisheries with inadequate data	Total formally managed fisheries
2004–05	62.9%	5.7%	11.4%	20.0%	100%
2005–06	65.7%	8.6%	8.6%	17.1%	100%

Data source: Department of Fisheries, 2006; Data analysis: EPA.

Recreational fishing has grown over the past decades as the State's population and economy expanded. About 600 000 people now fish in WA waters, compared to 284 000 in 1987. However, fish stocks on which recreational fishing is based are finite. In WA fishing effort is highest in the more heavily populated south of the State, from Port Gregory to Augusta. This is the State's most significant recreational fishing area, having 68% of the recorded effort, or an estimated 5.6 million fishing days during 2003–04 (Department of Fisheries, 2005a). By contrast, only 4% of the State's recreational fishing effort (an estimated 348 000 fishing days in 2003–04) occurred in the Gascoyne region, with most of the fishing effort concentrated in the peak season of April to August.

There have been advances in angler efficiency through improved technology and competing users have placed greater fishing pressure on limited fish resources. Along with these changes has been an increasing awareness among recreational fishers of the need to fish sustainably and a greater concern for the state of the environment. Community groups such as Recfishwest use fishing clinics and other means to foster an appreciation of measures that provide for the sustainability and quality of recreational fishing.

PROTECTION OF NATURAL RESOURCES

There is concern that trawling (dragging a net behind a boat) may cause a decline in species and ecological communities in marine environments. Concerns focus on the impact of trawling on benthic habitats (including those made up of algae, seagrass, sponges or sandy bottoms), fish and invertebrate assemblages, the mortality of threatened species such as turtles, and catch of juvenile and/or adult fish and invertebrate species of commercial or recreational importance. Trawling can be done with or without disturbance of sea floor biota and sediments by using equipment that either scrapes the sea floor or is suspended in the water column (depending on the type of animal being targeted). The Shark Bay prawn fishery is of concern in relation to its trawling impacts on non-target species (bycatch) and the ecological impacts to shallow sandy habitats. The Pilbara demersal finfish fishery has a trend of decreasing by catch and food chain effects, and has been consistently assessed as having a moderate impact on protected species and habitats (Department of Fisheries, 2005a). Concern has also been raised about impacts of the Abrolhos Islands scallop trawl (see '*Marine*').

Preliminary findings of studies into the biodiversity impacts of trawling in Shark Bay, Exmouth Gulf and near Onslow (Fisheries Research and Development Corporation, in prep), showed that species richness and abundance in trawled areas were not significantly different to untrawled areas. However, some individual species showed higher abundance in untrawled areas indicating vulnerability, while other species showed a preference for the trawl grounds. Management actions are in place to maintain sustainable fisheries, so trawling occurs within a defined season, where a limited number of boat operators hold licences, and the annual area trawled is a small proportion of the total trawl ground. Recent improvements to net design also allow for unwanted bycatch animals (such as turtles and dolphins) to escape via windows.

Apart from putting pressure on fish stocks, recreational fishing may have environmental impacts if not carefully carried out. Discarded line and litter may entangle or harm wildlife. The incorrect use of four-wheel drive vehicles may damage coastal and riverbank areas. In addition, reef top

harvesting for species such as abalone may result in trampling of reef organisms. The death of unwanted or undersized species can also be an issue for recreational fishers if they are unaware of correct handling and release techniques. Currently there is limited policy for assessing the ecologically sustainable development of predominantly recreational fisheries. This is problematic because although other industry sectors (such as State domestic fisheries and aquaculture) are assessed for ecological sustainability, the environmental impacts of recreational fisheries are not quantified.

MANAGEMENT OF FISHERIES

Commercial fisheries are managed through restrictions on catching capacity (number of fishing boats, type of fishing gear used, areas where the gear can be used, closed seasons), size regulations (covering gear, catch and prohibition on the capture of breeding females) and caps on the maximum number of licences that can be issued. This type of management requires careful monitoring of fish stocks and adaptive management to ensure that the catch remains within the sustainable yield of the fishery. A high level of fisheries surveillance has contributed to the success of management practices in commercial and recreational fisheries. Assessments of the sustainable management of fisheries have been a priority since 2002.

The western rock lobster is the most valuable single species fishery in Australia and usually represents about 20% of the total value of Australia's fisheries (Department of Fisheries, 2004). The western rock lobster fishery is also one of the first fisheries in the world to be certified as ecologically sustainable by the Marine Stewardship Council (2006). The Council is a global independent organisation that recognises well managed fisheries and improves consumer marketability of the product.

For most WA fisheries, formal management plans are in place to directly control the amount of fishing effort being applied to fish stocks, with the level of the catch taken providing a measure of the effectiveness of the management plan. Where the plan is operating effectively, the fishery industry's catch should fall within the projected target range. The target range allows for environmental variability where the rate of juvenile recruitment to stock can not be controlled by the management plan (Department of Fisheries, 2006).

In the past, fish resources have been shared mainly on an implicit basis, with no explicit setting of catch shares within an overall total allowable catch (or effort). Integrated fisheries management is a new approach being implemented in WA that considers aggregate effects of all fishing sectors. Integrated fisheries management involves (Department of Fisheries, 2006):

- setting a total sustainable harvest level for each resource to allow for an ecologically sustainable level of fishing;
- allocating explicit catch shares for commercial, recreational and Indigenous fishers;
- continually monitoring each sector's harvested catch;
- managing each sector within its allocated catch share; and
- developing mechanisms to enable the reallocation of catch shares between sectors.

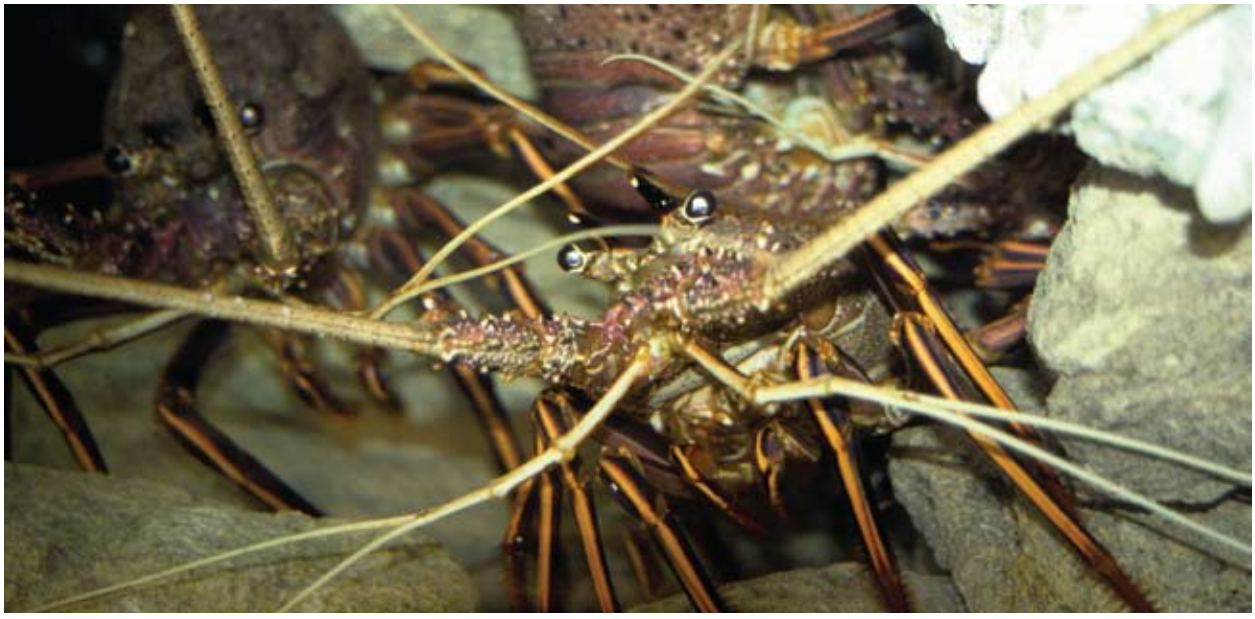
This approach, believed to be a world-first, follows the recommendations of the Integrated Fisheries Management Review Committee (2002). As the community's use and value of fish resources changes over time, reallocation mechanisms will be introduced to enable changes in catch allocation. Integrated fisheries management will be progressively phased in and is likely to take 10 years to bring the majority of WA fisheries under the new framework (Department of Fisheries, 2006).

Pressures

There are a number of significant issues and trends to be addressed in the short to medium term to ensure the conservation and sustainable development of the State's fish resources and the protection of fish habitat into the future.

POPULATION GROWTH AND DEVELOPMENTAL PRESSURE

A growing and more affluent population is placing more pressure on the marine environment. Increased coastal residential development places pressure on inshore fish stocks as a result of increased recreational and commercial fishing pressures, a greater amount of pollutants being discharged via stormwater and treated sewerage outfalls, and increased habitat disturbance through boating activity and new infrastructure. Recreational fishing has grown over 200% in the past decade as the State's population and economy has expanded. Construction of marinas, ports and other coastal developments in sensitive marine environments can have dramatic impacts via dredging, toxicants and habitat destruction or modification.



The Western Rock Lobster industry is the most valuable fishery in Australia and is leading the way with Integrated Fisheries Management (Department of Fisheries)

CLIMATE CHANGE

Western Australia's fisheries industries are highly climate dependent, with recruitment and migration patterns of some fish species sensitive to climatic conditions. The productivity of many WA fisheries is influenced by the El Niño Southern Oscillation, which in turn influences the Leeuwin Current. These fisheries could be affected if El Niño becomes more prevalent (Australian Greenhouse Office, 2003). Coastal fisheries that are dependent on vulnerable coastal wetlands and estuaries as nursery grounds may be particularly impacted. Freshwater fisheries, such as marron and estuarine fisheries, are likely to be the most affected, particularly in areas where rainfall changes are expected (e.g. South West).

COMPETITION WITH OTHER NATURAL RESOURCE SECTORS

Pressures on fisheries are arising from conflicting resource requirements of different community and industry stakeholders, particularly in once-remote coastal areas that are now coming under increasing development pressure. The increased complexity and lack of integration of conservation and planning processes as they affect coastal fisheries is also complicating fisheries management. Aboriginal fishing rights and the development of the law in respect to Native Title is also contributing to uncertainty.

ILLEGAL FISHING

Illegal fishing has become an increasing problem for the sustainable management of fisheries in the State's North West, particularly for trocus and shark. In such remote parts of the State it is difficult for Department of Fisheries staff to protect fish stocks. At times members of the community, including Aboriginal communities, have been employed as part time marine rangers. In recent years, there has been an increase in the number of interceptions and prosecutions of illegal fisherman.

GROWTH IN RECREATIONAL FISHING

Recreational fishing is likely to increase with the State's growing population, so there is an ongoing need to manage this effort to prevent stock collapse and ecosystem damage (compared to commercial fisheries where the total number of fishing licences is capped). Recreational fishing effort has been a significant factor in the collapse of fish stock. For example, fish stocks that are restricted to the inner gulfs of Shark Bay were subjected to significant recreational fishing pressure and now require special management arrangements. Detailed research identified that pink snapper stocks were over-exploited by recreational fishers in the early to mid 1990s. As a result a total prohibition on the take of pink snapper was introduced in the eastern gulf of Shark Bay between June 1998 and December 2002. Compliance with the ban and subsequent fishing regulations has allowed the fish population to rebuild. In 2003, for the first time in fisheries management in WA, a total allowable catch was set for each pink snapper stock/fishery area in Shark Bay. The recreational sector, which includes catches from charter vessels, was allocated 75% and the commercial sector 25% of the available catch in each management area. Lessons learned from the Shark Bay snapper fishery are now being applied at other locations in the State, such as Cockburn Sound, where fishing was recently closed to protect spawning stocks of pink snapper.

Current responses

Ecologically sustainable development assessments: a requirement of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) is for the Department of the Environment and Heritage to conduct assessments of ecologically sustainable practices in the management of a fishery, and evaluate responses to the issues identified in those assessments. The framework allows managers to demonstrate that ESD principles are being used and provides a way to judge the results. For example, before they can be granted an export licence, each fishing industry will have to show that their fishing operations and methods are not endangering any species or ecosystem.

Integrated Fisheries Management (IFM): the implementation of IFM in WA fisheries has progressed since its inception in 2004. A final allocation report has been prepared for the western rock lobster, and a final report for metropolitan abalone is expected in 2007. Focus will now turn to finfish resources over the next two to three years – in particular, the West Coast and Gascoyne demersal scalefish fisheries (especially for dhufish, baldchin groper and snapper). A 10 year plan for IFM is in progress that will ensure a long term program for the continued implementation of IFM.

State of the Fisheries reports: Annual 'State of the Fisheries' reports are prepared by the Department of Fisheries and have increasingly focused on broader ecosystem management. The reports summarise the outcomes of many departmental activities including management changes, compliance work, and research to assess stock levels, monitor breeding stock and undertake environmental assessments.

Community programs: Fishing industry involvement in non-government organisation programs, particularly the Marine Stewardship Council certification of the western rock lobster fishery and the various programs of Oceanwatch and Seanet (mitigating non-target species, including protected species).

Codes of conduct: Industry-initiated codes of conduct, such as *Western Rock Lobster Managed Fishery Code of Practice for Reducing Whale Entanglements* (Western Rock Lobster Council Inc., c. 2005), *Northern Shark Industry Association Industry Code of Practice for Responsible Fishing* (Bevilacqua & Diver, n.d.), *South Coast Purse Seine Code of Practice* (Ocean Watch & SeaNet, 2005b), *Lake Argyle Handling Manual* (Bevilacqua, c. 2005) and *Lake Argyle Bycatch Action Plan* (Ocean Watch and & SeaNet, 2005a).

Raising awareness: Programs are in place to increase awareness among recreational fishers of fishing practices that are sustainable and environmentally responsible. For example, fishing clinics by Recfishwest, Volunteer Fisheries Liaison Officer program (Department of Fisheries); the promotion of release weights to return fish with inflated swim-bladders to deep water to reduce trauma and incidental mortality (Department of Fisheries, Recfishwest and Australian National Sports Fishing Association); and to research recreational fishing practice and impacts (Department of Fisheries and Murdoch University).

Aboriginal fishing strategy: was developed with four main elements (Franklyn, 2003) including: consultative and joint management mechanisms to involve Aboriginal people in the management of fish resources; employment and training opportunities for people in natural resource management and compliance, particularly in regional areas; economic development initiatives linked to the State's soon to-be released Indigenous economic development strategy (which provide opportunities for Aboriginal people to access commercial fishing authorisations through open market processes); and recognition of continuing customary fishing rights and responsibilities (including traditional ownership of waters) within fisheries legislation and policy. National principles that recognise the cultural significance of fishing to Aboriginal people have recently been formally endorsed by the Commonwealth Government, the majority of state and territory governments, the Australian Seafood Industry Council, Recfish Australia and peak Aboriginal representative bodies. These national principles support increased participation by Aboriginal people in the protection, sharing and use of fish resources and are consistent with the State's draft *Aboriginal Fishing Strategy*.

Implications

Ecologically sustainable development certification for export fisheries under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* ensures that environmental issues are at the forefront of fisheries management. The process will set a benchmark for the management of all fisheries, although there is currently no formal requirement or strong urgency to assess non-export and recreational fisheries and aquaculture. Sharing of fish stocks between sectors will continue to be an important issue requiring careful management while recognising the requirements of commercial, and recreational sectors and Aboriginal people. Good environmental management of fisheries will require an increased research focus on the environmental and ecological impacts of fishing, and the value of fish habitats, including the identification of habitats of critical importance in the life cycle of fishes. Further aquaculture development in the State will require improved consideration of coastal planning and pollution issues. Remote marine and coastal areas of the State are coming under increased pressure from a range of development pressures and other impacts, such as illegal foreign fishing.

SUGGESTED RESPONSES

9.14 Continue to implement ecologically sustainable development, including the completion of accreditation of all Western Australian fisheries through the Department of Environment and Heritage process, and the extension of the assessment process to minor and low value fisheries, recreational fisheries and aquaculture.

9.15 Progress the introduction of Integrated Fisheries Management to allow the integrated management of critical Western Australian commercial and recreational fisheries.

9.16 Increase the focus on ecosystem management of marine resources.

Recreational fishing is a popular recreational activity in WA (Tourism WA).

CASE STUDY – THE INTRODUCTION OF TURTLE AND BYCATCH EXCLUSION DEVICES IN THE EXMOUTH GULF PRAWN FISHERY

The Exmouth Gulf prawn fishery is confined within the waters of Exmouth Gulf, with the prawn nursery grounds, spawning areas and trawl grounds all within the gulf. The fishery has been operating since 1963 and is the second largest trawl fishery in the State with 13 boats fishing during 2003. The fishery targets western king prawns, brown tiger prawns, endeavour prawns and variable quantities (according to season) of banana prawns. The fishery is managed using a variety of controls to limit fishing effort, including regulations that specify fishing gear that can be used in the fishery.

An issue of concern in many prawn trawl fisheries around the world is the incidence of bycatch of unwanted fish species and the capture of large animals such as turtles, sharks and rays. Typically, in tropical demersal trawl fisheries, more than 10 kg of unwanted fish are trawled for every 1 kg of the target prawns. In the Exmouth prawn fishery a bycatch action plan has been successfully implemented which has resulted in the low rate of bycatch in the fishery today.

In 1999 the industry, in association with Fisheries WA (now the Department of Fisheries), commenced voluntary trials of grids fitted into the trawl nets to allow any turtles entering the nets to escape (termed turtle exclusion devices). A wide variety of turtle exclusion devices were trialled over two years and then these devices were made mandatory within the fishery. The introduction of turtle exclusion devices to the fishery has virtually eliminated the capture of turtles. However, work is continuing to improve the fishery's performance with respect to bycatch. Secondary bycatch-reduction devices (fish-exclusion devices designed to reduce the catch of unwanted fish) such as square mesh panels have been trialled prior to adoption within the fishery. In addition, many of the boats operating in the fishery have installed 'hopper' sorting tables. With this arrangement the catch is dumped from the cod end of the net into a well of flowing seawater. The catch is then removed from the well on a moving conveyor belt and sorted. This reduces the amount of time bycatch species spend out of water and increases survival.

The success of the various turtle-exclusion and fish-exclusion device designs has been monitored through the use of voluntary logbooks and through an observer program. The efforts made by industry to address the environmental impact of the fishery have paid off. The fishery has achieved Commonwealth ecologically sustainable development accreditation, as well as certification for export to the United States.

9.5 MINING AND PETROLEUM

Iron ore mine pit operations at Hamersley Iron, Tom Price (Tourism WA).

Description

Mining and petroleum industries are referred to collectively as the resources sector. The WA resources sector is a world-scale supplier of petroleum and mineral commodities (Geological Survey of Western Australia, 2005), including:

- precious minerals and metals (diamonds, gold and silver);
- steel industry metals (iron and magnesium);
- specialty minerals and metals (titanium, vanadium and rutile);
- base metals (lead and copper);
- alumina and specialty alumina-based products;
- industrial minerals (garnet, gypsum and talc);
- basic raw materials (limestone and granite); and
- energy and petrochemical feedstock (oil, natural gas, liquid natural gas, liquid petroleum gas and coal).

Mining and petroleum operations have a finite life during which there are three distinct phases, including exploration, production and decommissioning at the end of the project's economic life. The life span of resources projects can range from as little as a few months to 50 years. Impacts on the environment are varied due to the wide range of extraction and processing operations, phases of operational life, and the diverse range of environments where resource extraction occurs. This sector report presents only the significant environmental issues directly related to the extraction of minerals and petroleum – not downstream processing activities.

From a natural resources perspective, the mining and petroleum sector is unique in that the resource base (i.e. minerals, ores, petroleum) is extracted and not replenished over time. This makes it difficult to apply the concept of sustainability to this sector in terms of 'environmental integrity'. However, the sector is applying environmental stewardship practices to manage its environmental impacts, and is recognised for providing significant economic and social benefits to the State. In 2006, the value of sales from the resources sector was $48.4 billion. The sector contributes about 85% of the total value of State exports (Chamber of Minerals and Energy, 2006) and is directly responsible for about 5% of the State's total employment (Chamber of Minerals and Energy, 2005).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The mining and petroleum sector has a vision that "minerals and petroleum production in Western Australia remains at world best practice and the industries help to establish the standard for sustainability" (Government of Western Australia, 2003, p. 139). The objectives for the sector include:

- Ensure that responsible development of the State's mineral and petroleum resources comply with relevant legislation and undertake appropriate levels of planning, environmental research and environmental management.
- Minimise and mitigate emissions to the environment from mining and petroleum operations.
- Maximise the efficiency of natural resource use and resource extraction in mining and petroleum projects.

Headline indicators

Indicator TS10: Area of land disturbed and rehabilitated.

Estimates based on data collected between 1986 and 2002 indicate that the area disturbed by mining was approximately 162 00 hectares. Comprehensive data on the area disturbed by mining after 2002 was not available. Approximately 24 000 hectares of land was rehabilitated between 1986 and 2002.

Indicator TS11: Per cent of environmental conditions in compliance.

Mining and petroleum operations are audited, through several mechanisms, for compliance with the Department of Industry and Resources and the Department of Environment and Conservation environmental conditions. This information has not been standardised to enable reporting as a headline indicator.

Indicator TS12: Greenhouse gas emissions from sector.

Annual greenhouse gas emissions from the resources sector nearly doubled between 1990 and 2002 to 12.3 million tonnes.

Indicator TS13: Water use by sector.

It is estimated that the sector's total water use was approximately 428 gigalitres (GL) in 1999–2000. Up to 30% of the water used on mine sites is recycled at least once.

Woodside's Goodwyn Platform, North West Shelf (Woodside).

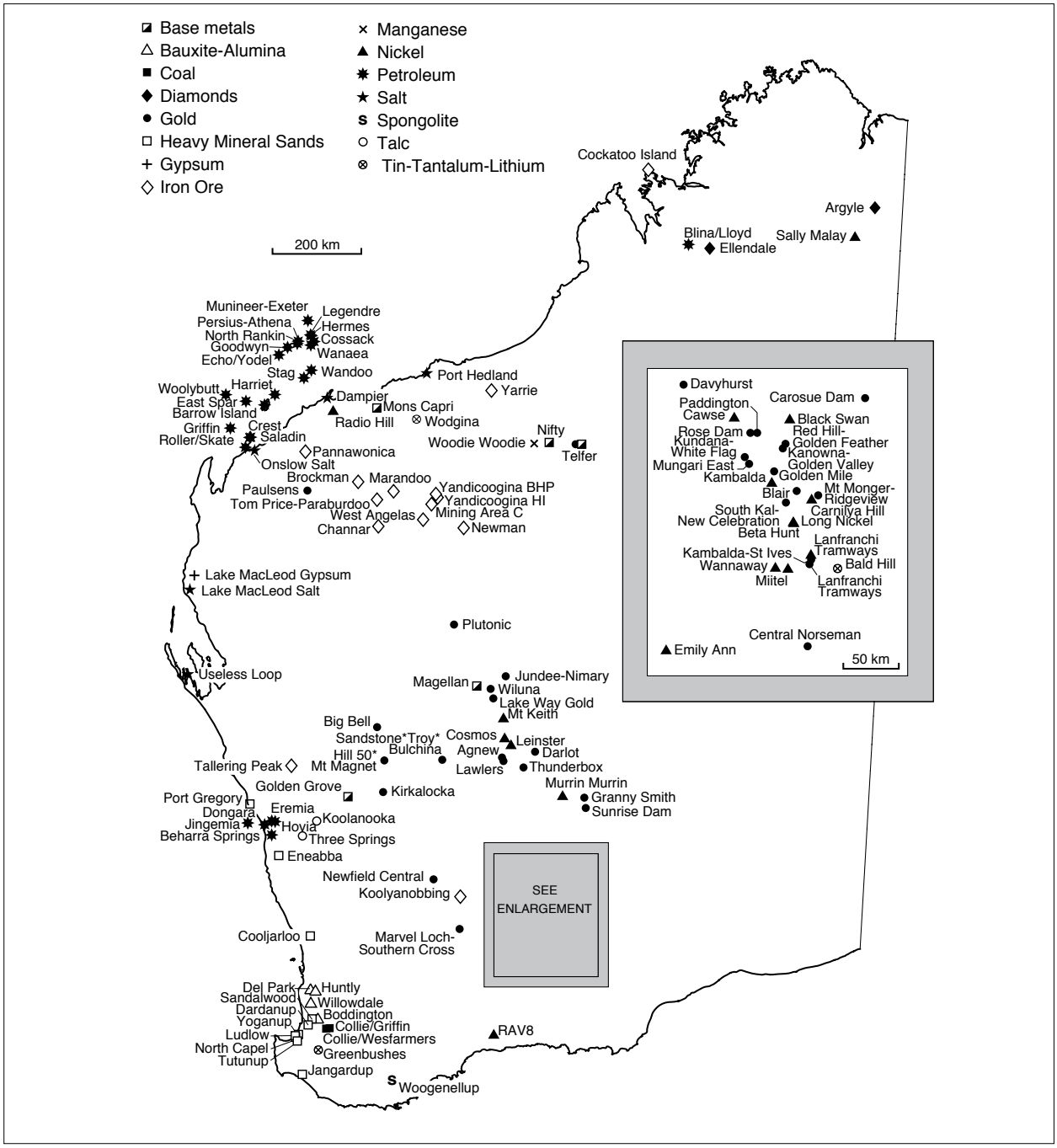


Figure TS5.1: Major mineral and petroleum projects in Western Australia.

Courtesy of Department of Industry and Resources.

Status

USE OF NATURAL RESOURCES

Currently there are 67 producing oil and gas fields and 560 commercial mineral projects in the State, including 1222 operating mine sites (open pit, underground and quarries) which produce over 50 different minerals (Figure TS5.1).

During 2005–06, petroleum production for the State totalled 11.5 GL of crude oil, 5.63 GL of condensate and around 7.71 giga-cubic metres of gas. Production of other key mineral commodities during 2005–06 included 11.5 million tonnes of alumina, 161 tonnes of gold, 191 000 tonnes of nickel and 244 million tonnes of iron ore (Department of Industry and Resources, 2006a). The sector is experiencing rapid growth and projections indicate that sector output is likely to grow by 50–75% over the next decade (Chamber of Minerals and Energy, 2005).

Most of the land disturbed by mining activity is used for tailings dams/evaporation ponds, waste rock dumps/heap leaches, infrastructure or it becomes a pit. Estimates based on data collected between 1986 and 2002 indicate that approximately 162 000 hectares of land was disturbed by mining, which represents approximately 0.07% of the State's total land area (Figure TS5.2; Department of Industry and Resources, 2003). The area of land revegetated over this period was approximately 24 000 hectares. These estimates should be considered incomplete for this period as comprehensive data collection only began in 1995 and do not include disturbance from exploration. The area of land disturbed and rehabilitated post-2002 was not available, as reported information was not compiled comprehensively for these years. However, an increasing trend in the approved number of notices of intent to clear for mining between 2002 and 2004 suggests that the area of land being disturbed is rising (Figure TS5.2). In 2004 a new system for application to clear native vegetation was established with the introduction of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. During 2005 and 2006, applications were made to clear approximately 10 600 ha for mining. This data is not comparable with the data from the notice of intent process.

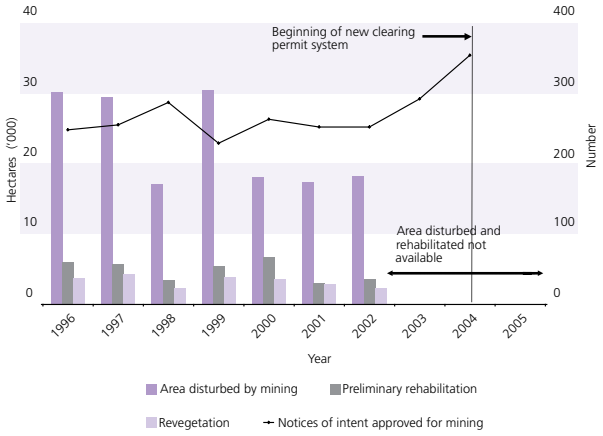


Figure TS5.2: Area subject to disturbance and rehabilitation and number of notices of intent approved for mining in Western Australia.

Data source: Department of Industry and Resources. Note: 'Disturbed' includes areas where vegetation has been cleared and/or topsoil has been removed. 'Preliminary rehabilitation' includes areas that have undergone reshaping, capping and water/wind erosion control. 'Revegetation' includes areas that have established self sustaining vegetation cover based on data available through established reporting mechanisms but does not include all legacy sites.

The efficient use of natural resources is widely acknowledged in the mining and petroleum sector. This sector ranks second to agriculture in the total volume of water used in the State. Around half of the water used is of poor quality (naturally saline) and not well suited to most other uses. It is estimated that the sector's total water use was approximately 428 GL in 1999–2000. Up to 30% of the water used on mine sites is recycled at least once before discharge to tailings storage facilities or evaporation ponds (Economics Consulting Services, 2004). The major water resource issue for the sector is potential contamination. While precise data on the volume of water used by the sector is not available, data on water allocations to the mining industry is available (Figure TS5.3). Petroleum operations use very little water in the production process.

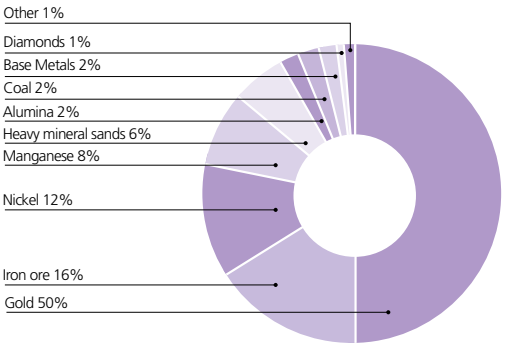


Figure TS5.3: Proportion of mining sector water licence allocation by mineral commodity in Western Australia, 2004.

Data source: Economics Consulting Services (2004).

In comparison, energy use in the minerals and petroleum sector is increasing (Figure TS5.4). Despite efforts to improve energy efficiency within the sector, there has been an overall increase in energy use due to growth in sector activity.

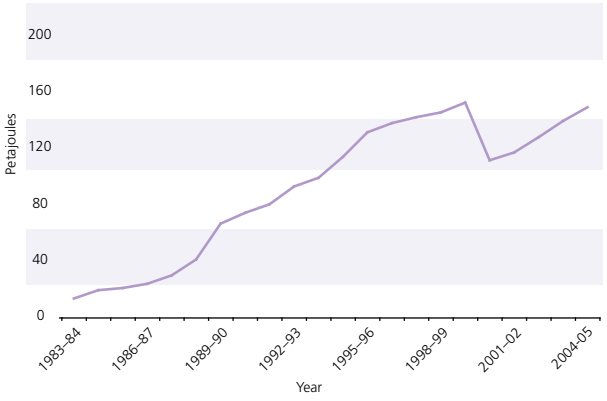


Figure TS5.4: Energy use in the resources sector in Western Australia.

Data source: Australian Bureau of Agricultural and Resource Economics (2005a). Note: Includes all industries in the Australian and New Zealand Standard Industrial Classification Codes under 'Division B: Mining' (Australian Research Council, n.d.).

MANAGEMENT OF NATURAL RESOURCES

Before mining or petroleum extraction projects commence, companies submit proposals to the Department of Industry and Resources for assessment. These proposals detail the measures that will be taken to minimise impacts on the environment and plans for closure and decommissioning once operations have ceased. Projects having proposed impacts to environmentally significant areas are also assessed by the EPA. Operating conditions included in environmental licences and ministerial approvals are employed to manage environmental risks and impacts.

Conditions may address:

- limits on emissions or discharges to the environment;
- land clearing and rehabilitation criteria;
- storage and handling requirements for environmentally hazardous materials;
- water allocation limits, balance, and water use efficiency; and
- reporting criteria for project specific environmental issues.

Mining operations are audited against criteria relating to various aspects of environmental performance. Currently, audit assessment scores are collated by the Department of Industry and Resources and presented in an environmental compliance index. In 2005–06, the overall score for mining operators was 106 against a baseline of 100 for the year 1998–99, which represents a slight improvement compared with the baseline year (Department of Industry and Resources, 2006b). This assessment and scoring process is currently being reviewed to enable compliance with the *Mining Act 1978*. Auditing of the petroleum industry is also undertaken to determine compliance with relevant environmental management criteria. In 2005–06, 100% of audited projects had no reports of major corrective actions (Department of Industry and Resources, 2006b). Data on levels of compliance with ministerial conditions set by the Minister for the Environment and licence conditions implemented under the *Environmental Protection Act 1986* are unavailable.

Mining companies are required to undertake rehabilitation of land disturbed by mining upon a project's completion. Industry financial securities are held by government authorities to ensure rehabilitation is completed to a satisfactory standard. For the mining industry, the State Government holds around $455 million in unconditional performance bonds for the purpose of funding a program of rehabilitation works in the event that operations fail to meet rehabilitation standards agreed to in their conditions of approval (Department of Industry and Resources, 2006b). Petroleum companies are required to prepare decommissioning and closure plans and maintain adequate insurance against environmental risks such as oil spills. Currently, it is not common practice to require bonds for onshore petroleum projects.

While there are now processes governing the rehabilitation of land, this has not always been the case. There are many abandoned mines sites that were approved before rehabilitation protocols were established and there remain areas of land yet to be rehabilitated. Historical sites continue to have an impact on flora and fauna. On-ground exploratory drill holes can also act as pitfall traps for native fauna and contribute to local erosion and the formation of sinkholes. For example, a study undertaken in the early 1980s in Fitzgerald River National Park recovered the remains of nearly 300 marsupials and reptiles from two shallow uncapped drill holes (Geological Survey of Western Australia, n.d.). Surveying of abandoned mine sites has been ongoing since 1999 and 82% of known high priority sites have now been inspected (Geological Survey of Western Australia, 2005). Companies are now required to routinely plug drill holes and also to plug the holes of previous explorers on their acquired mining leases.

The environmental impacts of petroleum operations arise from drilling, ship and platform anchoring and the construction of infrastructure such as subsea pipelines, production facilities and shore-based facilities that process oil and gas. Onshore operations, such as oil and gas processing facilities, also generate environmental impacts. Active management is required to minimise land disturbance, impacts on biodiversity and loss of conservation and heritage values. When offshore drilling operations cease, all wells are plugged below the seabed surface.

PROTECTION OF NATURAL RESOURCES

Many operational discharges are authorised under project approvals and licence conditions. However, some accidental releases and spills occur. Releases to the environment from the mining industry potentially include spills of fuel, oil, chemicals, process water, saline borefield water or tailings. Tailings storage facilities are of most concern as they pose a risk to native flora and fauna and groundwater contamination. While mining facilities are audited and spills investigated by the Department of Environment and Conservation, comprehensive data on quantities of spills and releases to the environment are unavailable.

For the petroleum industry, releases to the environment can include oil, gas, fuel, other hydrocarbons and saline water. Data on accidental releases of gas or liquid hydrocarbons are submitted to the Department of Industry and Resources and the Department of Environment and Conservation. In 2005–06 there were 384 L of total hydrocarbons released during reportable incidents from onshore operations in the upstream petroleum industry. A total of 582 L of hydrocarbons were released in State and Commonwealth waters from offshore operations during the same period. Reportable gas venting totalled 387 200 m^3 during 2005–06.

Acid mine drainage is an emerging issue for the mining industry. Acid mine drainage occurs when sulfidic minerals along the walls of open pits and in waste rock dumps and tailings storage oxidise, resulting in the release of acidic drainage water and dissolved metals which may impact on terrestrial and aquatic environments. The sector has recognised acid mine drainage as a significant issue and a number of industry groups are undertaking research to improve management of acid mine drainage .

Greenhouse gas emissions from the sector are increasing (Figure TS5.5). New gas ventures in the North West are expected to increase the State's carbon dioxide emissions by up to 10 million tonnes. Coal mining is also a significant source of fugitive methane emissions, with smaller amounts of fugitive emissions resulting from the extraction and storage of oil and gas. Some operators are working to improve efficiencies and consequently, emissions have declined on a per unit production basis for some projects. However, these improvements have been offset by significant overall growth in sector activity.

Minesite rehabilitation with native vegetation (Department of Industry and Resources).

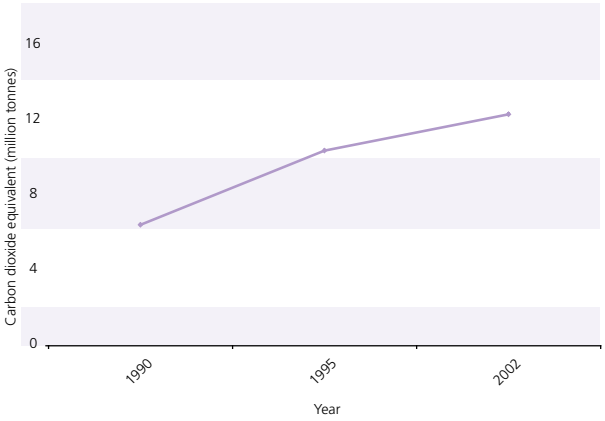


Figure TS5.5: Total sector greenhouse gas emissions (carbon dioxide equivalent) in Western Australia.

Data source: Australian Greenhouse Office (2005).

The sector emits a significant quantity of sulfur dioxide, most of which is produced during the smelting of sulfide ores in mineral processing and some from the flaring of natural gas while extracting crude oil. There is an increasing trend in the emissions of sulfur dioxide from the sector (Figure TS5.6), with it being a significant issue in the Kalgoorlie–Boulder area (see '*Sulfur dioxide*'). Dust is also recognised as having significant localised impacts, particularly around mining facilities in the North West (see '*Particulates*'). Various dust suppression techniques are being developed and implemented by the sector.

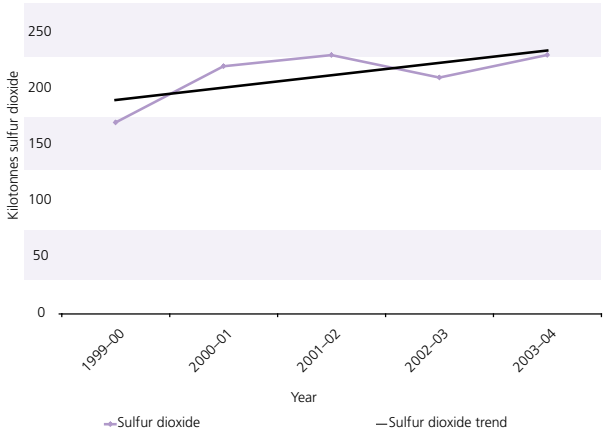


Figure TS5.6: Sulfur dioxide emissions from the mining and petroleum sector in Western Australia.

Data source: National Pollutant Inventory (2006). Note: Includes all industries in the Australian and New Zealand Standard Industrial Classification Codes under 'Division B: Mining' (Australian Research Council, n.d.). Reporting is only required for facilities emitting more than 10 tonnes of sulfur dioxide per year.

Pressures

TRENDS IN SECTOR ACTIVITY

Sector activity is significantly influenced by the cyclical nature of commodity prices on international markets, and experiences 'booms' and 'busts'. Over the last ten years the resources sector has experienced a nominal growth rate of about 8% per annum (Figure TS5.7). As at December 2006, it was estimated that $81 billion worth of projects were either under construction or planned for the State. It is anticipated that the State will continue to experience growth in demand in the resources market fuelled by strong economic activity in Asia (Department of Industry and Resources, 2005c; Department of Industry and Resources, 2007). While some per unit production impacts on the environment (e.g. from atmospheric emissions and energy usage) are decreasing, the increasing demand for resource commodities and the corresponding increasing levels of production will continue to place pressures on the environment.

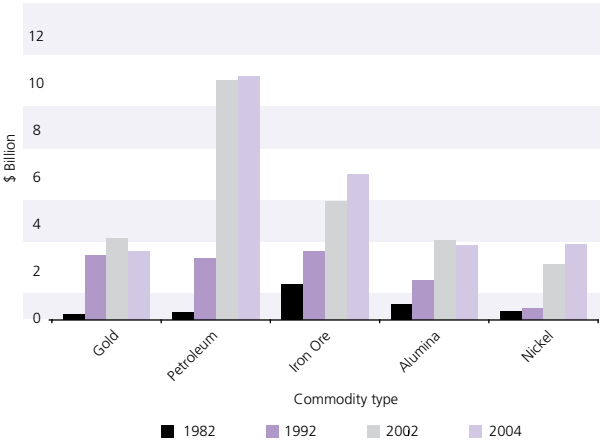


Figure TS5.7: Value of Western Australia's minerals and petroleum sales for selected commodities.

Data source: Department of Industry and Resources (2005c).

WATER USE AND DISPOSAL

Sourcing water for use in resource extraction (particularly for the mining industry) has become a major problem in specific areas in recent years with increasing competition for water resources and the need to allocate more water for the environment. In particular, the rapid expansion of downstream processing related to the mining industry along the Pilbara Coast between Karratha and Port Hedland is resulting in increasing pressures on available water supplies.

ATMOSPHERIC EMISSIONS

The international focus on the contribution of industrial emissions to climate change has increased pressure on the sector to reduce greenhouse gas emissions. There is also a recognition of the importance of environmental health issues and the need to minimise particulate emissions. While per unit levels of emissions are decreasing, this will continue to be offset by sector growth.

Current responses

Legislation: The relevant State legislation governing the environmental impacts of the sector includes the *Mining Act 1978*, several petroleum Acts and the *Environmental Protection Act 1986*. In addition to these Acts, there is a range of other Commonwealth and State legislation governing specific aspects of environmental management in the sector.

Sector initiatives: A number of industry-led initiatives aim to support sound environmental management and provide mechanisms for the broader public to identify organisations adhering to more stringent requirements. State-based industry organisations actively involved in supporting sound environmental practice include Chamber of Minerals and Energy, Australian Petroleum Production and Exploration Association Limited (WA), Chamber of Commerce and Industry, and Association of Mining and Exploration Companies (WA). International organisations that have developed codes of practice to guide responsible environmental planning and management of sector operations include:

- International Petroleum Industry Environmental Conservation Association;
- International Council on Mining and Metals;
- Mining, Minerals and Sustainable Development Project; and
- Global Reporting Initiative.

Greenhouse gas emissions: An increasing number of resource companies operating in WA are members of the Commonwealth's Greenhouse Challenge Program (see '*Greenhouse gas emissions*'). As of 1 July 2006, participation in the Greenhouse Challenge Plus program became compulsory for all Australian companies receiving fuel excise credits of more than $3 million and for proponents of large energy resource development projects.

Rehabilitation: The Department of Industry and Resources is undertaking a review of the environmental bond system for rehabilitation works which is investigating the adequacy of environmental bond rates, assessment methodologies and bond administration.

Abandoned mine sites: Since 1999, the Geological Survey of Western Australia (2000) has been undertaking an inventory of abandoned mine sites. The aim of this project is to provide a basis for planning of remedial action and rehabilitation of high-risk features on abandoned mines. Priority has been given to areas within 10 km of major towns or less than 1 km from main roads, where rehabilitation is now largely completed. Surveying has now commenced in areas within 5 km of smaller towns or less than 1 km from selected tourist routes.

Land and water contamination: The *Contaminated Sites Act 2003* and supporting Regulations came into effect in December 2006 and has become an effective mechanism for improved reporting, assessment and management of soil and water contamination on mine sites.

Recognition of excellence in environmental management: The Department of Industry and Resources mission is to facilitate responsible resource development in WA. The department established the Golden Gecko Awards for Environmental Excellence in the Mineral and Petroleum Industries in Western Australia to recognise excellence and leadership. The awards acknowledge the outstanding contribution recipients have made in balancing environmental responsibility with the successful development of the State's resources (Department of Industry and Resources, 2005a). A Golden Gecko Award symbolises the commitment of companies and individuals to go beyond basic compliance with regulations, and provides public and industry recognition for their efforts.

Implications

The management of environmental impacts, including impacts on biodiversity and emissions to the environment, is essential to maintain broad community support for the operations of the mining and petroleum sector. Without such support, the sector's capacity to contribute to the State's economy is reduced, with significant economic impacts felt in regional WA, where a high proportion of employment is often due to the resources sector. Resource companies and their shareholders have a direct financial stake in implementing appropriate environmental management practices to manage pressures on the environment. As well as company funds being held in performance bonds, increasingly well-informed global consumers are basing investment and purchasing decisions on factors other than price, one of which is environmental performance (Chamber of Minerals and Energy, 2004).

SUGGESTED RESPONSES

9.17 Develop a comprehensive central database to collate and process environmental data and information prepared by the sector to enhance the State's environmental knowledge.

9.18 Establish sector-wide targets and benchmarks in order to assess whether implemented environmental strategies are achieving required outcomes.

9.19 Develop guidelines on rehabilitation and relinquishment standards consistent with the Australian and New Zealand Minerals and Energy Council/Minerals Council of Australia *Strategic Framework for Mine Closure.*

9.20 Develop strategies for more effective information exchange between mining companies on practical and effective mine closure and rehabilitation techniques.

9.21 Coordinate and advance research in rehabilitation techniques in WA.

9.22 Adopt collaborative processes when significant environmental values and significant resource development economic benefits coincide, to achieve multiple land-use objectives.

Alcoa's Huntly minesite - inspecting rehabilitation (Alcoa).

9.6 PASTORALISM

Cattle mustering in the Kimberley (Tourism WA).

Description

Western Australian rangelands account for 87% (about 2.175 million square kilometres) of the State's land area, including all but the South West corner (Environmental Protection Authority, 2004). About 42% of the rangelands are vested as pastoral leases. There are two broad regions of the pastoral rangelands; the grasslands of the Kimberley and Pilbara regions (known as the Northern Rangelands), and the shrublands of the Gascoyne, Murchison, Goldfields and Nullarbor regions (known as the Southern Rangelands).

Pastoralism is the extensive grazing of native vegetation by livestock. In WA it occurs on Crown land held under pastoral leases. There are 525 pastoral leases across the State, ranging in size from 3000 to 500 000 hectares (ha). Grazing of livestock (cattle, sheep and goats) represents the major land use on pastoral leases, although diversification to activities such as tourism, rural retreats, conservation, wood production, horticulture and aquaculture is becoming more common (Department for Planning and Infrastructure, 2003). Some Aboriginal communities with a historical connection to the land use leases to generate income while meeting traditional social and cultural needs.

The pastoralism sector in this report is defined as the use, management, conservation and protection of pastoral land for the purposes of livestock grazing. Grazing animals are reared for their meat and for associated products, such as wool and fibre. Pastoral production contributes about $200 million annually, which is around 3% of the State's gross value of agricultural production (Department of Agriculture, 2004b). The Southern Rangelands contributed 27% of that amount with pastoral activities consisting mostly of wool production, although meat production from cattle, sheep and goats is becoming increasingly important. The Northern Rangelands contributed 73% , mostly from meat production from cattle (Department of Agriculture, 2005b).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108).

Sustainable pastoralism requires objectives that reflect the above vision, including:

- Ensure that the pastoral rangelands are managed sustainably in accordance with the requirements of the *Land Administration Act 1997*.
- Protect land, water and biodiversity resources to maintain ecosystem services and prevent degradation.
- Provide opportunities for diversified and sustainable production from the pastoral rangelands.
- Support off-reserve conservation of biodiversity on pastoral lands to complement the conservation reserve system.

Headline indicators

Indicator TS14: Average Range Condition Index for pastoral leases.

The Range Condition Index summarises pastoral lease performance for range condition, namely perennial vegetation and surface soil condition. Index scores range from 1 to 3, with 1 = good condition, 2 = fair condition, and 3 = poor condition. The headline indicator score of 1.79 is the average index score for all pastoral leases where recent inspections were undertaken between 1999 and 2005. This score indicates that most pastoral leases are in good to fair condition, showing a marginal improvement over time compared to range condition surveys undertaken between 1972 and 1998, when the average score was 1.85 (Department of Agriculture, unpublished).

Indicator TS15: Per cent of Western Australian Rangeland Monitoring System sites for which shrub density or perennial grass frequency remained steady or increased.

The Western Australian Rangeland Monitoring System sites are based on the dominant vegetation type (shrubs or grasses) present on a pastoral lease. Per cent change was calculated by comparing the most recent sampling occasion with the previous sampling occasion. Generally, an increase in shrub density or perennial grass frequency is seen as an improvement. The indicator shows that shrub density or perennial grass frequency remained the same or increased for 68% of sites (984 out of 1448) over the past decade. Thirty-two per cent of sites experienced a decline.

Controlling access to watering points is an important tool for managing stock distribution on pastoral leases (B.Lloyd)

Indicator TS16: Median stocking rate of pastoral leases.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Median stocking rate (dry sheep equivalent per ha)	0.067	0.067	0.071	0.067	0.067	0.063	0.059	0.048	0.050	0.052	0.053

Data source: Department of Agriculture. Note: Dry sheep equivalent is a method of reporting cattle, sheep and goat numbers on the same scale.

There has been a decline in the median stocking rate of pastoral leases since the late 1990s, with current stocking rates of about 0.05 dry sheep equivalent per hectare (or about 20 hectares per head of livestock). Lower stocking rates mean fewer head of livestock being grazed on pastoral land. This may be a response to poor seasonal conditions; for example, much of the Southern Rangelands experienced drought in 2003 and 2004.

Status

USE OF PASTORAL LAND

Family-owned businesses make up nearly half of the pastoral industry (Figure TS6.1). The number of pastoral leases has declined over the past decade, due largely to the purchase of leases by the Department of Environment and Conservation for the conservation reserve system. Demand for lifestyle properties is also increasing.

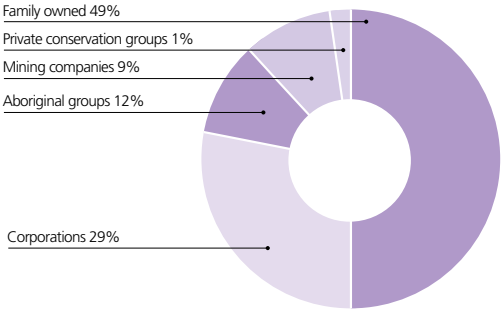


Figure TS6.1: Composition of pastoral industry based on pastoral lessee types.

Data source: Pastoral Lands Board [ver. 2005].

Historically, sheep have been the most common pastoral livestock type in WA (Figure TS6.2). Since the mid-1990s there has been a steady decline in sheep numbers and a rising trend in cattle numbers. As of 2004, cattle numbers outweigh sheep numbers. Widespread drought, low wool prices and difficulties with labour and infrastructure for wool production have forced many pastoralists to cut sheep numbers. The gradual rise in cattle numbers was largely driven by access to new markets at profitable prices and the greater tolerance of cattle to wild dog predation. Goats are increasingly recognised by pastoralists as valuable livestock and numbers are slowly rising.

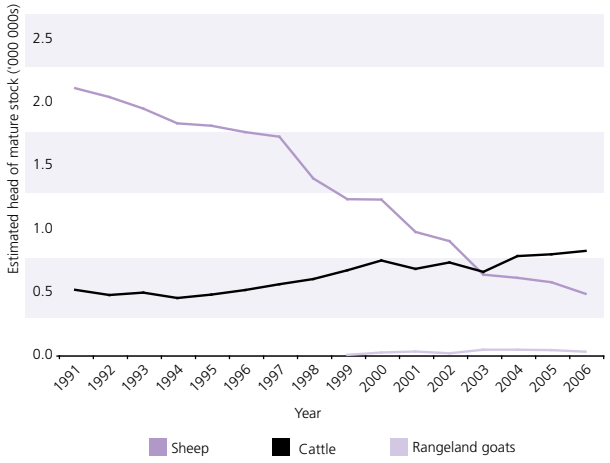


Figure TS6.2: Trends in stock types based on estimated number of head in pastoral Western Australia.

Data source: Department of Agriculture. Note: Goat numbers are independent of the number of feral goats in pastoral areas.

Sustainable use of pastoral lands is largely determined by stocking rates. Pastoralists must control the distribution of stock and the intensity and length of grazing to prevent land degradation and allow vegetation to regenerate. Comparing actual stocking numbers with the land's maximum carrying capacity is a useful method to track the sustainable use of pastoral land (Figure TS6.3). Maximum carrying capacity refers to the potential stocking rate when the land and vegetation are in good condition and the lease is fully-watered (5 km to 8 km maximum distance between watering points). A low percentage indicates that the land has low stock levels which may be the result of conservative management decisions, seasonal conditions, or degraded land condition. A high percentage (close to 100%) indicates that the land is carrying close to maximum stocking levels. Since the early to mid 1990s, increasing trends towards maximum carrying capacity have occurred in the Pilbara and Kimberley districts, with current levels at about 110% and 75% respectively. Decreasing trends have been observed for the Goldfields, Gascoyne and the Murchison in recent years.

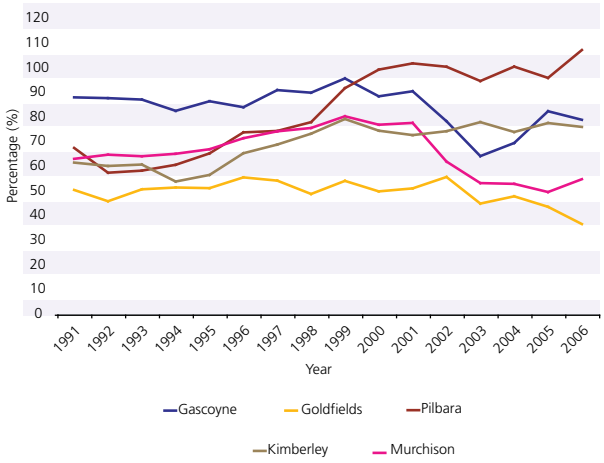


Figure TS6.3: Actual stocking rate compared to maximum potential carrying capacity, by district.

Data source: Department of Agriculture.

MANAGEMENT OF PASTORAL LAND

Pastoralists recognise the need to balance productivity increases and station performance with natural resource condition. This involves knowledge of pasture types, understanding stock distribution and grazing patterns, managing stocking rates based on land capability and pasture production, and knowing the stocking thresholds before damage occurs. Recent surveys indicate that 53% of pastoralists have a management plan that addresses land management issues (Pastoral Lands Board, unpublished data). Occasionally the Pastoral Lands Board may request a pastoral station to develop a management plan where environmental management or other issues have been identified.

Environmental management systems are tools that help businesses improve their environmental performance. They have not been widely embraced by Western Australian pastoralists, but are becoming recognised as a way of enhancing their competitiveness in international markets that are now demanding evidence of sustainable practices. Three pastoral leases in the Gascoyne–Murchison region have been involved in a trial to attain certification for food safety and environmental accreditation systems.

PROTECTION OF PASTORAL LAND

It is important to protect the natural assets in the pastoral rangelands in order to maintain key ecosystem services, such as soil and vegetation health, habitat provision, water capture and filtration, carbon sequestration, landscapes and a sense of place. Inadequate protection of these ecosystem services will not support productive pastoralism.

A good measure of pastoral rangeland condition is the Range Condition Index, which is derived from traverse assessments of the impact of grazing on perennial vegetation and surface soil condition collected during pastoral lease inspections. The index is scaled from 1 (good range condition) to 3 (poor range condition). Index scores for the most recent assessment show most leases in good to fair condition (Figure TS6.4). A high proportion of leases in the Southern Rangelands are in fair to poor range condition, which may be due to drought conditions, inappropriate grazing management practices or inadequate maintenance of infrastructure leading to uncontrolled grazing. Consideration should also be given to whether the Range Condition Index is stable, improving or declining over time (Figure TS6.5). Most leases show little or no change over time. However, attention should be focused on pastoral leases showing significant deterioration (large negative change) and recognition given to leases showing significant improvements (large positive change).

Monitoring results from the Western Australian Rangeland Monitoring System were analysed at the bioregion scale to determine change in vegetation condition, i.e. shrub density or perennial grass frequency (Figure TS6.6). Change was determined by comparing the most recent sampling occasion (1999–2004) with the previous sampling occasion (1993–2002). For most bioregions, shrub density or perennial grass frequency remained the same or increased on the majority of sites over the past decade (yellow or green in Figure TS6.6). Shrub density or perennial grass frequency decreased on the majority of sites for several bioregions in the Murchison and Pilbara coast (pink in Figure TS6.6). While these areas have recently been exposed to a prolonged dry period, there are also indications that inappropriate grazing management has contributed to the decrease (Department of Agriculture, unpublished).

Fencing on pastoral leases can be problematic and costly due to the massive size of leases and the terrain involved (B.Lloyd).

Many pastoralists are swapping from sheep to cattle livestock (Tourism WA).

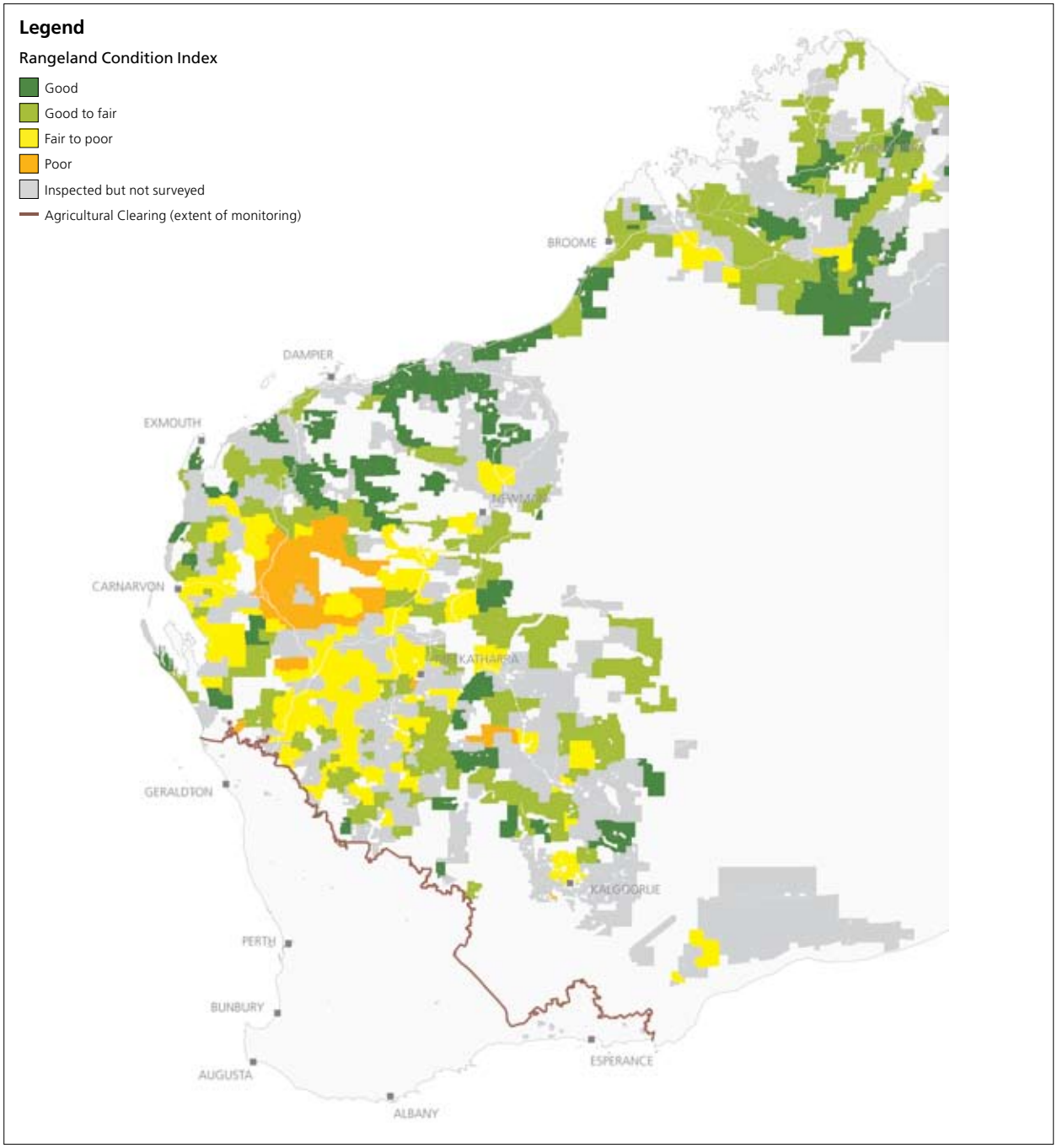


Figure TS6.4: Range Condition Index values at last inspection, 1999 to June 2005.

Data source: Department of Agriculture [ver. 2005], Analysis: Department of Agriculture, Presentation: EPA.

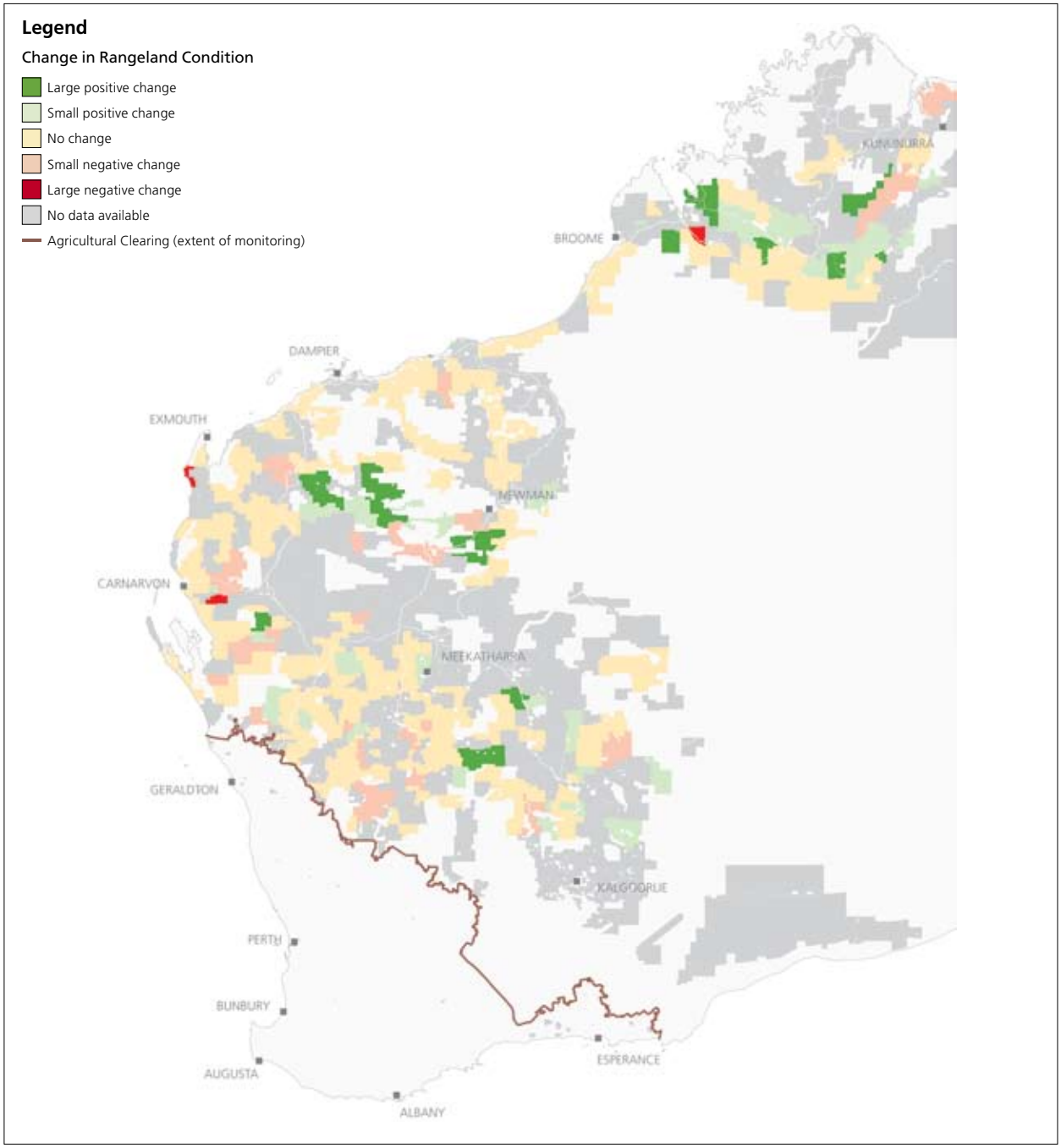


Figure TS6.5: Change in Range Condition Index from historic surveys (1972–98) compared to recent inspection.

Data source: Department of Agriculture [ver. 2005], Analysis: Department of Agriculture, Presentation: EPA. Note: This map depicts change in Rangeland Condition Index (RCI) between an RCI monitoring site's intial survey (1972 to 1998) and it's last inspection (1999 to 2005). Negative change indicates a decline in pastoral lease condition and positive change indicates an improvement.

CONSERVATION OF VALUED PASTORAL LAND

The sustainability of pastoralism depends on the conservation of native species (particularly perennial plant species) and the ecological processes they support, minimising land degradation, generating seed, and providing habitat for native animals that pollinate and scatter seed. Areas of land placed under conservation also helps to maintain landscape integrity and biodiversity and enable greater diversification opportunities for alternative land uses, such as ecotourism or bioprospecting.

Since 1989, a number of pastoral leases have been placed in the conservation estate for biodiversity conservation. Twenty-nine whole pastoral leases with an area of 4 527 371 ha and parts of 23 pastoral leases with an area of 1 108 280 ha have been purchased and included in the formal conservation reserve system. As a result, the area of conservation reserve in the rangelands has increased 37% over the past decade (N. Sercombe, Department of Environment and Conservation, pers. comm.). Private conservation groups have also purchased six pastoral leases. Informal conservation agreements between Department of Environment and Conservation and pastoral landholders make up only 7235 ha.

In 2015, the State Government will resume land from about 20% of pastoral leases. Just over one million hectares will be added to the State's conservation reserve system, in addition to providing land for recreation and tourism, Aboriginal uses, and townsite expansion (Table TS6.1).

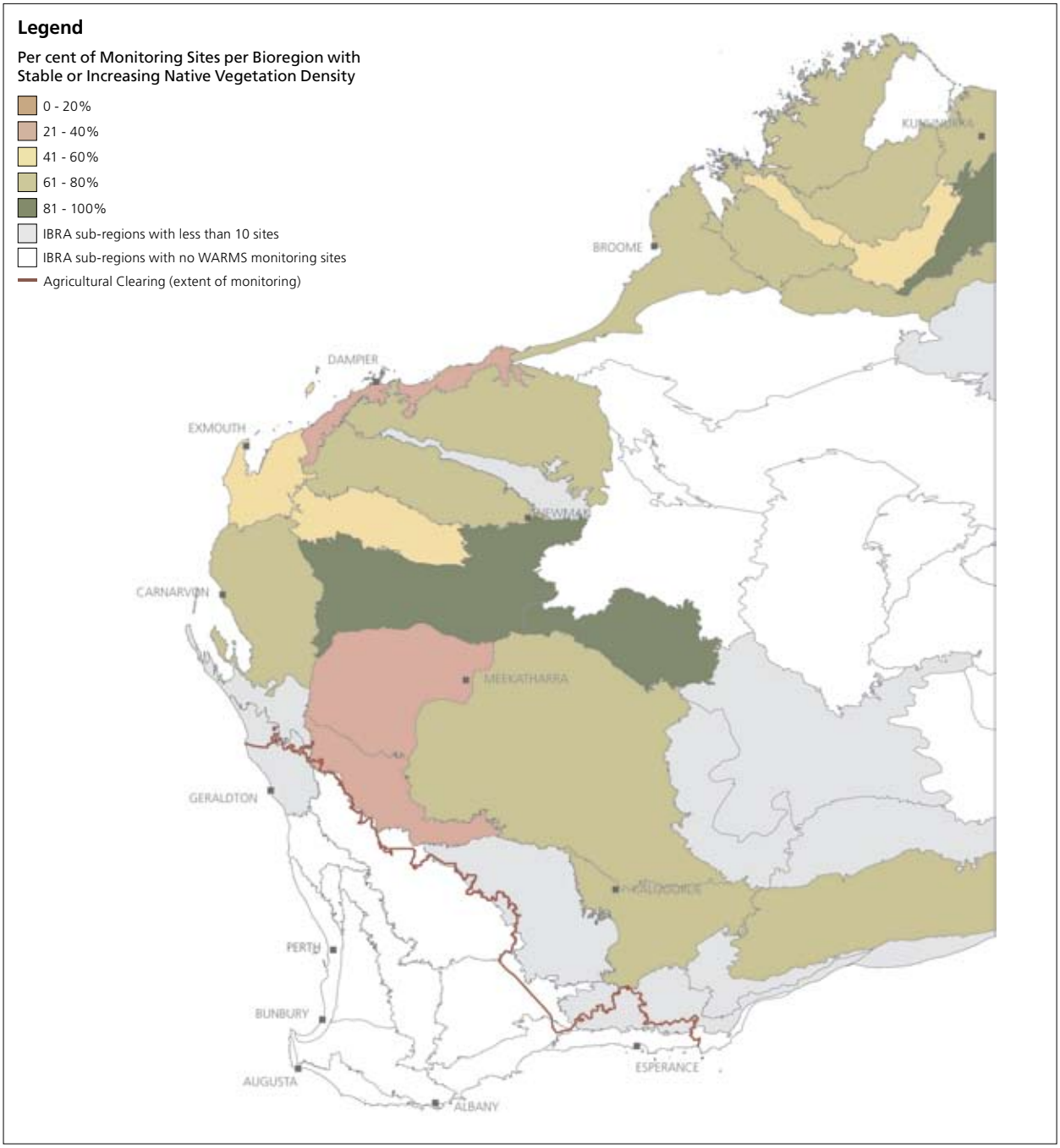


Figure TS6.6: Per cent of Western Australian Rangeland Monitoring System sites with stable or increasing native vegetation per bioregion.

Data Source: Department of Agriculture [ver. 2005], Analysis: EPA, Presentation: EPA.

Table TS6.1: Area of pastoral leases to be transferred into the conservation reserve system in 2015.

Conservation region	Summed area of pastoral leases to be transferred in 2015 (ha)
Kimberley	347 106
Pilbara	400 202
Midwest	179 865
Goldfields	125 930
TOTAL	1 053 103

Data source: Department of Environment and Conservation.

Pressures

CLIMATE CHANGE

Pastoralists in WA work with variable weather on a day-to-day basis. However, climate change is likely to pose a long-term challenge for the pastoral sector (Robertson, 2002). A projected rise in temperature across the State of several degrees Centigrade is likely in this century, in line with global projections. Temperature increases may have significant implications for the pasture growing season. If rainfall decreases by more than 10%, animal production will decline (Commonwealth of Australia, 2002). While significant rainfall declines are expected over the State's South West, rainfall predictions in the Northern Rangelands remain uncertain. A substantial decline in rainfall of more than 15% would markedly reduce livestock carrying capacity and the viability of the sector. In the Northern Rangelands, enhanced storm and cyclone intensity may pose an increased threat to livestock. The actual outcomes depend on global action on limiting greenhouse gas emissions over coming decades and these cannot be predicted (Indian Ocean Climate Initiative, 2005b).

INTRODUCED AND PEST SPECIES

Feral grazing animals are considered threats to the pastoral sector as they compete with livestock for available feed, water and habitat, and can cause land degradation and spread of disease. These grazers include camels, pigs, buffalo, donkeys, horses, rabbits, horses and goats (Rangelands NRM Co-ordinating Group, 2005). Other introduced animals, such as foxes and wild dogs, can cause significant stock losses through predation. Even though kangaroos and emus are native, they too can pose a threat to pastoral activities, especially when large populations compete with livestock for available feed and water.

Invasive weeds potentially reduce the area of productive land and increase pastoral management costs. Although damaging from a biodiversity perspective, some introduced species such as buffel grass and birdwood grass are useful for pastoral grazing. Of 463 exotic pasture species introduced to northern Australia, less than 5% became useful, and less than 1% of those are useful without also being a weed. About 10% of species became weeds with no recorded use (Lonsdale, 1994). The introduction of foreign diseases also represents a significant threat to livestock and native animals.

LAND AND WATER DEGRADATION

Land degradation issues such as soil erosion, increased runoff, loss of soil health and vegetation decline all reduce the productive potential of pastoral land and the provision of ecosystem services. Inaction by pastoralists (i.e. failure to reduce stock numbers in times of drought), or re-stocking immediately following a drought (before the vegetation recovers) can result in soil erosion and loss of perennial shrubs and grasses. Grazing pressure is highest where water is available. Natural water sources often have riparian areas with soils that are highly susceptible to erosion. Excessive animal movement in these areas can severely degrade fringing vegetation, increase sediment transport and cause water pollution.

WATER SUPPLY

Pastoralists are reliant on access to water. Surface water availability in the Pilbara, Gascoyne–Murchison, Goldfields and Nullarbor is extremely seasonal in response to rainfall. However, most pastoral activities rely on access to groundwater and many groundwater supplies remain undiscovered or unassessed. The key challenge facing water planners is the ongoing impact of climate variability, increased water consumption and other longer-term changes in water supply.

FIRE

Large-scale fires have a destructive impact on infrastructure, grazing vegetation and livestock numbers. When fire is used in a controlled manner, it can be an effective management tool. However, excessive use of controlled fires can radically alter the landscape by affecting plant community composition and biodiversity, and reducing pastoral productivity. Frequent burning also leads to increased soil erosion and air and water quality problems. The Kimberley has the most frequent and extensive fires in the state.

SOCIAL AND ECONOMIC THREATS TO PASTORAL LAND

The rangelands in WA are currently undergoing rapid change affecting many pastoralists and local communities. Many pastoral areas are being depopulated, particularly as a result of reduced sheep numbers (and associated need for shearers) and also the fly-in fly-out policy for mine site workers. Lack of a permanent population in regional towns often results in a reduced number of services being made available to pastoralists. Some pastoral landholdings are not of an adequate size and do not have adequate carrying capacity or infrastructure required for a profitable enterprise. Sound governance is needed to prevent land degradation issues on these leases. Some leases also support large Aboriginal communities and should be considered differently to those running business enterprises.

Some pastoral leases are economically marginal and affected pastoralists face a constant struggle to make a living from the land. When markets are low or drought conditions persist these pastoralists could be forced out of the industry. At best there is limited capacity to undertake best management practices.

Current responses

Review of the Pastoral Industry: The review involved an extensive public consultation process including two major pastoral industry forums (the 'Gascoyne Musters'). The *Pastoralism for Sustainability* report (Department for Planning and Infrastructure, 2003) outlined a number of recommendations to progress the sector towards achieving sustainable pastoral rangelands management.

Rangelands natural resource management strategy: The strategy has been developed by the Rangelands NRM Coordinating Group (2005) to ensure on-ground environmental improvements occur via a targeted strategic approach at the regional level. An investment strategy outlines specific targets and on-ground projects.

Land Administration Act 1997: The Pastoral Lands Board is established under this Act. One of its functions outlined in s. 95(c) is to '… ensure that pastoral leases are managed on an ecologically sustainable basis'. The board has developed policies relating to best pastoral and environmental practices including best management practice guidelines for sheep, cattle and goat grazing and fire management.

Management plans: The Pastoral Lands Board may require a pastoralist to develop a management plan to address specific issues that have been raised following a range condition assessment of the pastoral lease.

Rangeland Resource Inventory: This inventory provides detailed mapping of landforms, soils and vegetation types in the rangelands. It provides information comparing pre-settlement condition and condition following land use development or degradation. Almost 87% of the pastoral rangelands are mapped to land system level.

Pastoral lease inspections: provide advice on range condition and trend, infrastructure issues, and plant and animal pests at the paddock and property scale. Pastoral

leases are assessed on a 1–6 year cycle according to land management issues on the lease. A Range Condition Index has recently been developed to summarise this information at the lease scale.

Western Australian Rangeland Monitoring System: This system provides regional and district scale trend assessments of perennial vegetation and soil surface condition. Currently, it is made up of 1628 sites, comprising 996 shrubland sites and 632 grassland sites. Shrubland sites are assessed every five years in the southern Pilbara through to the Nullarbor. Grassland sites are assessed every three years in the Kimberley, Pilbara and north-western Gascoyne. About 400 sites are reassessed each year.

2015 lease exclusions: All pastoral leases expire on 30 June 2015. Most leases have been offered for renewal after this date. Under the lease renewal process parts of a number of leases will be excluded for conservation, recreation and tourism, Aboriginal uses and townsite expansion.

Implications

Unsustainable pastoral practices result in lost productive potential for an industry that occupies a large percentage of WA's land area. Such practices can result in loss or decline in vegetation, reduced biodiversity, invasion of weed and introduced species, soil erosion, sedimentation, eutrophication, and contamination of waterways and wetlands. They may also render the land unsuitable for other potential land uses. Unsustainable pastoral practices may result in a net migration of people away from pastoral stations, when leases are no longer profitable or become degraded. A decreasing population base will generally result in a gradual loss of community services and business interests that support the pastoral industry.

SUGGESTED RESPONSES

9.23 Develop a State strategic policy for the rangelands, providing for effective, coordinated and integrated sustainable management of natural resources.

9.24 Develop an action plan to progress implementation of the *Pastoral Industry Review*.

9.25 Encourage diversification of activities beyond traditional cattle and sheep production on pastoral leases, based on sound sustainability planning.

CASE STUDY – EVALUATING THE *GASCOYNE–MURCHISON STRATEGY*

The *Gascoyne–Murchison Strategy* was a collaborative effort between the State and Commonwealth governments and the local community. The goal of this innovative strategic approach was to establish '… a socially and economically viable community involved in a range of industries, based on the use of the rangelands in a sustainable way' (Department of Agriculture, 2004b, p. 6). One of the strategies was the establishment of a regional environmental management program to promote sustainable land and water management and biodiversity conservation through grants to implement best practices. The strategy has been independently evaluated recently (URS Australia Pty Ltd, 2004). Two examples from this report that highlight successful actions at the pastoral lease scale are discussed below.

DEVELOPING AN ENVIRONMENTAL MANAGEMENT SYSTEM

Assistance was provided to the Dowden family of Challa Station, Mount Magnet, to develop an environmental management system for their business (URS Australia Pty Ltd, 2004). The family found it a lengthy process, but they now have an accredited management system under the Safe Quality Food 1000 standard. Although obtaining accreditation came at a cost, the owners recognise definite benefits for the business, including:

- a limited increase in interest in the Challa wool clip from buyers. Although this hasn't translated into higher prices, it has made the wool more saleable at the shed door with minor cost savings;
- greater control over staff and contract employees (e.g. shearers) who can use the environmental management system-related documentation to clearly explain to workers what is required under their business practices; and
- greater sense of pride in the way they are managing their business and the land.

USING TOTAL GRAZING MANAGEMENT YARDS

A family in the Shire of Meekatharra sought to improve the efficiencies of cattle mustering on their pastoral lease (URS Australia Pty Ltd, 2004). Normal operations involved several mustering vehicles to gather the cattle and the occasional use of a plane. This represented a drain on staff time, money and resources that could be used elsewhere on the property. With the assistance of the *Gascoyne–Murchison Strategy*, the family installed several total grazing management yards to trial. These yards use a trapping system to control entry of livestock and feral animals to watering points, thereby allowing animals to be gathered together without mustering. The family's experience was very positive, with several advantages being noted, including:

- significant reductions in the cost of cattle mustering and handling;
- more time to attend to other things on the property;
- significant increase in percentage of herd handled each year;
- greater capacity to control grazing pressure from cattle, native and feral animals; and
- greater capacity to control feral animals such as donkeys and horses.

While costs involved the initial construction and ongoing maintenance of the yards, the family recognised that the benefits heavily outweighed the costs. Eventually, all 22 watering points on the property were set up with total grazing management yards. The family said that the general concept of total grazing management yards was 'fantastic' and that they made a significant improvement in the capacity to manage the property. Approximately 1000 total grazing management yards have been installed across 8 million hectares of pastoral land in the Gascoyne–Murchison region (Rangelands NRM Coordinating Group, 2005).

9.7 TOURISM

Camel trek on Broome's Cable Beach (Tourism WA)

Description

The World Tourism Organization defines tourism as '… the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes…' (Commission of the European Communities et al., 2001). Tourism is a service-based sector comprising a number of tangible and intangible components. Tangible components include accommodation, transport, natural and built attractions, tour operators, restaurants and other infrastructure used by tourists. Intangible components relate to the experience that people have when they visit an area, and how well that experience matches their needs and expectations.

Tourism is one of a few sectors that place a value on the conservation of the environment for economic and social benefit. The natural environment is a major attraction for visitors to WA. International and domestic visitors are drawn to the State for its pristine ocean, waters and reefs, spectacular outback gorges, tall forests and wildlife (plants and animals). The future of tourism in WA relies heavily on the maintenance of the quality of the environment and the management of natural attractions and their associated cultural values.

Tourism makes a major economic contribution to WA, generating a range of economic and social benefits. Tourism generates approximately $3.6 billion annually from visitor expenditure, contributing 5.5% of the State's Gross State Product. The sector employs approximately 54 000 people, or 5.8% of the State's workforce (Access Economics Pty Ltd, 2003).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). Objectives derived from this are to:

- Ensure that visitor numbers, visitor behaviour and tourism operations are managed to minimise the impact on the environment.
- Ensure that future tourism developments are sustainable and minimise environmental impacts.

Headline indicators

Headline indicators that measure the environmental performance of the tourism sector are only now being developed by tourism research bodies and management agencies (Tonge et al., 2004). The following headline indicators, while not ideal, are the most relevant existing headline indicators.

Indicator TS17: Per cent of ecotourism businesses that have obtained environmental accreditation under recognised tourism certification programs.

Only 4% of ecotourism businesses have obtained environmental accreditation, which certifies ecotourism businesses based on various environmental management and sustainability practices. Currently, 384 nature-based tourism businesses are registered to operate within Department of Environment and Conservation's conservation reserves. Of these, 16 are accredited ecotourism businesses.

Indicator TS18: Per cent of tourists (domestic and international) that visit natural icons or undertake outdoor activities in Western Australia.

This indicator represents a surrogate measure of the value placed on our State's natural environment by tourists. There has been a marginal increase in the percentage of tourists visiting natural icons or undertaking outdoor activities in recent years. This may be related to nature-based tourism marketing strategies, or it may reflect that the WA environment is becoming more important for the tourism sector. It should be noted that a large percentage of visits to WA by tourists are business or family related.

Year	2000	2001	2002	2003	2004	2005	2006
Per cent of tourists	38%	35%	37%	41%	42%	41%	40%

Data source: Tourism Western Australia.

Status

MANAGEMENT OF TOURISTS

The sustainability of the Western Australian tourism sector is closely linked to the health of the State's environment, and the quality of nature based experiences. The sector requires that natural resources and the environment are maintained so that the tourism experience, with its economic and social benefits, is available for future generations.

In 2006, WA recorded approximately 7.39 million overnight visitors, made up of international (8.4%), interstate (18%) and intrastate visitors (73%) (Tourism Research Australia, 2007). In Australian terms, the WA tourism industry is not large, representing a market share of about 10–12%. The Tourism Forecasting Council predicts that domestic visitation to WA will grow by less than 1% a year over the next 10 years, while international visitation will grow between 5–6%. By 2014 the number of overnight visits in WA is forecast to increase by approximately 20% from current levels (Tourism Research Australia, 2005).

About 40% of all visitors to WA in 2006 participated in an outdoor or nature experience, such as going to the beach, visiting national/state parks, bush walking, rainforest walks, visiting botanic/public gardens, scenic tours and visiting farms (Table TS7.1). Over 80% of international visitors participated in nature or outdoor activities, reflecting the value overseas people place on the State's natural attractions and biodiversity (Table TS7.1). It also demonstrates the ability of natural icons to inspire people to travel. This verifies studies that found the main reason for international tourists visiting Australia was the unique wildlife and open landscape (Working Group on Tourism, 1991; Tourism and Transport Forum, 2004). When combined with anticipated growth rates for international visitors, this will put significant additional pressure on the State's natural icon sites. In contrast, only 36% of domestic visitors participated in nature or outdoor activities, which may be associated with a large proportion of business or family related trips (Table TS7.1).

Table TS7.1: Total visitor numbers for tourism zones in Western Australia and per cent of those undertaking nature and outdoor activities in 2006.

	Domestic		International		Total		
Tourism region	Visitors per region	Per cent of nature/ outdoor visitors per region	Visitors per region	Per cent of nature/ outdoor visitors per region	Total (domestic and international) visitors per region	Per cent of total visitors to region	Per cent of nature/ outdoor visitors per region
Experience Perth [a]	3 212 000	27%	601 500	83%	3 813 500	52%	35%
South West	1 966 000	51%	102 200	96%	2 068 200	28%	53%
Golden Outback	778 000	22%	42 300	95%	820 300	11%	26%
Coral Coast	585 000	55%	61 400	98%	646 400	9%	59%
North West	675 000	36%	60 900	86%	735 900	10%	40%
Total [b]	6 764 000	36%	624 000	83%	7 388 000		40%

Data source: Tourism Research Australia, National and International Visitor Survey (2007). Notes: (a) The Experience Perth region stretches from Lancelin in the north, east to Northam and York, and south to Mandurah and Dwellingup. (b) Total visitors do not represent the sum of regional visitors, as a visitor may visit multiple regions and be counted multiple times.

Most visitors to WA travelled in the Perth and South West tourism zones, with considerably fewer visitors distributed across other parts of the State (Table TS7.1). The key appeal of most of the State's tourist regions is linked to their natural icons and environmental values (Figure TS7.1). For example, a study by the Sustainable Tourism Cooperative Research Centre estimated that natural icons such as the Ningaloo Reef and Cape Range National Park were the primary reason for travel of 92% of all visitors to the Exmouth region. In Pemberton and Walpole in the South West region, native forests are the primary reason for travel of 80% of all visitors (Carlsen & Wood, 2004). Expenditure linked to tourists visiting the dolphins at Monkey Mia is estimated to make up between 5–11% of the total regional economy in the Gascoyne region (Stoekl et al., 2005). Visitation to areas such as Exmouth (whale sharks) and Albany (whales) are highly dependent on wildlife populations at certain times of the year. Likewise, the peak season in the Golden Outback region coincides with the annual wildflower season.

The treetop walk in Denmark's Valley of the Giants is a popular tourist attraction (Tourism WA)

Figure TS7.1: Icons and icon experiences by tourism region .

Courtesy of Tourism Western Australia.

While environmental impacts from tourism are considered to be low on a statewide level, there are a number of natural icons identified by Tourism Western Australia that could be seen as 'hot spots', which reflect their importance as tourism attractions and potential for environmental degradation (Table TS7.2). For many hotspots, the trend has been one of continuous growth. In 2003–04 it was estimated that 10.9 million people visited Department of Conservation and Land Management national parks and reserves across the State, an increase of 12.3% since 2000–01.

In some areas, licences are issued to commercial tourism operators who operate businesses in national parks. Issued licences increased 3% between 2000–01 and 2003–04, with increases in the Experience Perth, South West and Golden Outback regions and small reductions for the Coral Coast and North West regions. Operator licenses may reflect demand for nature-based experiences in those particular regions and may also be an indicator of pressures imposed on nature reserves by tourism operators and their clients (such as increased vehicle traffic and waste generation).

Table TS7.2: Visitor numbers to various natural icons per financial year, 1999–2006.

	1999–00	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	% change
North West								
Karijini	50 000	76 064	87 115	88 284	104 098	114 110	120 000	140%
Purnululu	17 073	17 800	21 451	21 152	22 641	21 995	23 844	40%
Gibb River Road (a)	40 037	40 538	41 045	41 558	41 975	44 074	46 277	16%
Coral Coast								
Nambung (Pinnacles)	194 100	170 518	173 314	205 784	212 349	223 296	258 857	33%
Cape Range	135 229	120 316	132 858	132 862	194 742	180 521	180 523	33%
Kalbarri	88 567	102 664	100 999	98 765	107 776	128 861	196 897	122%
Monkey Mia	100 751	92 555	107 285	100 875	108 554	91 743	86 156	–14%
South West								
Leeuwin Naturaliste	1 490 300	1 506 321	1 489 582	1 696 672	1 897 908	1 917 872	2 165 323	45%
Stirling Range	78 142	86 538	76 901	66 993	71 373	63 144	54 673	–30%
Walpole Valley of the Giants	204 529	192 063	201 926	200 006	188 030	171 640	162 110	–21%
Golden Outback								
Cape Le Grand	73 433	72 865	96 542	105 388	110 152	116 587	124 742	70%
Cape Arid	17 189	16 290	15 611	13 035	16 059	16 352	12 581	–27%
Experience Perth								
Rottnest Island (b)	348 498	347 045	351 292	353 750	338 389	314 115	n/a	–10%
Kings Park (c)	n/a	n/a	4 560 000	5 200 000	5 200 000	4 700 000	4 800 000	5%

Data source: Department of Conservation and Land Management; Main Roads Western Australia; Rottnest Island Authority; Botanic Gardens and Parks Authority. Notes: (a) Gibb River Road figures are estimates from Main Roads Western Australia. (b) Rottnest Island figures are for the number of people arriving by commercial aircraft or boat; visitors arriving by private means (estimated at around 150 000 per annum) should be added to this figure. (c) Kings Park estimates are from the Botanic Gardens and Parks Authority annual reports. Basis of collection of visitation figures changed in 2001–02, making comparisons with previous years inappropriate.

Pressures

GLOBAL PRESSURES

Global pressures such as climate change pose significant future threats to biodiversity and natural systems that form the basis for many natural tourism attractions. The Australian Greenhouse Office has identified Ningaloo Reef and Rowley Shoals as being at particular risk from rising ocean temperatures (Allen Consulting Group, 2005).

Tourism is a significant contributor to global greenhouse gas emissions, with the bulk of these created by the aviation industry. The energy footprint of tourism is large in relation to other sectors and this is counter to its projected image of being environmentally benign. While important, efforts to develop ecofriendly infrastructure will only have a very small effect on the overall reduction of the sector's energy consumption. The impact of the increasing cost of fuel as global oil supplies diminish may have considerable impacts, particularly on remote tourism communities. Research published recently by the Australian Greenhouse Office has indicated that the nature-based tourism sector needs to consider adaptation strategies to protect itself from climate risk (Allen Consulting Group, 2005).

Conservation practices in Australia and overseas may have a significant impact on migratory species such as whale sharks, humpback whales and migratory birds, which are important for tourism in WA. The tourism sector in WA is volatile and competes with many other Australian and international destinations. Threats of global terrorism, diseases (e.g. bird flu epidemic), natural disasters (e.g. tsunamis, earthquakes and cyclones) and wars are also having a significant impact on the economy and subsequently affect individual travel decisions. Apart from major global events, it is also influenced by economic factors (including interest rates, employment, inflation, economic growth and exchange rates) that determine whether people can afford to travel. The availability of quality tourism infrastructure such as accommodation, attractions, restaurants, tours and transport is an important factor for whether a destination can attract tourists.

CAPACITY TO MANAGE DURING PEAK SEASONS

Tourism is often highly seasonal, with the number of tourists varying widely depending on the time of the year (Table TS7.3). Seasonal changes in visitation can have a huge impact on the profitability of tourism operators and their capacity to implement best practice. High visitor to resident ratios (i.e. during peak season) also creates enormous challenges for conservation agencies managing large visitor numbers to sensitive environments and the associated environmental impacts. Local governments may sometimes struggle to deliver key environmental services during peak seasons (such as waste management, energy and water supplies), particularly where visitor numbers outstrip the availability of local supplies. Peak season issues such as accommodation availability, traffic congestion, litter, air and noise pollution may detrimentally affect the amenity of local communities, the environment and the experience of tourists.

Table TS7.3: Number of overnight visitors and seasonal visitor/resident ratios for 2006.

	March quarter 2006		June quarter 2006		September quarter 2006		December quarter 2006	
Local government area	Visitors	Visitor / Resident ratio	Visitors	Visitor / Resident ratio	Visitors	Visitor / Resident ratio	Visitors	Visitor / Resident ratio
Perth	405 800	0.27	461 000	0.31	511 200	0.34	619 000	0.41
Exmouth	6 800	3.03	18 300	8.15	29 200	13.0	27 800	12.4
Shark Bay	13 800	13.9	16 400	16.5	33 100	33.3	44 300	44.6
Kalgoorlie–Boulder	42 700	1.48	57 900	2.00	56 000	1.94	37 200	1.29
Broome	41 100	2.79	49 800	3.39	105 400	7.17	61 900	4.21
Wyndham–East Kimberley	2 500	0.32	15 800	2.03	51 000	6.56	33 500	4.31
Ashburton	6 800	1.13	14 900	2.47	23 500	3.89	19 100	3.17
Augusta–Margaret River	129 600	10.8	100 200	8.35	63 900	5.33	130 000	10.8
Busselton	216 100	7.54	148 700	5.19	118 300	4.13	159 200	5.56
Manjimup	76 400	8.00	64 300	6.73	29 700	3.11	59 700	6.25

Data sources: Tourism Research Australia (2007); Australian Bureau of Statistics.

COMPETITION WITH OTHER NATURAL RESOURCE SECTORS

Tourism often has conflicting values for natural resources and can be affected by environmental impacts of other sectors. In the Pilbara region, very few rooms are available to accommodate tourists due to the demand from local mining companies. Mining operations and infrastructure may drastically alter landscapes and natural icons that appeal to tourists. Commercial fisheries close to popular tourist destinations may result in decreased tourist recreational fishing or diving experiences. Timber production in South West forests may impact on sensitive wildlife populations or alter scenic landscapes that may not be particularly attractive to tourists. In contrast, increased tourism in forest reserves may inadvertently lead to the spread of dieback or other diseases. Increased mobility of tourists can also introduce or spread weeds or pests in rangeland areas, and cause fires or traffic damage to native vegetation and habitat.

ENVIRONMENTAL IMPACTS

Tourism is the world's largest industry. Global visitation exceeded 800 million for 2005, representing an all-time record (World Tourism Organization, 2006). This is at a time when there is mounting evidence of serious global environmental degradation. The tourism industry is a contributor to issues such as climate change, species loss, habitat destruction, water availability, pollution and waste. It has been slow to respond to these issues, show leadership and take firm action to initiate change and manage its impacts (Worboys, Lockwood & De Lacy, 2005).

Tourism impacts on the environment occur in different ways. The construction of major tourism infrastructure (e.g. hotels and marinas) can impact local environments and encourage a greater influx of visitors than would otherwise visit the area. The additional demand on water and energy supplies may also require further infrastructure development. Large developments also have the potential to generate significant quantities of waste that may lead to pollution and degradation of ecosystems if inadequately managed. While environmental impact can be addressed through good design and best practice, impacts caused by inappropriate location of tourism activities will be difficult to address. Examples of inappropriate location impacts include coastal camping and activities like sand boarding and four-wheel driving in fragile dunes, resorts with high water use in arid environments, and concentrated recreational and charter fishing in sensitive marine habitats.

Pressure to open up new wilderness experiences may threaten pristine values and may also generate unwanted environmental consequences, such as the desire to interact with native animals, pick wildflowers or touch rock paintings. Impacts will depend on the level of visitor controls in place, education and interpretation facilities and visitor type.

Current responses

Nature based tourism: Tourism Western Australia is the State's statutory authority responsible for promoting and developing the Western Australian tourism sector. In December 2004 it launched *Keeping it Real – A Nature Based Tourism Strategy* for Western Australia, outlining a vision and strategies for the development of sustainable nature-based tourism through business development, environmental accreditation, strategic research, marketing, education and training. Among other things, the strategy recommended: closer links between tourism accreditation and licensing; the development of strategic research programs through the Sustainable Tourism Cooperative Research Centre; the development of low impact, innovative tourism developments; and integration of tourism into regional, district and park management plans (Tourism Western Australia, 2004).

Diving with whale sharks in Ningaloo Marine Park (Tourism WA).

The Commonwealth Government launched the Tourism and Conservation Initiative in 2004. The partnership program promotes the development of nature-based tourism businesses that feature native ecosystems and biodiversity and encourages regional cooperation and collaboration between the tourism and conservation sectors.

Regional planning and management: Tourism Western Australia has developed destination development strategies for the State's five tourism regions. The strategies guide the development of iconic tourism areas, identify infrastructure gaps and develop strategies to disperse visitors across the State.

The *Ningaloo Coast Regional Strategy Carnarvon to Exmouth* was developed in 2004. Key elements of the strategy include banning high impact developments such as marinas and canals, zoning to ensure appropriate tourism developments in natural areas and expanding the current marine park system (Department for Planning and Infrastructure, 2004). Similarly, the *Rottnest Island Management Plan 2003–2008* guides the Rottnest Island Authority in its management of the island (Government of Western Australia & Rottnest Island Western Australia, 2003).

Conservation reserves: The Department of Environment and Conservation uses a range of strategies implemented through individual park management plans to manage tourism impacts in the State's conservation estate. This includes developing site plans for recreation development, licensing tourism operators, managing access to sensitive environments and developing tourism infrastructure.

Accreditation and best practice: Ecotourism Australia is the peak body for the ecotourism industry that runs an Eco Certification program. Certification means the product is backed by a commitment to ecological sustainability, natural area management, and the provision of quality ecotourism experiences. Tourism operators in WA conservation reserves are also licensed according to tourism accreditation. Tourism Western Australia also provides advice to tourism businesses about best practices for nature-based activities and eco-ethics.

Ecotourism ventures: A number of ecotourism operators work closely with conservation partners to advance environmental goals. For example, Ningaloo Deep Charters has worked with researchers from CSIRO, Murdoch University and James Cook University to study whale shark behaviour. Landscope Expeditions is a joint venture between the University of Western Australia and Department of Environment and Conservation that offers visitors the opportunity to help preserve endangered wildlife and their habitats. The Dolphin Discovery Centre operates a popular tourist and research centre in Bunbury and is run by community volunteers and corporate sponsors.

Research: Through the Sustainable Tourism Cooperative Research Centre, CALM, Tourism Western Australia and State universities, a partnership to research the environmental impacts of tourism in WA has been developed. Key studies have focused on the application of visitor data in protected areas, the economic value of nature tourism (Carlsen & Wood, 2004), an inventory of wildlife tourism (Sandilands, 2004) and the effectiveness of visitor management strategies in national parks (Walker, 2004). The research centre is also working on a sustainable destination model which, in the future, could act as an effective monitor of a destination's status from a sustainability point of view.

Implications

Unsustainable tourism practices have the potential to threaten the future of the $3.6 billion tourism industry in WA. Tourism relies on satisfying the needs and expectations of visitors to the State and the WA community. Research highlights the key role the natural environment plays in the decision-making process of visitors to this State. A fine line exists between encouraging tourism to a region and the need for environmental management. Declining environmental values, or limited ability to manage the natural environment for tourism, will eventually result in declining tourism numbers. A decline in tourism may threaten the social sustainability of many small regional communities. Tourism provides an

economic benefit to remote communities in proximity to tourist destinations and for those landholders who choose to protect the environment.

To protect iconic natural attractions from degradation, strategies need to be developed that focus on quality experiences with higher economic returns, rather than promoting as many visitors as possible. Tourists also need to be dispersed across regions and natural icons to maximise social and environmental benefit and limit environmental impacts. The tourism sector needs to promote sustainable tourism business practices and educate visitors to appreciate and respect the environment.

SUGGESTED RESPONSES

9.26 Develop strategies to assist local governments in implementing sustainable tourism planning through their local plans.

9.27 Develop and promote sustainable tourism practices to the Western Australian tourism industry and market.

9.28 Assist the development of sustainable tourism products that enhance the uptake of environmental accreditation.

CASE STUDY – PURNULULU NATIONAL PARK

Purnululu National Park, in the Kimberley, is expected to have increasing numbers of visitors in the future, especially in light of its recent attainment of World Heritage Status. The Park's managing agency, the Department of Environment and Conservation (DEC), looked at ways to ensure that the activities of commercial operators offering camp accommodation and activities would lead to more sustainable outcomes. DEC developed sustainability based selection criteria (environment, built and social) that tour operators could be audited against to assess their performance. These three criteria have been coupled with a standard DEC business sustainability selection criterion to assist in identifying financially sustainable operations.

The "Pressure-State-Response" framework, originally developed by the Organisation for Economic Cooperation and Development (OECD) and consistent with State of the Environment Reports, was used to define a set of sustainability indicators. In the context of low impact nature-based (sustainable) tourism assessment at Purnululu National Park, pressures relate mainly to the scale and style of proposed activities. State indicators relate to the impact of the tourism activities on people and on the biophysical environment. Response indicators relate to management or engineering systems (visitor interpretation and education, landscape, architectural and engineering design).

For each pressure, state or response a range of possible measures was identified as well as a minimum standard (expected of all successful applicants) and a best practice standard (to which operators will be expected to move towards through their licence period). Applicants were also required to provide business plans and demonstrate their ability to be financially viable as well as contributing financially to the management of the park. Operators were required to consider strategies for fulfilling the indicators within the four assessment criteria (environmental, built, social and business). Minimum standards were identified to set short-term benchmarks, and strategic objectives were provided to guide operators in the application of the sustainability principles to their operations.

Nine significant key issues were identified for consideration in the development and delivery of sustainable tourism services at Purnululu. The issues ranged from impacts on the biophysical environment to less tangible aspects of sustainable tourism, such as visitor satisfaction and ethical marketing. Some of the outcomes pertinent to improving sustainability are:

1. The sustainability criteria allowed for applicants to be innovative in meeting the Department's requirements and also developing facilities that met market needs.
2. Licence conditions were developed that were consistent with the sustainability indicators that were measurable and auditable.
3. The demonstrated measure of an operator's performance can be used when assessing renewals and also assists the Department in meeting its audit responsibilities to the Purnululu Park Council (which includes traditional owners) and the Conservation Commission of WA.
4. The criteria and its subsequent uptake have significantly improved the quality and standard of the tourism product and environmental sustainability.
5. The model has been adopted in other protected areas across the State and applied to other forms of tourism activities.

Visitors to Purnululu National Park have increased 40% over the past 6 years (Tourism WA).

9.8 WATER SUPPLY

The irrigated agriculture industry is the State's largest water user by sector (Department of Water).

Description

Western Australia's environment, economic productivity and the community's lifestyle and health all depend upon the availability of good quality fresh water. To provide these services, water needs to be extracted from waterways and groundwater aquifers. Careful management and use of water resources is necessary to ensure that ecosystems are sustained while delivering economic and social benefits.

The water supply sector aims to provide public and private users with a reliable water supply, both in quantity and quality, while safeguarding the needs of the environment. The sector is responsible for managing, protecting and allocating the use of surface water and groundwater resources in a sustainable manner for the benefit of current and future generations. This sector refers to water that is directly used for consumptive or productive purposes. While it does not extend to sewerage disposal, mine dewatering or agricultural surface drainage, it is recognised that these forms of water can be treated and reintroduced to the water supply chain for productive purposes.

As the State's population has grown so has demand for water, bringing with it the responsibility to manage this resource sustainably. The past decade has seen a continuation of reduced rainfall and increased population growth in the South West. These trends have placed unprecedented management pressures on the State's water resources. It has become clear that water managers must address the shift to a drier and warmer South West climate, rather than regard it as short-term drought. This requires the water sector to become more strategic in the way water resources are developed, protected, used and reused.

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The *State Water Plan* (Government of Western Australia, 2007c) has a vision of 'Our precious water resources are managed and developed in a sustainable manner to maintain and enhance our natural environment, cultural and spiritual values, our quality of life and the economic development of the State', and is supported by objectives that include:

- Use and recycle water wisely.
- Plan and manage water resources sustainably.
- Protect ecosystems, water quality and resources.
- Enhance the security of water for the environment and use.

Headline indicators

Indicator TS19: Per cent of water management areas (surface and groundwater combined) that have at least one management unit approaching or exceeding full allocation.

This headline indicator represents an average of how sustainably WA's surface water and groundwater resources are being managed. In 1997, 36% (or 16 out of 44) of surface water management areas had at least one unit that was at, or exceeded, its allocation limit (most up to date information available). In 2006, 32% (or 12 out of 38) of groundwater management areas had at least one unit that was approaching or had exceeded its allocation limit.

Indicator TS20: Per cent of household drinking water schemes that comply with water conservation targets.

This headline indicator summarises the water use efficiency of WA households. Sixty-four percent of the State's 116 water supply schemes met the *State Water Strategy* water use target of less than 155 kL a person per year in 2005–06. Although this target level was developed for Perth households, the target can be applied across the State as an interim measure.

Indicator TS21: Annual household water consumption per capita for Perth.

	1999–2000	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
Water consumption (kL/person)	175	187	153	150	155	154	151

This headline indicator summarises the household water use efficiency of Perth, the main area of drinking water consumption in the State. Consumption of scheme water in the Perth metropolitan area for 2005–06 was 151.4 kL per person. The target adopted in the *State Water Strategy* of less than 155 kL per person in a given year has been met since 2001–02. Annual water consumption per capita has decreased considerably in recent years, which may be attributed to intensive awareness campaigns and moderate sprinkler restrictions.

Status

USE AND REUSE OF WATER RESOURCES

An estimated 2340 gigalitres (GL) of water was used in WA in 2005 (Government of Western Australia, 2006b), representing an increase of over 300% since 1980 (Figure TS8.1) and is still increasing. The State's population growth is one of the major drivers influencing water consumption. Climate change is also beginning to affect water supplies in the South West and increase water demand. Until the 1960s most of the State's drinking water came from surface water sources (rivers and creeks). Since the mid-1980s, groundwater has become the State's major water supply source. In 2005, this represented about 70% of total water use (Figure TS8.1).

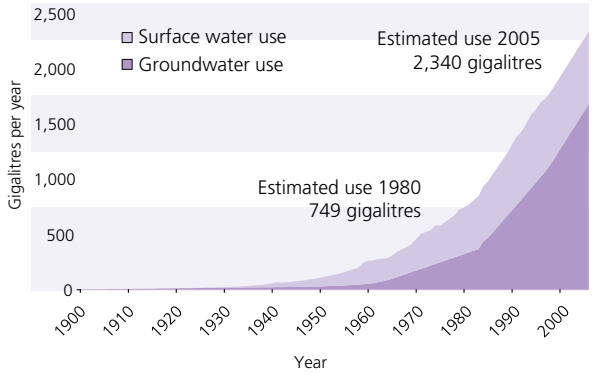


Figure TS8.1: Historical water use for Western Australia.

Courtesy of Department of Premier and Cabinet.

The Perth region has the highest water use in the State. Historic records from the Water Corporation show that water use per capita has generally increased since the 1940s until peaking in 1975 at 233 kL per person (Figure TS8.2). Consecutive dry years in the mid- to late-1970s prompted severe restrictions that dramatically reduced water consumption. Through the 1980s and 1990s, yearly water use ranged between 160–180 kL per person. This was further reduced in recent years to about 150–160 kL per person per year under the influence of the *State Water Strategy*.

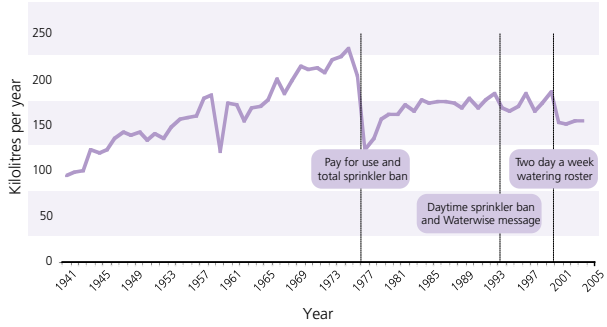


Figure TS8.2: Per capita water demand for households in the Perth Integrated Water Supply System.

Courtesy of Department of Premier and Cabinet.

About three-quarters of the State's water resources are used by the private sector, primarily for agriculture, mining, industry and services (Figure TS8.3). The largest water users are from the irrigated agriculture (40%) and mining (24%) sectors. In comparison, households use only 18%. Nearly two-thirds of total surface water extracted from waterways is used by irrigated agriculture (65%). The major users of groundwater are mining (35%) and irrigated agriculture (25%).

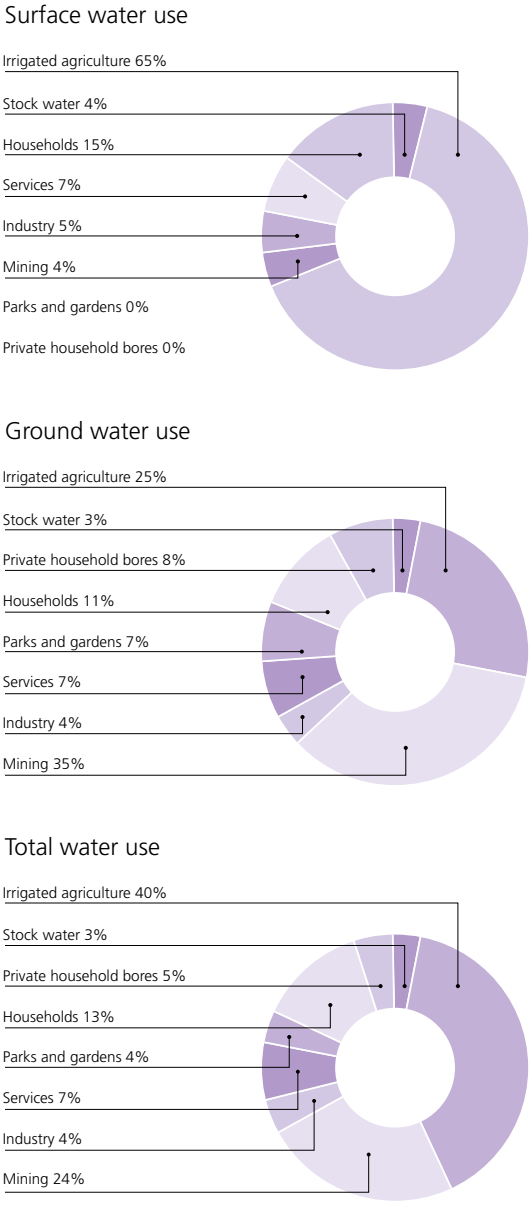


Figure TS8.3: Total water use by Western Australian user group, 1999–2000.

Data source: Department of Water.

Water is a valuable resource and efforts to recycle and reuse water (in appropriate circumstances) are being encouraged. The *State Water Strategy* set a target of 20% of treated wastewater to be recycled by 2012 (Government of Western Australia, 2003b). On average, about 12% of the State's treated wastewater is currently recycled. Regional communities currently reuse about 40% of all municipal wastewater due to limited supplies of freshwater and the high cost of alternative supplies. Only about 5% of treated wastewater in the Perth city region is being recycled (See'*Human Settlements*').

MANAGEMENT OF WATER RESOURCES

The new Department of Water is responsible for determining the sustainability of water resources. This involves determining how much water can be taken for consumptive use without significant risk to ecological systems. Ecological water requirements are determined from scientific investigations and modelling. Environmental water provisions take into account the ecological, social and economic context. This information is used to derive the sustainable yield and set the allocation limit for consumptive use. (Department of Water, 2006).

In 2006, about 30% of groundwater management areas and groundwater management units were close to full allocation or over-allocated (Table TS8.1). Of all management areas and management units, 13% and 11% respectively were over-allocated (exceeded their allocation limit and deemed to be unsustainable), (Table TS8.1). Groundwater management plans, some of which incorporate preliminary environmental water provisions, exist for 21% of heavily allocated groundwater areas (see '*Altered water regimes*').

Current information for surface water allocation is not available and presents difficulties in managing the resource sustainably. In 1997, about 36% of surface water management areas in the State had at least one management unit that was at full allocation or over-allocated. At the smaller management unit scale, one-quarter of those units were at or exceeding the estimated sustainable yield (Table TS8.2). Surface water management plans, containing detailed environmental water provisions, exist for 12% of heavily allocated surface water areas, namely the Harvey River and the Ord River (see '*Altered water regimes*').

Surface water in the South West is allocated to public and private users to various extents (Figure TS8.4). Under most pressure are surface water resources in the Harvey River Basin, which is nearing 100% of the allocation limit, and surface water resources in the Swan Coastal and Murray basins, which have reached more than 80% of sustainable yield. The use of surface waters in other parts of the South West is comparatively small and remains largely unmanaged, and there is significant additional water demand in the Collie and Denmark basins.

Table TS8.1: Allocation status for groundwater management areas and units.

Year	Per cent of groundwater management areas approaching or exceeding allocation limits	Per cent of groundwater management areas exceeding allocation limits	Per cent of groundwater management units approaching or exceeding allocation limits	Per cent of groundwater management units exceeding allocation limits
2006	32% (12/38)	13% (5/38)	31% (216/700)	11% (74/700)

Data source: Department of Water. Groundwater management areas represent a collection of units with similar characteristics. Groundwater management units represent only sedimentary resources where specific sites where allocation limits have been set.. It is difficult to determine a sustainable yield and an allocation limit for fractured rock resources (148 units), other than assigning a bulk limit to allow licences to be issued, hence these have been excluded from the table. Allocations set aside for future town water supplies have been included.

Table TS8.2: Allocation status for surface water river basins and units for 1997.

Year	Per cent of river basins with at least one management unit at or exceeding sustainable yield	Per cent of surface water management units at or exceeding sustainable yield
1997	36% (16/44)	25% (75/304)

Data source: Department of Water. Note: River basins represent the natural catchment of a major river. Surface water management units represent sites where allocation limits have been set.

Inter-regional transfer of water supplies (such as the CY O'Connor Goldfields pipeline) is important when existing water supplies become inadequate (S. Wild).

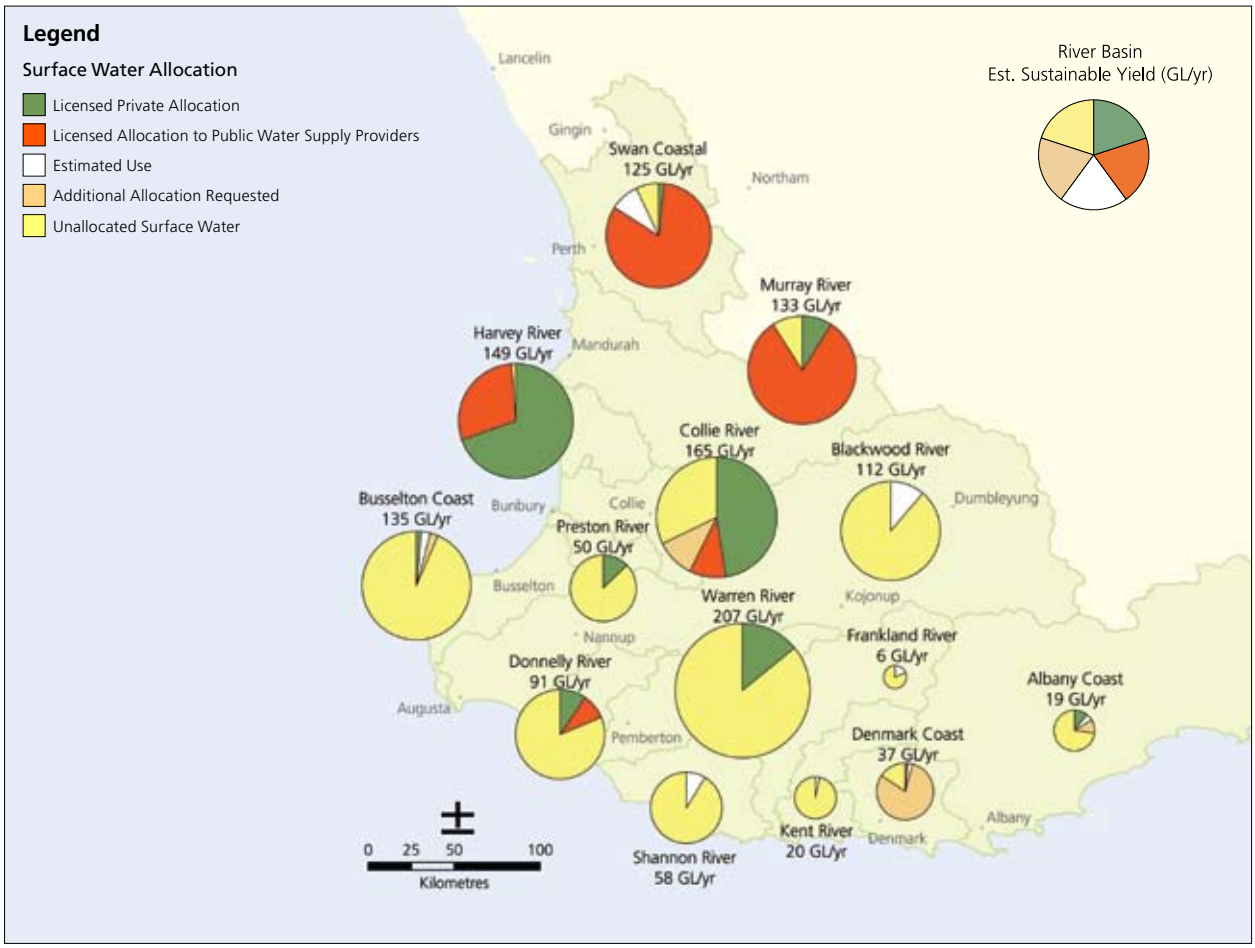


Figure TS8.4: Surface water allocation status in the South West.

Courtesy of Department of Water. Cited in McFarlane (2005). Note: The size of the circles represents the relative volume of the surface water resources. Only allocations >1% of the estimated sustainable yield displayed in the pie charts.

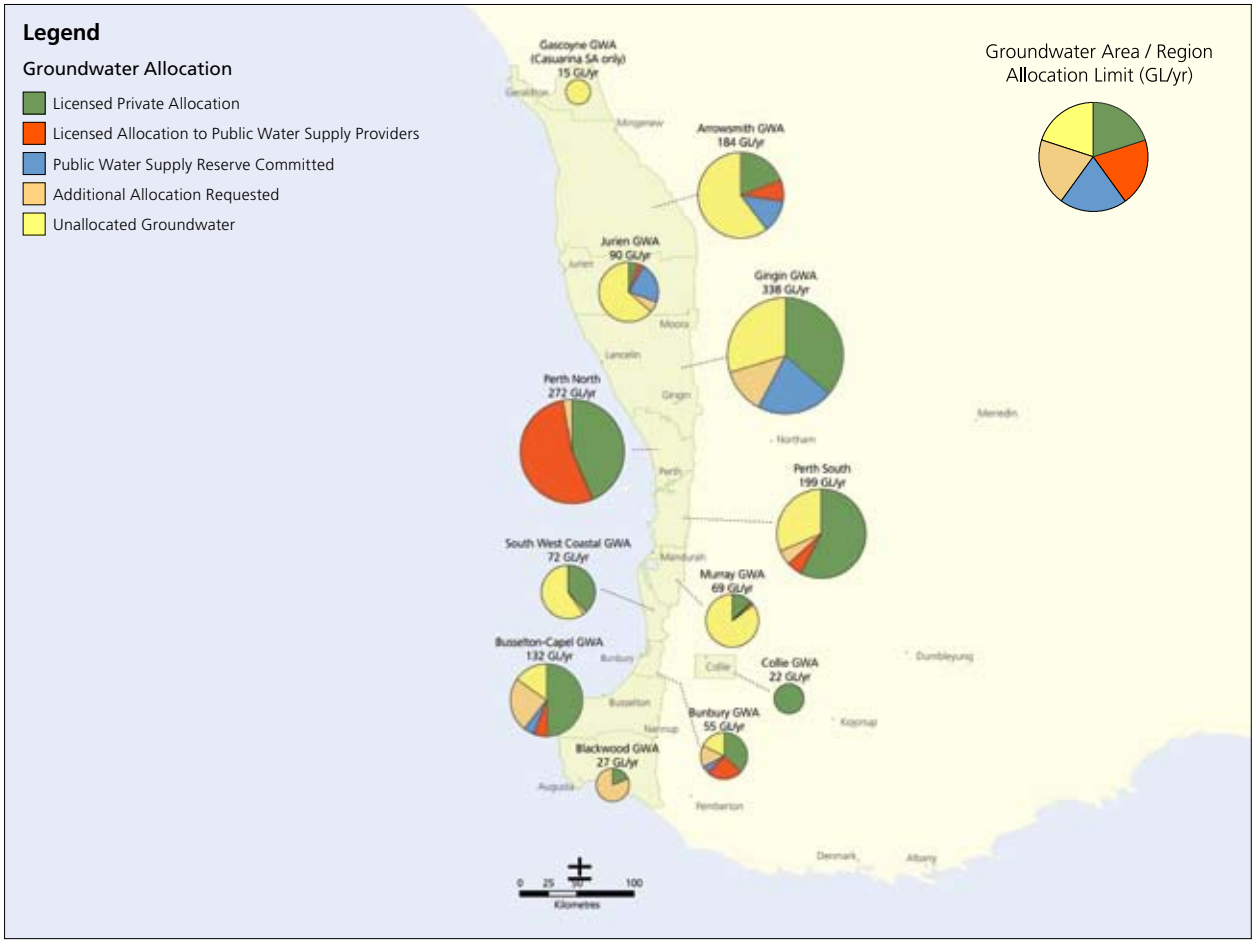


Figure TS8.5: Groundwater allocation status in the South West.

Courtesy of Department of Water. Cited in McFarlane (2005). Note: The size of the circles represents the relative volume of the groundwater resources. Only allocations >1% of the estimated sustainable yield displayed in the pie charts.

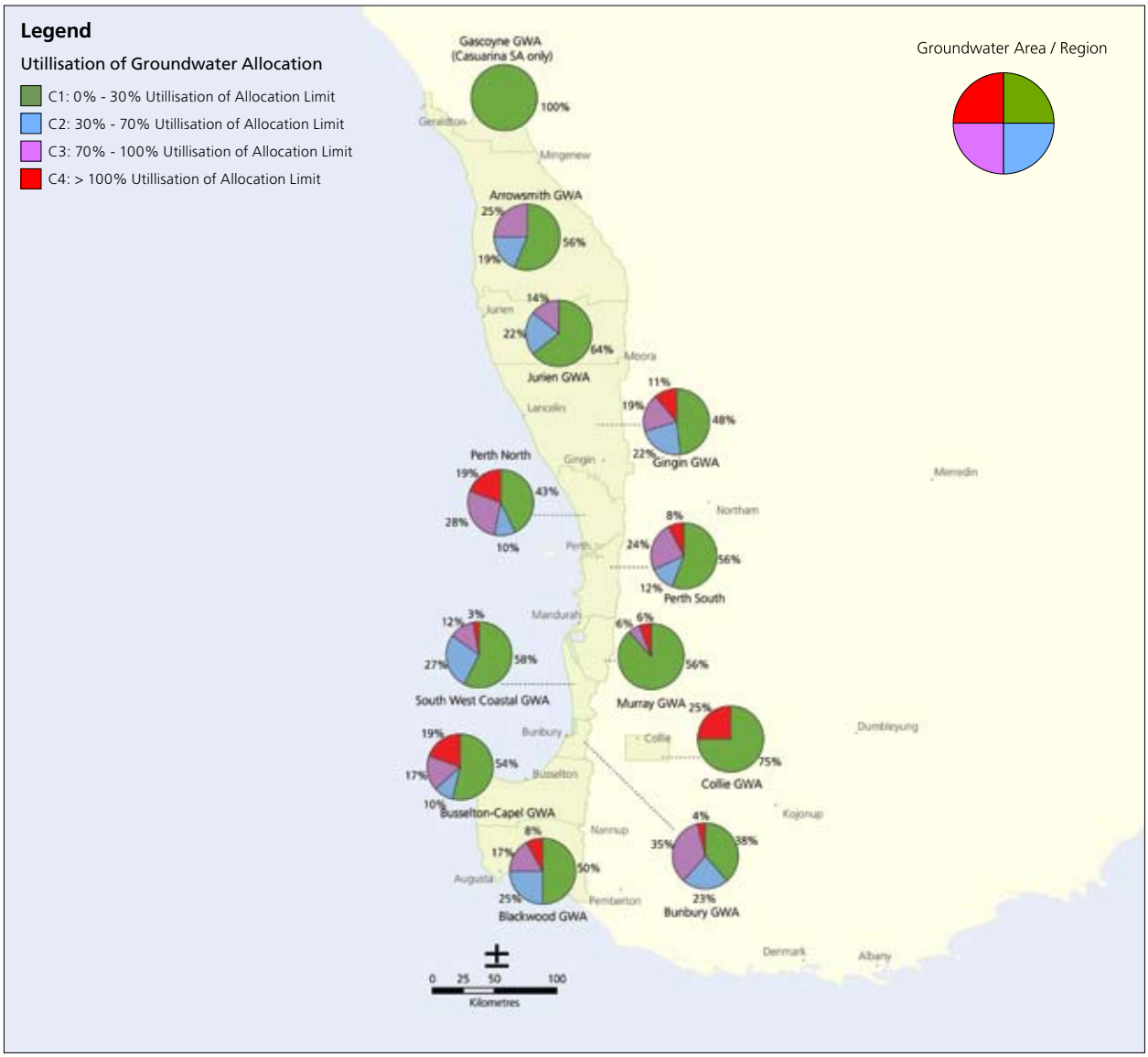


Figure TS8.6: Groundwater resource allocation categories (C1 to C4) in the Perth and Collie Basins for 2005.

Courtesy of Department of Water. Cited in McFarlane (2005).

With the exception of the Perth North Basin, groundwater in the South West is mostly allocated to private users (Figure TS8.5). Groundwater use is highest for the Perth North, Perth South, Bunbury and Busselton–Capel basins, with allocations typically exceeding 50% of sustainable yield. Groundwater in the Perth North Basin (including the Gnangara Mound) is under the most pressure, exceeding 100% sustainable yield, and environmental damage has been documented on the Gnangara and Jandakot mounds. Other groundwater basins in the South West remain largely unallocated, although there is significant additional groundwater demand in the Bunbury, Busselton–Capel and Augusta basins.

Some areas of the South West utilise a large proportion of their allocated limits (Figure TS8.6). While the majority of groundwater areas along the coast remain within allocation limits, there is evidence of over allocation in many areas. In the Gingin, Perth North, Busselton–Capel and Collie basins, up to 10% of management units are over-allocated.

PROTECTION OF POTABLE WATER RESOURCES

There are 139 water supply sources in the State that need to be protected to a high standard to provide drinking water (Government of Western Australia 2003a). Protecting water at the beginning of the supply system minimises the risk of contamination and reduces the amount and cost of treatment. Management consistent with the Australian Drinking Water Guidelines (NHMRC & ARMCANZ, 1996; NHMC & NRMMC, 2003) helps ensure that water supplies are protected. An important element of protection is the recognition of public drinking water source areas and the preparation of drinking water source protection plans (Table TS8.3). These plans focus on the characteristics of individual catchments so that suitable land use controls can be established and pollution risks and other issues addressed. As of June 2006, plans had been completed for 41% of water source areas requiring a protection plan. While the number of plans completed is gradually rising, the number of newly developed water supply sources has also increased marginally.

Table TS8.3: Per cent of drinking water source protection plans completed identifying protection measures for consumptive use of public water supplies, as at June 2006.

	2002–03	2003–04	2004–05	2005–06
Completed drinking water source protection plans	33%	35%	40%	41%

Data source: Department of Water.

CONSERVATION OF WATER

Water conservation means using water more efficiently (see '*Water use in settlements*'). The *State Water Strategy* set a yearly target level of consumption of 155 kL/person for Perth domestic scheme consumers (Government of Western Australia, 2003b). This target has been met since 2001–02 and is largely attributed to rebates on water conservation and efficiency products, awareness campaigns and sprinkler restrictions. Although the target was not designed for regional water supply schemes, their performance against the target shows that 64% of schemes achieved the target in 2005–06 (Table TS8.4).

Industry has also played a leading role in the conservation of potable water supplies by sourcing other alternative water supplies. For example, Alcoa has developed a strategic water conservation program that achieved a 20% reduction in potable water use from 2001 to 2005. Between 1996 and 2001, BP's Kwinana Refinery achieved a 25% reduction in total water use and an 82% reduction in drinking water use. Swan Brewery saved about 60 ML per year of potable water by implementing recycling initiatives and Wesfarmers CSBP had reduced its industrial use of potable water by about 440 ML per year (Chamber of Commerce and Industry, 2002).

Table TS8.4: Per cent of major water supply schemes (per region) that met the 155 kL/person/yr target over time.

		Per cent of schemes meeting target		
Water supply region	Number of schemes	2003–04	2004–05	2005–06
Perth	1	100%	100%	100%
South West	31	48%	48%	71%
Agricultural	1	100%	100%	100%
Goldfields	11	55%	27%	73%
Great Southern	16	81%	44%	81%
Mid West	42	52%	46%	56%
North West	14	57%	29%	36%
TOTAL	116	57%	44%	64 %

Data source: Water Corporation, Aqwest (Bunbury Water Board), Busselton Water Board.

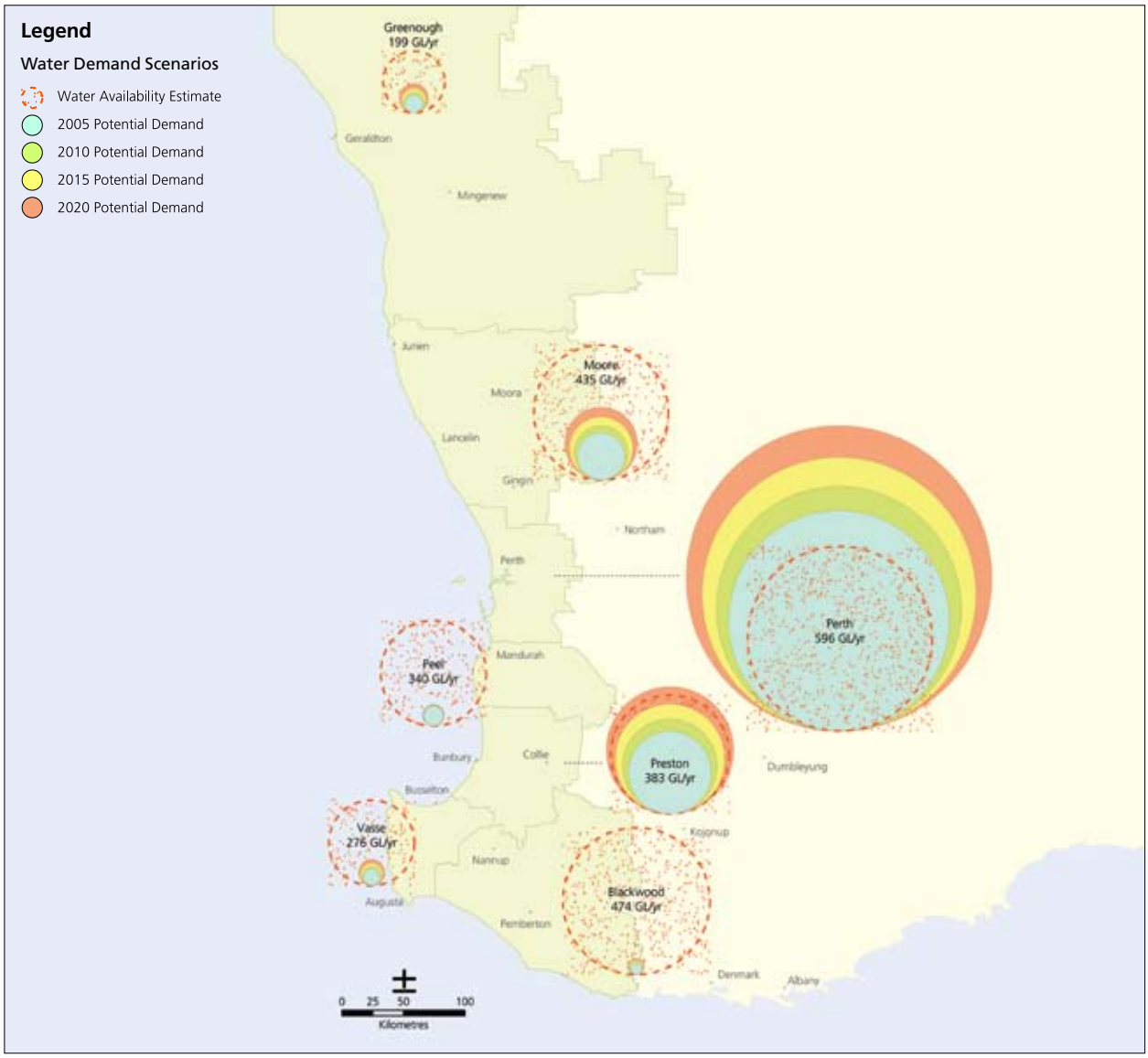


Figure TS8.7: Projected South West water demand scenarios.

Courtesy of Department of Water. Cited in McFarlane (2005).

Pressures

POPULATION AND ECONOMIC GROWTH

Water use in WA has tripled over the last 25 years, and may double again over the next 20 years. This is caused mainly by growth in private supply for irrigated agriculture and mining, and a steady growth in demand for public water supplies as the city of Perth and regional centres continue to grow (Figure TS8.1). The Perth region has already outgrown its readily available water resources (Figure TS8.7) and its continued growth will place water supplies in neighbouring regions under more pressure (e.g. Preston and Peel regions). The biggest growth is expected in the Perth–Moore regions (due to urban use and irrigation), the East Kimberley (due to Ord Stage 2 irrigated agriculture), Preston (due to urban growth and manufacturing industry) and the Goldfields (expansion of gold and nickel mining). Additional demand for water resources will place more pressure on infrastructure and the environment. In some areas water from natural sources may be insufficient to meet demand and alternative supplies may be costly, limiting economic development.

INAPPROPRIATE CATCHMENT MANAGEMENT

Inappropriate catchment management may lead to biological or chemical contamination of potable water supplies. Salinisation, eutrophication and erosion are considered significant threats to urban, industrial and agricultural water supplies. For example, more than one-third (36%) of waterways in the South West have become brackish or saline and are no longer fit to be used for drinking water (Government of Western Australia, 2000). A further 16% is of marginal quality. In terms of eutrophication, there is also evidence of some regional water supplies becoming impacted by nitrate plumes originating from horticultural practices (Water Corporation, unpublished). In terms of erosion, Lake Argyle (the State's largest water supply dam on the Ord River) has been heavily impacted by sedimentation, with more than 10% of the dam's capacity being filled by eroded sediment from the catchment over the last three decades (Government of Western Australia, 1998a).

CLIMATE CHANGE

A projected rise in temperature across the State of several degrees Centigrade is likely in this century in line with global projections. This is expected to be accompanied by further significant decrease in rainfall over the South West. The actual outcomes are dependent on global action on limiting greenhouse gas emissions over coming decades and these cannot be predicted. However, it is expected that climate change will place water supplies under significant pressure (Indian Ocean Climate Initiative, 2005b). The South West has already experienced a 10–20% decline in rainfall over the last 30 years, caused by a sudden climate shift in the mid-1970s (Indian Ocean Climate Initiative, 2002 & 2005a). This has subsequently reduced surface runoff of water into dams by an average of 50% (Figure TS8.8; Government of Western Australia, 2006b) and reduced water infiltration to groundwater aquifers. Future changes to climate will have significant implications for the determination of sustainable yields for surface and groundwater resources, the allocation of water resources to consumers, and infrastructure development.

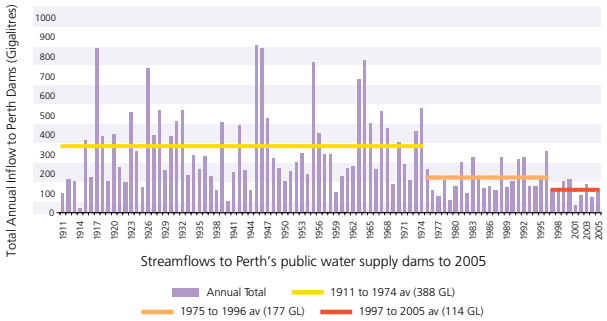


Figure TS8.8: Streamflows to Perth's public water supply dams since 1911.

Courtesy of Department of Premier and Cabinet.

INSTITUTIONAL ARRANGEMENTS

In 1996, Western Australian government institutions for water services and water resource management were separated in line with national water reform policy. While this may have assisted in removing conflicts of interest between water service providers and resource managers, and improved the efficiency of water service provision, it did not benefit water resource management to the same degree. Previously, WA was a national leader in water resource assessment and management, but these institutional changes diluted and weakened the State Government's water resource management expertise. Part of the reason for the decline was a 33% reduction in funding over the period 1998–2003 for core water resource management operations which include water resource investigation, assessment, planning, licensing and regulation. There is also a severe deficiency of information for private water use (i.e. mining, industry, agriculture and household bore use). A review of State water resource management in 2003 (Auditor General for Western Australia, 2003) identified significant deficiencies in most water resource management functions and some major challenges now facing water management. A new Department of Water has been formed to address these deficiencies.

Current responses

State Water Strategy and *State Water Plan:* The *State Water Strategy* (Government of Western Australia 2003a) was released largely in response to drought conditions. It outlined means of improving water use efficiency, recycling, research and innovation and community understanding of the real value of water. A *State Water Plan* (Government of Western Australia, 2007c) was recently released to build on the strategy and outlines the policy direction for the sustainable management of water resources, including the development of regional water plans, strategic water issue plans and statutory water management plans.

Water reform: As part of the *State Water Strategy*, the State Government undertook a review of irrigation activities in WA (Government of Western Australia, 2005). The review made a series of wide ranging recommendations with implications for the way water resources were planned, allocated, managed and monitored. The government also signed the National Water Initiative in 2006, which required further water sector reform. The *Blueprint for Water Reform in WA* (Government of Western Australia, 2006) provides recommendations for development of statutory water management plans, water access entitlements, metering, water resource management charges, water use efficiency, integration of land and water planning. A Government response document (Government of Western Australia, 2007a) outlines a number of actions to implement water reform.

National Water Initiative: In April 2006 WA became party to this Commonwealth program that recognises the imperative to ensure the health of groundwater and river systems, ensure environmentally sustainable levels of extraction, increase the productivity and efficiency of water use and secure water supply services. It builds on the 1994 National Water Initiative (Council of Australian Governments, 1994) where greater attention was made to ensure adequate environmental water provisions are set when sustainable water allocation limits are assessed. Western Australia has since developed a draft implementation plan (Government of Western Australia, 2007b). The plan will be underpinned by reform of water legislation and will focus on water access entitlements, the planning process for setting allocations, water entitlement trading, metering and water pricing.

Water use efficiency: Water use efficiency measures for public water supplies were developed through the *Perth's Water Future Report* (Stokes et al., 1995) and then enhanced through the *State Water Strategy*. Highly successful components were sprinkler restrictions and the suite of Waterwise programs for householders and industry, including the State Government's rebate scheme for efficient household appliances. A total of 5.5 GL per year had been saved through the Waterwise program since 2003 (Kobelke, 2007). It has been extended on-farm with an education and training program for irrigators and farmers, coordinated by the Department of Agriculture. The program has also been extended to plumbers, garden centres, land developers, garden irrigators and schools. There has not been an equivalent education program to improve the water efficiency of private users. CSIRO is undertaking several research programs including the development of models that better utilise technology for water allocation, storage, treatment and reuse in relation to sustainability principles.

Water reuse: Increasingly, wastewater, stormwater and rainwater are being seen as recyclable water alternatives, rather than as disposal problems. Only about 5% of treated wastewater in the Perth city region is being recycled. To increase this figure the Water Corporation is focussing on four key categories of water recycling schemes for Perth: reuse, public open space irrigation, agricultural irrigation and scheme water augmentation. Comparatively, wastewater reuse in regional settlements is much greater.

Water quality protection: Protecting the quality of water resources in public drinking water source areas is important. There are currently some 80 public drinking water sources in the State that lack a protection plan. As the plans can affect what landowners can do on their land, considerable public consultation is required. Once proclaimed, they are used in planning decisions at the State and local government levels.

Desalinisation: the State's first desalinisation plant to be used as a major public water supply was officially opened in April 2007. It produces 45 GL/year at full production, which is currently ~17% of the annual demand from the Integrated Water Supply Scheme; including the Goldfields and agricultural region serviced by the Water Corporation. To reduce environmental impacts, electricity for the plant has been sourced from the Emu Downs Wind Farm.

Managed aquifer recharge: is the infiltration or injection of water into an aquifer for immediate or deferred use. There is a number of research projects currently underway using treated wastewater. In January 2007 the Water Corporation announced plans for a $38 million four-year groundwater replenishment trial in the Leederville aquifer. The Water Corporation would undertake this trial with the intention of implementing a full scale system to deliver 27 GL/y of public drinking water by 2015.

Implications

The State's growing population and its mining, industrial and agricultural sectors are dependent on adequate water supplies. While sustainable management and use of the State's water resources is essential, it is becoming increasingly difficult to achieve alongside optimal economic growth. As the community seeks to become more involved in water resources management, it will also become essential that quality information on the State's water resources is readily available. The health of our inland waters depends on adequate water flows and groundwater levels. The building of dams and bores to abstract water can directly impact and erode environmental and social values. It will be critical to determine environmental water provisions for all water resources to prevent this from happening. Water licence holders are seeking to enhance the value of water entitlements through greater security of water allocations (based on a share of the available water) and increased ability to trade them. Adopting more secure water entitlements needs to be balanced with the potential for increased risks to the environment and other users.

New sources of water are needed to meet demand across the State. The key challenge facing water planners is the ongoing impact of changing climatic conditions that may affect the amount of water available from various source options. For example, in response to consecutive dry years in the late 1990s, the State Government accelerated development of its water supplies, including recent construction of Stirling Dam on the Harvey River and the Kwinana seawater desalinisation plant. Other potential water source options including extracting water from the South West Yarragadee groundwater aquifer and transporting water from the Kimberley have been investigated. Without reliable sources of water, consumers face uncertain water supplies.

SUGGESTED RESPONSES

9.29 Develop and implement regional water strategies and statutory water management plans for priority areas.

9.30 Review water pricing structures to better reflect the true costs of water resource management. These costs should be passed on to all public and private consumers responsible for current consumption levels.

9.31 Promote water recycling and efficiency measures to allow for more to be done with the same volume of water, matching water quality to water use, and rationalisation of source development impacts on water dependent ecosystems.

9.32 Develop an appropriate and effective balance of water source options to maintain security of supply, while minimising environmental impacts in a changing climate.

CASE STUDY – MANAGING THE GROUNDWATER RESOURCES OF THE LOWER GASCOYNE RIVER

Carnarvon (population approximately 10 000) stands at the mouth of the Gascoyne River. The town's population and industry are totally dependent on river flow events for water supply. The river's unique hydrology is such that river flow almost instantly recharges groundwater. The groundwater supports a wide range of crops including bananas, citrus fruit, stone fruit and many different vegetables. It also supports native riparian vegetation, mainly river red gums and coolabah trees, along the lower Gascoyne River.

Water management areas (Basin A) in the lower Gascoyne River support mostly horticulture. Water management areas further upstream (basins B to L) support the Water Corporation's well field, which supplies scheme water to households and industries in the town. When the Gascoyne River stops flowing and river recharge to groundwater ceases, groundwater in Basin A can still be pumped for irrigation. However, excessive pumping may produce prolonged periods of drawdown that can cause salt water to move into freshwater areas, making the water unsuitable for irrigation, human consumption and riparian vegetation.

Following an 18-month period of no river flow in 1994, maximum groundwater drawdown levels ranged from 3.25 m to 10.30 m below the ground surface. Trees remained healthy during this time. However, excessive exposure to saline groundwater could have lead to death of fringing vegetation along the river. In 2002, the former Water and Rivers Commission (now Department of Water) worked with the Carnarvon community to produce a strategy that ensured optimised water use, provided drought security and enabled key environmental goals to be met. Several agreed management actions were:

- When groundwater salinity reaches 1000 mg/L, pumping ceases in agricultural bores. Farmers have a choice of ceasing irrigation or purchasing water from the scheme supply in basins B to L. This continues until the next river flow when the groundwater reserves are replenished.
- Farmers are encouraged to access the scheme water in basins B to L, which will allow the horticultural industry to expand in Basin A.
- Groundwater abstraction is managed to protect the environment so that maximum drawdown levels experienced in 1994 are not exceeded.
- As farmers begin to access more groundwater in the future, historical maximum drawdowns may be exceeded. If this occurs, the rate of fall will not exceed 5 mm a day to allow the river red gums to adapt to the new water level regimes.

It is expected that these management actions will ensure a greater reliability of water supply during times of no river flow and prolonged drought, and protect the native vegetation along the lower Gascoyne River. Groundwater use in this area has proven to be very efficient. Carnarvon's productivity to usage ratio is one of the highest in the State (around $4000/ML) compared to other areas (around $2000/ML).

Gascoyne River (S. Wild).

9.9 WOOD PRODUCTION

Harvest of jarrah (G.Stoneman).

Description

Wood is derived from the harvesting of trees from native forest, woodlands and plantations. Approximately 25.7 million hectares of Western Australian land is classified as forest, representing about 10% of the total land area of the State (National Forest Inventory, 2003). Forests provide a range of values and services such as ecosystem services, biodiversity conservation and social and economic values. Wood production in this report is defined as the conservation, protection, management or use of forests from which wood is harvested. Harvested wood and wood products are sold on domestic and international markets, although WA is a net importer of wood products by value. Wood that cannot be sawn for solid wood products (construction timber, furniture) may be used for reconstituted fibre products (particle board, paper), industrial firewood (charcoal for silicon manufacture), biomass for energy generation or domestic firewood.

State Government figures for 2005–06 show that the total volume of native hardwood harvested was 0.54 million cubic metres, valued at $39.5 million (Forest Products Commission, 2006). This volume represents an increase over 2004–05 of 6.4% while remaining within the limits imposed by the *Forest Management Plan 2004–2013* (Conservation Commission of Western Australia, 2004), which incorporated the Government's *Protecting Our Old-Growth Forests Policy*.

The plantation industry has experienced considerable growth over the past decade, particularly with hardwood species planted in higher rainfall areas of the South West. In 2006, WA had the second largest plantation area of all Australian states (396 000 ha or 21%), comprising 27% softwood species and 71% hardwood species (Parsons & Gavran, 2007). Softwood species consist mostly of Pinus species (otherwise known as pine trees) and hardwood species consist mostly of Eucalyptus species (mainly blue gums). In 2005 private landholders and businesses own 72% of plantations, while government owns 20% and joint cooperative ownership represents 8% (Parsons et.al, 2006). State Government plantations produced 0.87 million cubic metres, principally of softwoods, in 2005–06 valued at $47.7 million (Forest Products Commission, 2006). Production figures from private plantations are not readily available, but in 2002 about 2.62 million cubic metres of timber was produced (Ferguson et al., 2002).

Objectives

The *State Sustainability Strategy* outlines a vision for our natural resources by ensuring that they are '… conserved, protected, managed and used sustainably for the common good' (Government of Western Australia, 2003a, p. 108). The State's *Forest Management Plan 2004–2013* outlines specific objectives based on the Montreal Process Criteria for sustainable forest management (Conservation Commission of Western Australia, 2004). Most objectives have been derived using this plan:

- Ensure that forest resources are harvested within sustainable yield limits.
- Maintain, and where applicable, enhance the productive capacity and vitality of forest resources subject to wood production.
- Conserve biodiversity and landscapes in native forests subject to wood production.
- Protect forest resources from pressures that may damage productivity and ecosystem health.
- Prioritise plantation developments that deliver environmental, social and economic benefits.

Headline indicators

Indicator TS22: Per cent of South West native forest available for wood production.

This indicator reflects the relative value the community places on wood production in the State's South West native forests. About 55% (1 041 830 ha) of South West native forests vested in the Conservation Commission is in formal conservation reserves (current and proposed) or informal reserves that are established under the *Forest Management Plan 2004–2013*. In 2004, 45% of native forest vested in the Conservation Commission was available for wood production (848 380 ha). Changes over time reflect the value that the State Government and the community place on native forests. The data for this indicator are limited to the area covered by the *Forest Management Plan* from Lancelin to Denmark.

Indicator TS23: Average per cent of jarrah and karri sawlogs harvested compared to sustainable yield.

Financial year	2001–02	2002–03	2003–04	2004–05	2005–06
Annual average per cent harvest	71%	50%	60%	98%	102%

Jarrah and karri are the two major timber species harvested in native forests in WA. This indicator represents an average of the volume of jarrah and karri sawlogs harvested compared to their respective sustainable yield levels. This reflects the compliance of the wood production sector in relation to established harvest limits. Figures exceeding 100% may indicate unsustainable levels of harvesting. However, because levels of harvest can be averaged over the 10-year life of the *Forest Management Plan 2004–2013*, small overcuts can be balanced by undercuts over this period. The lower percentages between 2001 and 2004 reflect the government negotiating lower harvest levels than provided for in the *Forest Management Plan 1994–2003* (Conservation Commission 2004) following introduction of its *Protecting Our Old-Growth Forests Policy* (Australian Labor Party Western Australian Branch, 2001) and do not represent undercutting.

Status

USE OF WOOD RESOURCES

The principle of sustainability is contained in the relevant Acts relevant to the Forest Products Commission (the State Government's wood trading enterprise) and Department of Environment and Conservation (the State Government's forest management agency). Sustainability is also an important management objective of private enterprises in the wood production sector.

Since 1970, the area of native forest in the South West available for timber production has decreased by about 50% (Figure TS9.1). This decrease represents a gradual shift in State Government policy brought about by the increasing value the community has placed on native forests for uses other than timber production, which has increased the amount of native forest placed in reserves where wood production is not a permitted use.

The level of harvest in native forests is determined by a calculated sustainable yield. Sustainable yield is the quantity of timber that can be harvested from the area of forest available for timber harvesting each year, which can be continued indefinitely with minimal long-term environmental impact. The timber resource in native forest available for timber harvesting is measured using inventory plots to determine the quantity of timber available and the rate at which it is growing.

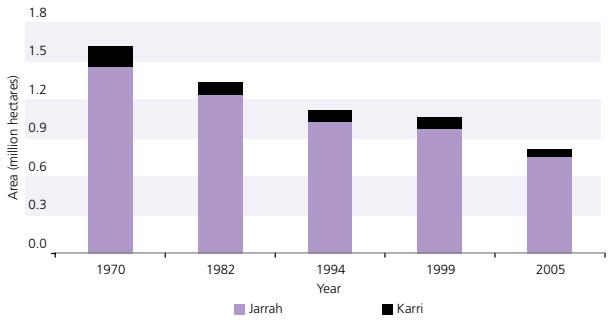


Figure TS9.1: Trends in the area of jarrah and karri available for timber harvesting, 1970–2005.

Data source: Department of Conservation and Land Management.

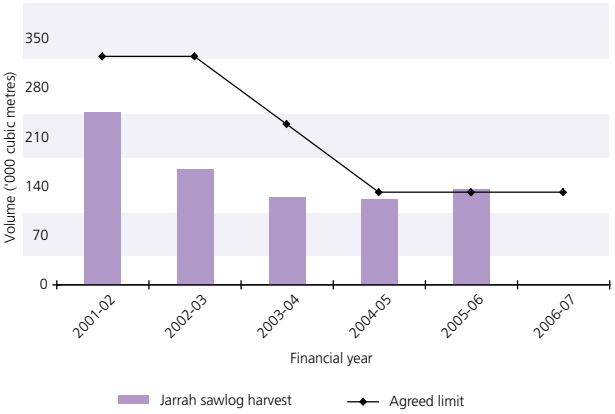


Figure TS9.2: Jarrah sawlog timber harvested relative to agreed limits.

Data source: Forest Products Commission. Note: 2003–04 limits represent a transition from previous limits established under regional forest agreements to current limits established under the *Forest Management Plan 2004–2013*.

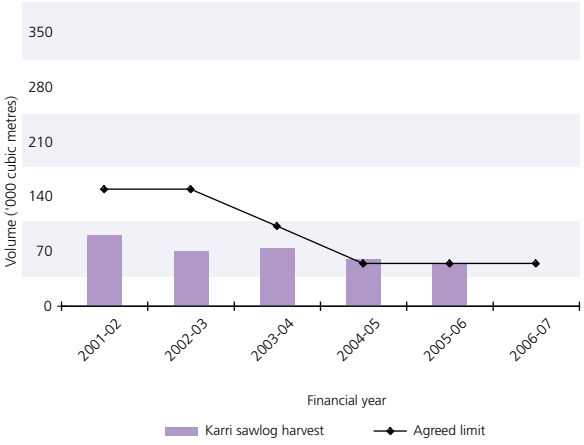


Figure TS9.3: Karri sawlog timber harvested relative to agreed limits.

Data source: Forest Products Commission. Note: 2003–04 limits represent a transition from previous limits established under regional forest agreements to current limits established under the *Forest Management Plan 2004–2013*.

A review of the sustainable yield limits was undertaken for the development of the *Forest Management Plan 2004–2013*, which began on 1 January 2004. This resulted in a reduction of the sustainable yield limit for sawlogs because of large increases in conservation reserves and more conservative forest management practices. Sustainable yields for jarrah and karri sawlogs were lowered, representing a 63% and 64% reduction from pre-2004 levels established by Regional Forest Agreements (Figures TS9.2 & TS9.3).

In 2005–06, actual harvested volumes of jarrah and karri sawlogs were 104% and 98% of sustainable yield levels respectively (Figures TS9.2 & TS9.3). Although the jarrah harvest exceeded the sustainable yield levels in 2005–06, the *Forest Management Plan* allows for the annual harvested volume to be averaged over three years and then compared to the sustainable yield limit. Marri sawlogs remain largely unused, with actual harvest levels at about 8% of the sustainable yield limit for bole logs in 2005–06.

Progress has been made with value-adding (improving the end uses of timber) in the past 15 years, with 60% to 70% of the sawmill output of native forest timbers now being used for flooring, joinery and furniture (Government of Western Australia & Forest Products Commission Western Australia, 2004). There is also pressure on sawmills to improve milling yields from higher value and scarce sawlogs and to effectively use logs that could not be previously used for sawmilling. Further improvements in native timber utilisation also need to occur with machine harvesting.

Sandalwood is a small tree that grows in the WA Southern Rangelands. This parasitic plant uses Acacia and other plants as a host. It is harvested for its wood and aromatic oils. In recent years sandalwood harvesting has been below the allowable harvest, and is current (Figure TS9.4). It is worth noting that allowable yield limits are used, as sustainable yields limits for sandalwood have not yet been determined.

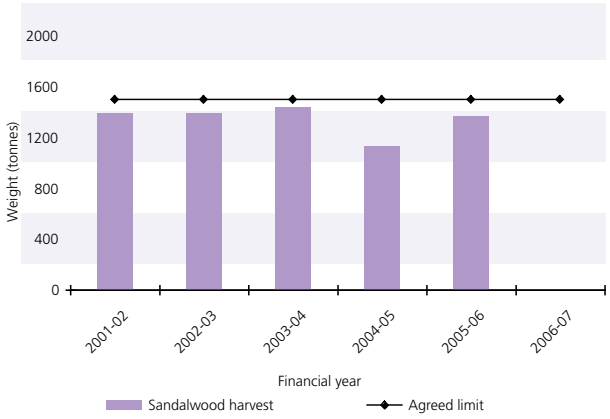


Figure TS9.4: Harvest of sandalwood from Crown land compared to allowable yield limits.

Data source: Forest Products Commission.

The plantation component of the timber industry has an increasingly important role to play in WA. Plantations have the potential to generate wood products to compensate for reduced harvesting from native forests, although recent growth in the area of plantations is mainly aimed at producing pulpwood rather than sawlogs. Plantations are strategically important resources, acting as sinks for greenhouse gases (storing carbon) and helping to remedy salinisation, erosion and other land degradation issues. If planted with appropriate species, plantations can help restore biodiversity values. Some plantation species also show potential for future bio-energy production.

In 2006, WA had the second largest plantation area of all Australian states of 396 000 ha (21%), comprising 27% softwood species and 71% hardwood species (Figure TS9.5) (Parsons & Gavran, 2007). In terms of annual volume harvested, output from plantations is much larger than from native forests, and is likely to continue to increase over the coming decades. Compared to the combined jarrah/karri harvest from native forests of about 0.5 million cubic metres:

- the State's pine plantations supply 1 million cubic metres of logs for wood panel manufacture, sawn timber, pulpwood, fencing materials, and export; and
- Eucalyptus globulus (blue gum) plantations currently supply over 1 million cubic metres of pulpwood logs for woodchips, which may rise to a predicted 4 or 5 million cubic metres by 2013 (Government of Western Australia & Forest Products Commission Western Australia, 2004).

The majority of plantation wood is used for relatively low value products, with about 27% of current production being sawlog material (Ferguson et al., 2002). This proportion will reduce significantly as production of hardwood pulpwood increases. The potential exists for plantation timbers to be used for high-value end uses as alternatives to native forest timbers. However, this is dependent on changing plantation management intent and techniques that may affect profitability.

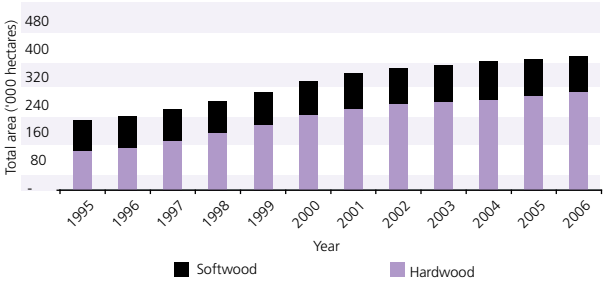


Figure TS9.5: Total area of Western Australian plantations, 1995–2006.

Data source: National Plantation Inventory (2000), Parsons and Gavran (2007).

PROTECTION OF WOOD RESOURCES

Protection of forest resources is aimed at controlling and reducing the risks such as fire, pests and disease that may impact wood production. Protection of soil, water and vegetation also plays an important role in biodiversity conservation, the provision of ecosystem services and protection of catchment water supplies. Much of the information about native forest condition and relevant threats can be found elsewhere in this report (see '*Loss or degradation of native vegetation*').

Protection of forest and its associated values also depends upon successful regeneration following harvesting. In 2005, some 6220 ha of forest were harvested for regeneration and 4920 ha were treated to achieve regeneration. In 2005, some 460 ha of karri forest was clear felled or partially cut, and 1070 ha were thinned. Regeneration was completed for 740 ha of karri forest. Improvements in sandalwood regeneration have been made in recent years by mimicking the natural seed distribution behaviour of woylies. However, feral goat grazing is likely to be limiting sandalwood regrowth in some rangeland areas.

MANAGEMENT OF WOOD RESOURCES

The *Forest Management Plan 2004–2013* has used the Montreal Criteria to provide a framework for setting the objectives and actions for the sustainable management of native forests in the South West (Conservation Commission of Western Australia, 2004). The Forest Products Commission has been operating with environmental management system accreditation (ISO 14001) for five years, and the Department of Environment and Conservation will be developing an environmental management system. Private companies involved with native forest harvesting must also follow a contractors timber harvesting manual, which outlines required practice.

Forest owners or managers can apply for certification against a sustainability standard, such as the Australian Forestry Standard or the Forest Stewardship Council. Currently two WA businesses has been certified under the Australian Forestry Standard, and six businesses are operating in WA with certification under the Forest Stewardship Council. Private plantations are usually required to develop a management plan. These plans are framed to address the principles, goals and guidelines documented in the *Code of Practice for Timber Plantations* in WA.

CONSERVATION OF FORESTS

About 15% of native forest statewide (3.8 million ha) is within formal conservation reserves, with another 37% (9.4 million ha) occurring on other Crown land (National Forest Inventory, 2003).

In the South West area covered by the *Forest Management Plan 2004–2013*, about 30% of the original extent of native forests (pre-European settlement) is within the State's conservation reserve system (Table TS9.1).

Concerns about the sustainable management and conservation of South West native forests were reflected in the State Government's *Protecting Our Old-Growth Forests Policy* (Australian Labor Party Western Australian Branch, 2001). The *Forest Management Plan 2004–2013* incorporated the relevant components of the policy, which resulted in considerable conversion of State forest to national parks and nature reserves (about 700 000 ha). Many of the new reserves were formally established through three reserve Acts that passed through Parliament in 2004.

Table TS9.1: Representation of native forest ecosystems in conservation reserves covered by the *Forest Management Plan 2004–2013*.

Forest type	Area of native forest types (ha) covered by the forest management plan (Per cent extent of forest type compared to pre-European settlement)	Per cent representation in conservation reserves compared to pre-European settlement
Jarrah	1 806 650 (65%)	25%
Karri	190 160 (82%)	43%
Wandoo	218 680 (42%)	19%
Total (including other forest ecosystems)	2 624 060 (63%)	30%

Data source: Conservation Commission of Western Australia (2004).

Pressures

ECONOMIC CONDITIONS

The significant reduction in the size of the native forest harvest and the increased complexity of management has created challenges to the ongoing economic viability of this component of the timber industry and thus its capacity to achieve best practice environmental management. While demand for plantation timber is expected to grow, market changes can threaten the industry's economic viability. Diversification of wood products is likely to be an increasingly important strategy to deal with this. The rapid growth of the plantation industry in recent years owes much to a booming house construction industry, improved tax incentives for investment and declining terms of trade for agricultural commodities. A reversal of these conditions could threaten future plantation expansion.

WEEDS, PESTS AND DISEASES

A major threat to the South West jarrah forests is the plant pathogen, *Phytophthora cinnamomi*, which causes the disease known as Phytophthora dieback. *P. cinnamomi* will affect the health, productivity and regeneration of native forest and plantations, thereby reducing productive capacity and ecosystem health. Hygiene management plans are prepared and implemented to minimise the risk of spreading the pathogen. Despite this, modelling by the Department of Environment and Conservation estimates that the percentage of the forest area infested by the pathogen will increase from 14% in 2001 to 34% by 2061. There are also a number of chronic or periodic crown dieback syndromes that affect tree species such as tuart, wandoo and flooded gum. Species of *Armillaria* are also known to cause root rot and subsequent losses of timber in native forest and plantations. A variety of insect pests including beetles, weevils, moths and locusts, can cause damage to plantations when infestations occur. Many types of weeds also have the potential to affect the growth of young plantations and affect forest values in surrounding lands. Control of wildlings (wild plant species) originating from plantations is imperative to prevent uncontrolled spread to nearby native forests. Some introduced animals (e.g. foxes and cats) can affect forest regeneration by preying on native animals that have an important role in seed dispersal or pollination and others (e.g. goats, rabbits and pigs) can affect regeneration through soil disturbance and overgrazing of young plants.

FIRE

Fire is necessary for the regeneration of native vegetation and release of nutrients for plant growth. Some fires may have significant impacts on forest ecosystems, depending on their intensity, frequency and the burn season. Prescribed burning of native forests has been employed as a management activity over the past 80 years to reduce fire fuel loads, minimise the risk of high intensity fires and prevent the loss of lives and property. However, uncontrolled fires, unmanaged burning practices or inappropriate fire regimes can be detrimental to native forests and plantations (Conservation Commission of Western Australia, 2004).

CLIMATE CHANGE

A projected rise in temperature across the State of several degrees Centigrade is likely in this century in line with global projections. This is expected to be accompanied by a further significant decrease in rainfall across the South West. The actual outcomes are dependent on global action on limiting greenhouse gas emissions over coming decades and these cannot be predicted (Indian Ocean Climate Initiative, 2005b). In the medium term, some models predict small to moderate increases in forest growth where rainfall remains stable, due to increased temperatures and carbon dioxide levels. Under drier conditions, forest productivity may be detrimentally impacted, including increased fire and disease risks (Allen Consulting Group, 2005).

COMMUNITY ACCEPTANCE OF PLANTATION INDUSTRY

While the plantation industry offers a sustainable approach to wood production in WA, there remains a negative perception of the plantation industry by some in the community. These concerns include the loss of prime agricultural land to plantations, increased fire risk and water consumption, increased nutrient and chemical runoff, and questions of ongoing social and economic support for the local community.

COMPETITION WITH OTHER NATURAL RESOURCE SECTORS

Mining for minerals such as bauxite and coal results in the clearing of some forest areas. While mining is generally a short-term activity (less than five years), it takes considerably longer for the forest to be rehabilitated to a productive state. Water supply catchments in the South West are generally located within native forest. However, during droughts there is increased water uptake by plants and reduced runoff into

dams. This is compounded by a growing demand for water from an expanding population and further pressure for increased environmental water provisions. Increasing water demand and a drying climate has increased the pressure for thinning and more frequent burning of forested catchments in order to deliver increased streamflow or groundwater recharge (e.g. forest thinning in the Wungong catchment and Gnangara Mound).

LACK OF STRATEGIC DIRECTION FOR THE PLANTATIONS INDUSTRY

At the national level, the *National Forest Policy* statement (Commonwealth of Australia, 1995) and *Plantations for Australia: The 2020 Vision* provide strong direction for plantation development. However, while the State Government has promoted a vision of a dynamic and profitable plantation industry, it is perceived there has been inadequate strategic direction for the industry. Consequently, there is a lack of consistency between local governments in assessing applications for plantation developments. Lengthy delays in plantation approvals, the imposition of significant legal and other costs and the setting of unreasonable development conditions have all affected the commercial viability of plantation developments and limited the potential growth of the industry. Contradictory policies at the national, State and local government levels reinforce this lack of a consistent strategic direction. For example, strategic plans being prepared by regional natural resource management groups recognise the strong role that plantations can play in remedying land and water quality problems, but these planning processes have weak input from plantation industries. Timber industry development plans may go some way to addressing these issues.

Current responses

Legislation: Statutory changes were made in 2000 to allow for the creation of the Forest Products Commission Western Australia and the Conservation Commission of Western Australia. The changes were required to remove potential conflicts of interest for the Department of Environment and Conservation arising from its role as an agency responsible for both conservation and timber harvesting. The amended *Conservation and Land Management Act 1984* established the Conservation Commission of Western Australia and defined the principles of ecologically sustainable forest management that are also outlined in the *Forest Products Act 2000*.

Protecting our Old-Growth Forests Policy: The State Government implemented this policy in February 2001. It ended logging of old-growth forests in the South West of the State and made progress towards ensuring sustainable forest management.

Forest Management Plan 2004–2013: This plan was developed by the Conservation Commission of Western Australia to provide for sustainable management of South West native forests. The plan requires that Forest Products Commission and Department of Environment and Conservation operate in accordance with the management plan. The Conservation Commission also undertakes audits of the performance of both agencies against the plan.

Private forestry development committees: Five regional committees comprised of community and industry representatives are working closely with government agencies, timber industry stakeholders, small business and local farmers in developing regional plantation and farm forestry strategies.

Action plan for tree farming: This State Government program coordinates plantation production by matching tree species with soil and rainfall conditions and proximity to commercial markets. Sustainable benefits include a capacity to deliver an ongoing source of wood and wood products, combating environmental problems such as saline and waterlogged land, and providing an additional income stream for farmers.

Timber industry development plans: The Forest Products Commission has prepared several tree farming and industry development plans related to specific target regions for industry and stakeholder consultation. The plans are designed to match specific tree species to suitable soils, rainfall, infrastructure and other issues to provide a viable industry focus for each region.

Accreditation programs: The Australian Forestry Standard has been developed with support from State and Commonwealth governments in collaboration with forest organisations and other stakeholders. It provides a basis for voluntary, independent third-party certification against auditable, sustainable forest management criteria and can be used in conjunction with an environmental management system. The Forest Stewardship Council is an international non-profit organisation that supports environmentally appropriate, socially beneficial and economically viable management of the world's forests. Labelling of accredited wood products provides an incentive in the market place for good forest management.

Infinitree program: Infinitree is a tree farming marketing program for the South West that partners the Forest Products Commission with farmers and investors to create commercial tree plantations on their properties.

Fire management program: Department of Environment and Conservation has a prescribed burning program in which low and high intensity fires are used to maintain biodiversity, regenerate the forest and reduce the build up of leaves and twigs on the forest floor to avoid destructive, high intensity wildfires.

Water management in forested catchments: Wungong and Gnangara Mound catchments, where water supplies and water-dependent ecosystems are threatened by falling watertables, are undergoing thinning and plantation harvesting to maximise water recharge and streamflow.

Bioenergy production trials: Western Power, in conjunction with other stakeholders, has established an Integrated Wood Processing Plant at Narrogin. Locally planted mallees are used as the fuel for renewable energy production. The plant produces other by-products such as activated carbon and eucalyptus oil.

Implications

Historically, native forest management has been a contentious topic in WA. Community and industry opinions have often been polarised between the view that native forests should not be harvested and the view that harvesting timber from native forests is a renewable activity that generates income and employment in the region. Government policy, implemented through the *Forest Management Plan 2004–2013*, aims to foster a balance of sustainable native forest uses, including biodiversity conservation, tourism and water supply. Government policy also promotes plantation development for industrial use and environmental benefits.

Unsustainable forest harvesting practices have been well documented worldwide. The major potential environmental impacts of forests policy and management practices are on conservation of biodiversity, maintenance of ecosystem health and vitality, and maintenance of soils and water resources. Policy and best practice in WA needs to continue to improve, especially in light of a growing plantation industry and the possible emergence of carbon markets.

SUGGESTED RESPONSES

9.33 Encourage owners and managers of native forest and plantations to adopt sustainable forest management accreditation schemes and public reporting against national and international standards.

9.34 Enhance the legal, institutional and economic framework to deliver sustainable forest management in the face of present and future challenges.

9.35 Develop a policy for greenhouse initiatives, such as efficient use of residues from harvesting native forest (minimal wastage), plantation harvesting for bioenergy and other greenhouse positive initiatives, while reducing the impact of greenhouse negative alternatives to wood products.

9.36 Research the impacts of climate change on forests to identify appropriate adaptation strategies for forest management.

9.37 Develop a strategic planning framework to provide certainty to the plantation industry and assist in maximising the social, economic and environmental benefits to the community, including taxation issues and market-based incentives (e.g. a carbon credit trading scheme).

CASE STUDY – THE ROLE OF FARM FORESTRY IN THE RECOVERY OF THE DENMARK RIVER

The Denmark River was dammed in 1960–61 to supply the south coast town of Denmark with drinking water. It has the potential to become a major water supply for the growing Albany–Denmark area. However, salt levels in the river increased in the late 1960s as a result of agricultural clearing in the upper catchment. This raised concerns that the water could become too salty to be used as drinking water.

Initial attempts to reduce salinity in the late 1970s involved the State and Commonwealth governments in purchasing land and replanting trees in cleared areas. In 1996, under the Salinity Action Plan, the river was identified as a water resource recovery catchment with the objective of reducing salinity to achieve drinking water quality (500 milligrams of salt per litre) by 2020. Many State Government agencies were involved in developing and implementing a catchment management plan with farmers and the local community.

Commercial and community actions played a vital role in recovery efforts. Preparation of farm plans led to local farmers establishing plantations on land previously used for crops. These tree farms utilised more groundwater than would have been used by annual crops and pastures, thereby reducing the threat of rising saline groundwater. Eucalyptus species (primarily Tasmanian blue gums) were the primary plantation type used, as they are well-suited to the climate. The strategic value of plantations in these areas was quickly realised and rapid private investment in blue gum plantations occurred.

Between 1990 and 2002, nearly 50% of previously cleared areas in the upper Denmark River catchment had been converted to plantations. Amongst other initiatives, tree farming projects have been pivotal in helping to reverse the salinity trend in the Denmark River (Figure TS9.6). This is the first major catchment in WA where a downward trend in river salinity is being observed in response to direct on-ground works, primarily revegetation (Bari et al., 2004).

Economic and social benefits have also been realised from an expanding plantation and timber-based industry. Farms have become more diversified and local and regional economies have been strengthened. The Forest Products Commission is now working with regional natural resource management groups to focus new plantation development in lower rainfall regions of WA with a view to delivering similar benefits in other salt-affected catchments.

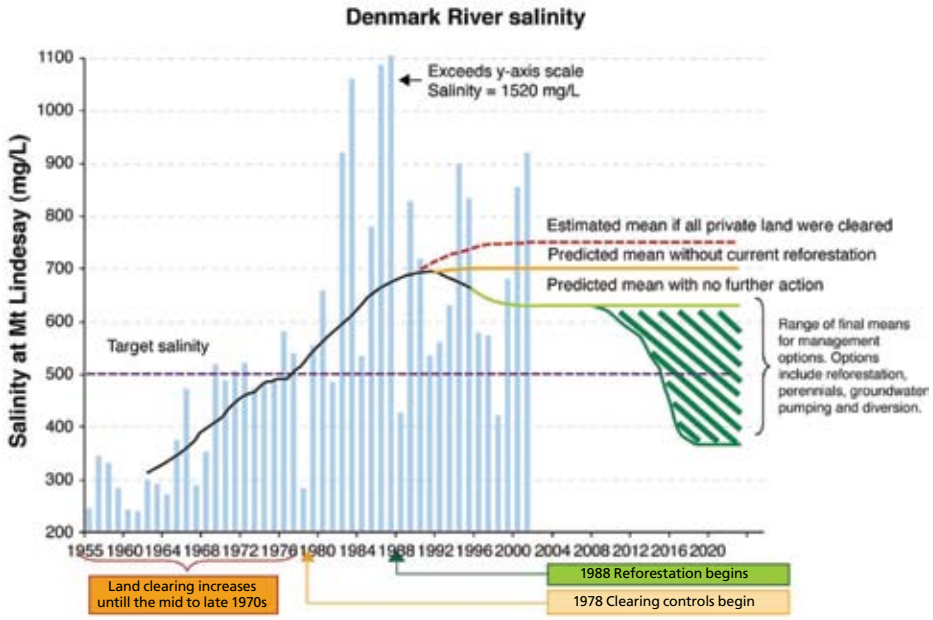


Figure TS9.6: Salinity levels in the Denmark River, with average and predicted forecasts under various management scenarios.
Data source: Bari et al. (2004). Note: Salinity is measured as total dissolved salts in milligrams per litre (mg/L).

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