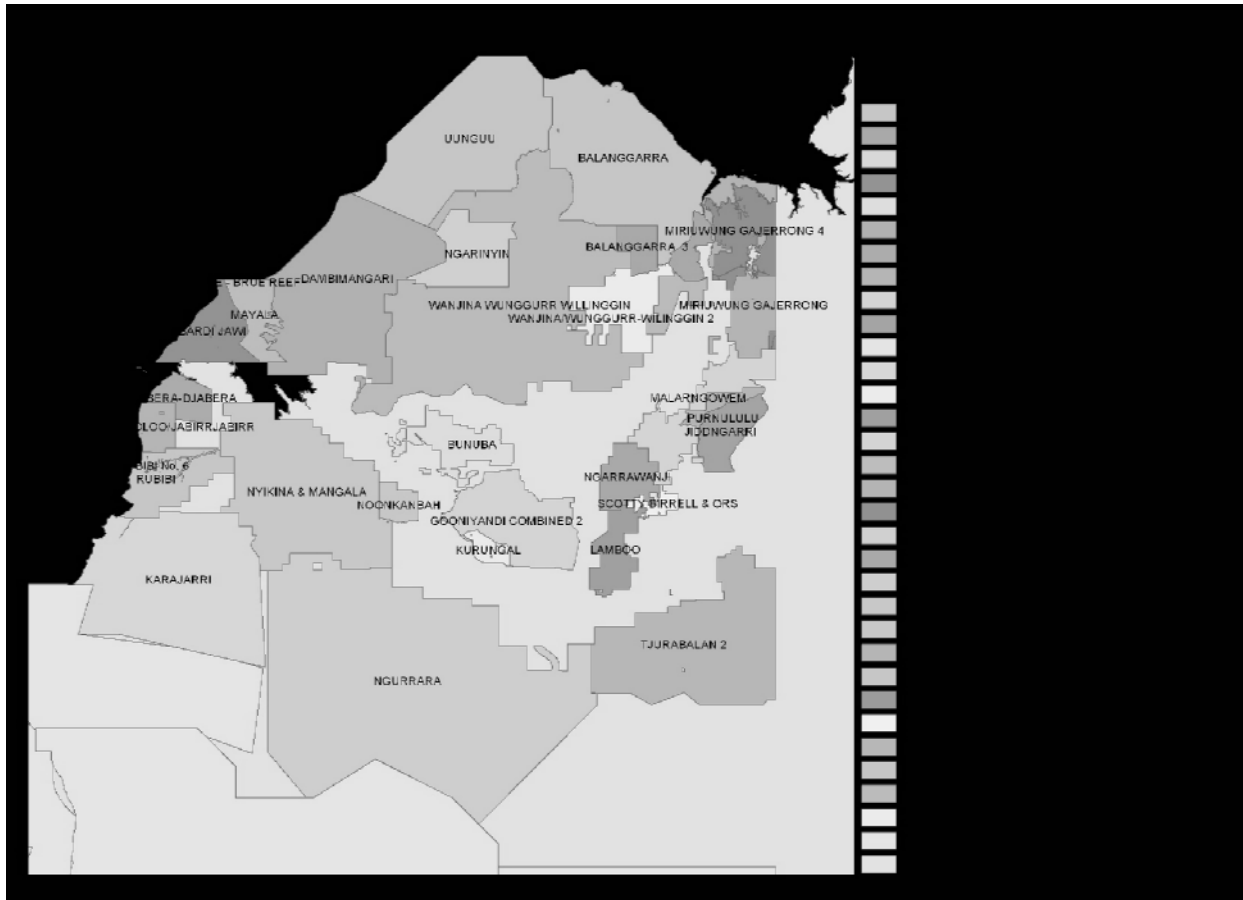


This continues today and in the western system, this process can be more readily recognised in the legal framework of Native Title. Native Title is readily recognised for almost a third of the Kimberley area, with more cases still to be decided upon.



Native Title Map 2004

The Kimberley was first explored by non-indigenous people in the late 1800s, with pastoralists being the first major settlers of the land. During this time pastoralists from across Australia claimed land and started to move cattle into the region. The first stations in the region were settled along the major river systems of the Ord and Fitzroy Rivers (Taylor 2003, p.13).

Often violent clashes with Europeans and Traditional Owners ended poorly for Aboriginal people and significant changes had an impact on the lifestyle of the original custodians. European settlement brought a more sedentary living arrangement and many Aboriginal people were moved to missions and became heavily involved in the cattle industry.

As country was being opened up to settlers, gold was found in Halls Creek in 1885. This again brought many fossickers across and up from more settled country. The major towns at the time were Derby and Wyndham, with cattle and supplies being shipped in through their ports to the region.

Whilst Derby, Wyndham and Halls Creek were busy centres, the early history of Broome is better compared to anchorage where people slowly built a town. In the early days Broome was dominated by Japanese and Chinese fleets that battled cyclones and harsh conditions. Down turns in mother of pearl shell supply, price and World War 2 kept the growth of the town in check till more recent times.

Prior to 1960 pastoral activities were the main source of employment and income. With the development of the Ord River Irrigation Area at Kununurra and a major upsurge in mining activity total population numbers increased to about 16,000 in 1979 (KDC, 2003). The population of the Kimberley has increased steadily over the last 20 years although it is still very sparse. There has been a steady drift of people from the stations and outside the region to move into the towns where the bulk of the population is now concentrated.

It was also tourism that begun to transform Broome in the early 1970s (The Shire of Broome 2004 Directory, p.302). The Broome Visitor Information Centre was opened in 1976 in an old DC3, which had crashed in Broome. Today tourism is the major industry for Broome. Many tourists travel there to spend time at Cable Beach, purchase pearl jewellery and as a base for wider Kimberley travel. Today the major towns of the Kimberley are Broome and Kununurra. The region continues to grow today with agriculture, mining and tourism being the main economic industries.

The Kimberley sub-region of the Rangelands NRM Strategy covers the four shires as shown in Figure 1.



Local Government boundaries in the Kimberley (DoE, 2004)

The total population of the region in 2001 was numbered by the Census at 40,644. The Indigenous population was 13,246, 32.7 percent of the total. It is notable that, with the exception Broome and Kununurra, the Aboriginal population comprises a substantial proportion, in many places the majority, of the population in all parts of the region. Significant Aboriginal communities are located around the region, in places such as One Arm Point (pop. 290), Beagle Bay (277), Bidyadanga (481), Djarindjin/Lombardina (188), Bayulu (241), Looma (276), Mowanjum (280), Yunggora (239), Kundut Djaru (106), Mindibungu (149), Mulan (186), Oombulgurri (186) and Yagga Yagga (70). Table 1 shows population distribution throughout the region.

Table One: Kimberley; Broome, Derby and Kununurra Regions; Aboriginal and non-Aboriginal population; main centres¹

Area	Aboriginal population	Non-Aboriginal population	Total	percent Aboriginal population
Shire of Broome				
Broome	2,539	11,407	13,946	18.2
Broome Pastoral	213	931	1,144	18.6
Other Broome	1,236	1,487	2,936	49.4
Total Broome	3,988	13,825	17,813	22.4
Shire of Derby – West Kimberley				
Derby	1,143	1,900	3,043	37.6
Fitzroy Crossing	743	619	1,362	54.6
<i>Total Urban</i>	<i>1886</i>	<i>2519</i>	<i>4405</i>	
Fitzroy Valley	906	400	1,306	69.4
Wyndham East Kimberley. (Far West)	167	256	423	39.5
Other Derby	1,630	2,075	3,705	44
<i>Total Rural</i>	<i>2703</i>	<i>2731</i>	<i>5434</i>	
Total Derby	4,589	5,250	9,839	46.6
Shire of Halls Creek				
Halls Creek	1,009	349	1,358	74.3
<i>Total Urban</i>	<i>1009</i>	<i>349</i>	<i>1358</i>	
Warmun	288	28	316	91.1
Balgo	388	41	429	90.4
<i>Total Rural</i>	<i>676</i>	<i>69</i>	<i>745</i>	
Total Halls Creek	1685	418	2103	
Shire of Wyndham – East Kimberley				
Kununurra	778	3,659	4,437	17.5
Wyndham	443	373	816	54.3
<i>Total Urban</i>	<i>1221</i>	<i>4032</i>	<i>5253</i>	
Lake Argyle	242	1,491	1,733	14
Wyndham East Kimberley - West	200	412	612	32.7
Kalumburu	289	47	336	86
Other Kununurra	1,032	1,928	2,960	34.9
<i>Total Rural</i>	<i>1763</i>	<i>3878</i>	<i>5641</i>	
Total Wyndham	2984	7910	10498	
TOTAL KIMBERLEY	13,246	27,398	40,644	32.6

The Kimberley region has a young population relative to Australia and Western Australia. The median age of the Kimberley population is 28 years compared to 34 years for WA (2001 Census). Halls Creek Shire has the youngest average age for any shire in Australia; the average age being 24 years old.

As with many regional populations, the Aboriginal population in the Kimberley is very much younger than the non-Aboriginal population. Over half (56.6 percent) of the Aboriginal population was under the age of 24 in 2001, compared with 22.2 percent of the non-Aboriginal population. However, higher proportions of non-Aboriginal than Aboriginal 25 to 44 year olds lived in the region – 34.1 percent as opposed to 28 percent. The gap grows larger when 45 to 64 year old populations are compared – 11.2 percent of the Aboriginal population is in this age group, compared with 33.4 percent of the non-Aboriginal population.

Industry and Economy

The Kimberley region has a diverse regional economy. Mining, tourism, agriculture, aquaculture, fishing and retail are major contributors to the regions' economic output.

Aboriginal organisations, community & decision-making structures

There are many non-government, community and private Aboriginal organisations in the Kimberley. They have varying decision-making structures ranging from registered incorporated body structures to clan structures. They are the formal avenue to engage Aboriginal people when addressing many environmental, social, economic and cultural issues throughout the Kimberley. These structures and decision making processes are mentioned here as there are many such organisations throughout the Kimberley and the government and public need to be aware of the cross-cultural environment in which they operate. For Traditional Owners of the Kimberley in relation to natural resource management, four main regional organisations are the Kimberley Land Council (KLC), Kimberley Language Resource Centre (KLRC), Kimberley Aboriginal Law and Culture (KALACC) and Kimberley Aboriginal Pastoral Association (KAPA).

Economic Overview

The economy of the Kimberley region has steadily increased since 1960's. Mining, tourism, agriculture, pearling, commercial fishing and government services are the major contributors to a vibrant Kimberley economy. Mining is by far the largest revenue earner and exploration activities include searching for diamonds, gold, iron ore, nickel, off-shore gas and crude oil.

Pearling and commercial fishing predominantly generate the highest revenue off the West Kimberley Coastline. Tourism provides the second greatest all-round contributor to the economy with great potential to increase. Pastoralism is iconic and a way of life in the Kimberley and continues to make a significant contribution to the local economy. Agricultural activities, horticulture provide substantial economic input into the region, especially in the Ord River Irrigation Area (ORIA).

Mining

Mining activity in the Kimberley has a long history, commencing with the discovery of gold near Halls Creek in 1885. Construction of an iron ore mine on Cockatoo Island began in 1944, with the first shipments of iron ore being made in 1951 (KDC, 2003). In the 1980s, diamonds and zinc/lead deposits were discovered and mines were commissioned at Argyle (diamonds) and Cadajbut (zinc/lead).

Currently, the major mineral and petroleum exploration and production activities are diamonds, iron ore, nickel, off-shore gas, and crude oil. Kimberley mining and petroleum production was valued at \$665.1 million in 2001/02, which represents 2.5 per cent of the State's total.

Tourism

From the thousand islands of the Buccaneer Archipelago to the spectacular falls of the King George River, the romance of the pearling industry and the white sandy beaches of Broome, the Kimberley offers a wide variety of outdoor recreation including swimming, exploring, mud crabbing, whale watching, camping and some of Australia's best Barramundi, sailfish and reef fishing. The main tourism activities include four wheel drive and camping safaris, scenic flights, fishing and boating, wilderness camps and adventure tours. Many pastoral enterprises are now involved in eco-tourism ventures further increasing the accessibility of previously unvisited areas. The majority of tourism is based on the larger towns of Broome and Kununurra although large numbers of transient tourists visit many of the remote sites. Cultural tourism is emerging as a prominent draw card to the region and has potential for significant growth in the future.

Tourism is by far the fastest developing industry within the Kimberley. As such it has the potential to provide both significant advantages and disadvantages to the sustainability of the ecosystems. The natural values of the region are increasingly being recognised, and remote Kimberley destinations are attracting travellers from both domestic and international origins. A rapid improvement in the accessibility of many remote areas in the Kimberley is leading to a significant increase in the number of people visiting the region.

In 2002 there were 325,000 domestic and international visitors to the Kimberley. Total overnight domestic visitor expenditure for 2002 was estimated at \$237 million compared to \$203 million in 2001 (KDC, 2003).

The Kimberley Sustainable Tourism Strategy - a new plan developed in partnership with key organisations outlines recommendations for sustainable tourism. Recommendations include Environmental Awareness and Promotion, Understanding and researching the market for sustainable outcomes, developing indigenous tourism and industry participation, sustainable tours and sustainable environment and connecting Kimberley tourism with the world.

Aboriginal perspectives of the environment and their physical manifestations such as rock art sites and other places of significance are a highly sort after experience.

Agriculture and Pastoral

The major agricultural activities of the Kimberley are, market gardening, fruit production and broad crops such as sugar cane are centred on the Ord River Irrigation Area and Broome. .

In 2000/01, there were approx 98 agricultural establishments in the Kimberley, covering 15,000 ha hectares. Irrigated agricultural production has increased significantly over the last ten years and was valued at \$57.0 million in 2001/02.

Pastoralism covers the largest area at approximately 224,000 km² of the total 320,000km² area of the Kimberley is covered by 93 pastoral leases, 32 of which are recognised as being under Aboriginal management. The Kimberley cattle herd is between 550-600,000 head of beef cattle (KDC, 2003). Cattle production is now focused on the live export trade, supplying mainly younger animals to South East Asian and Middle Eastern markets. The value of cattle disposals from the Region was \$59.2 million in 1999/00, being 16.5 per cent of the State total of cattle sales

There has been a shift out of pastoral employment, by Aboriginal people, from a generation ago. This has not yet been replaced with any firm engagement by local Aboriginal people in the emergent regional labour market which is dominated by employment in irrigated agriculture, mining, tourism and government services.

Fisheries and Aquaculture

Major aquaculture activities are based on the pearling industry around Broome and along the north Kimberley coastline. Commercial fishing is conducted throughout the Kimberley

The fishing industry in the Kimberley includes catches of wild stocks and an aquaculture industry dominated by pearling (KDC, 2003). The cultured pearling industry is the most significant part of the Kimberley aquaculture industry. Pearling has been an important industry in the West Kimberley since the 1880s. It has grown to a value of around \$150 million, and directly employs approximately 600 people in the Kimberley at the peak of the season. It also employs many people indirectly through servicing and downstream processing (eg. jewellery trade).

The total live catch of commercial fishery for the 2001/02 season was 1,731 tonnes, estimated to have a value of \$9.5 million (KDC, 2003).

The region provides rich commercial, customary and recreational fishing opportunities. Fishing is the most popular recreational activity of the region and provides a drawcard for many tourists to visit the region.

The marine environment abounds with corals, shell and fish. Recreational diving is restricted to mostly offshore areas due to turbid waters of inshore areas.

Climate

The Kimberley has a strongly arid to semi-arid monsoonal climate that is characteristically hot and wet in the summer (wet season) and warm and dry in the winter (dry season). The months of May to August are relatively cool with average temperatures between 16 degrees Celsius and 32 degrees Celsius. In the remaining months maximum temperatures exceed 35 degrees Celsius and in October-November often exceed 38 degrees Celsius.

Annual average rainfall ranges from 1,500 millimetres in the north-west coastal areas to less than 350 millimetres on the southern perimeter and is generally confined to the six-month 'wet' period November to April, with January and February being the wettest months. It has a pronounced north-south rainfall gradient, so that southern parts of the zone are semi-arid, with a shorter growing season, less reliable rainfall and higher annual temperature range than the northern parts.

Cyclones often occur over the Kimberley coastline – it is one of the most cyclone-prone coasts anywhere in the world. They form to the northwest and an average of two per year cross the coastline. There is usually one with destructive force about every two years (Zell, 2003).

Natural Resources

Past and Present Involvement in Natural Resource Management

Previous reports have been written addressing Aboriginal aspirations in natural resource management at a local and regional level. Various projects have been undertaken throughout the Kimberley for land and sea management. The Kimberley Land Council

assists Traditional Owners in managing country. Other organisations such as the Yirriman project and the Kimberley Regional Fire management project work collaboratively to work with Aboriginal youth and Elders in the combining of western and Traditional techniques in land management.

The sustainable management and protection of natural resources in the Kimberley region is a priority for many people living or having visited the region. Significant areas of the Kimberley have yet to be properly studied or documented.

Land

The geology of the Kimberley is quite complex and unique. For this reason it is probably more interesting than most other areas of Western Australia, with geological formations and rocks ranging from extremely ancient to relatively recent. Rocks exposed in the Kimberley record a geological story that takes in the last 1900 million years of the Earth's history. The oldest rocks form the Lennard Hills in the western Kimberley and the Bow River Hills and the Halls Creek ridges in the east Kimberley. They were formed between 1920 and 1790 million years ago, when the Kimberley was part of a larger continent to the north, which was drifting towards the rest of northern Australia. The collision between the Kimberley and northern Australia finally occurred about 1830 million years ago.

The landscape of the Kimberley is ancient and has been evolving for the last 250 million years. The present landscape of hills, valleys and gorges was produced by erosion that resulted in an uplift of the Low Kimberley surface that started 20 million years ago, as Australia began to drift north toward Asia. A rise in sea level about 17,000 years ago, following the last ice age, drowned the Kimberley coastline, with the sea filling what once were river valleys. The Fitzroy River floodplain and the Cambridge Gulf Lowlands, which form the floodplain of the Ord River, started to form at this time.

Traditional Owners have their own values and beliefs in relation to land and the formation of country. It is an integral part of Traditional law and culture.

Water

Large river systems are a significant feature of the landscape. The value of water resources in the Kimberley is enhanced by the hot climate and long dry season. Historically, rivers and wetlands were relied upon for water and food resources, and for navigation. Today, they remain important for cultural and recreational activities, and as water sources for irrigation and stock and as habitat for native birds and animals. Groundwater is used for town water supply, stock, domestic, mines and irrigation purposes.

The Kimberley includes over one hundred rivers and many more creeks and streams which generally flow north or west, forming the Timor Sea drainage division. The largest river in terms of flow in the Kimberley, and in WA, is the Fitzroy - which has floodplains many kilometres wide. The Ord is the second largest river in WA and one of the most well known. Water from the Ord River is used in the economically important Ord River Irrigation Area.

There are four declared Ramsar sites (listed as International wetlands of significance under a global treaty) in the Kimberley – Lake Kununurra & Lake Argyle, the Ord River Floodplain, Roebuck Bay and Eighty Mile Beach. Paruku (Lake Gregory) also satisfies criteria for listing as a Ramsar site.

The values for water are also expressed in a different cultural, social and economic perspective for Aboriginal people of the Kimberley. For many, access to natural resources is a direct access to food and drinking sources.

Biodiversity

Biodiversity encompasses all species, animals and plants, as well as their genes and all ecological communities and kinds of ecosystems. It implies a complex system of interacting living entities that form ecological patterns and processes. Today's broader understanding of biodiversity has encouraged a shift within conservation efforts from largely targeting human-valued species to focusing on all organisms, and more recently to focus on ecosystem management, where maintaining ecosystem function and health is one of the primary goals.

The Kimberley Region supports a diverse and spectacular variety of ecosystems within a tropical savannah landscape dominated by eucalyptus and acacia open woodlands with hummock and tussock grasslands. Ecosystems in the Kimberley include extensive coastal archipelagos, marine plains, mangrove creeks, coastal dunes with vine thickets, swamp rainforests, mound springs with monsoon forest, red and black soil plains, sandstone and limestone ranges, a network of permanent springs and riparian zones, cave systems and freshwater lakes.

The proportion of threatened and endemic species is high. 126 endangered and threatened fauna species, four declared rare and 132 priority listed flora species, 11 threatened ecological communities and a further 46 communities at risk have been listed within the Kimberley. In addition there are four wetlands listed under the international Convention of Wetlands, also known as Ramsar sites, 22 of the 120 wetlands listed in the Directory of Important Wetlands in Australia and seven wetlands of subregional significance.

Kimberley rivers and wetlands exhibit a freshwater fauna with high levels of endemism. This is particularly notable within the fish fauna of nearly 50 species. Endemism is found within several families of fish including gudgeons (Eleotridae), grunters (Terapontidae), hardyheads (Atherinidae) and rainbowfish (Melanotaeniidae).

The region's coastal environment also provides habitat for many important fauna species considered world-class assets. These include migratory waders at Eighty-Mile Beach and Roebuck Bay, breeding seabirds at Adele and Lacepede Islands, benthic intertidal fauna at Roebuck Bay, breeding turtles at Browse and Lacepede Islands and pearl oysters at Eighty Mile Beach.

The species richness of the Kimberley has historically formed the resource base for Aboriginal people living in this Region. Today it still remains important as a food resource, for cultural and recreational activities and as a resource for industries including tourism. Integrity of biodiversity enhances the productivity and resilience of ecosystems, which is important for any sustainable use of natural resources. Ecological processes resulting from biodiversity are also critical in maintaining climate and micro environments through the control of carbon dioxide levels and local temperatures.

Biodiversity conservation today has to aim for a balance between tactical responses, such as recovering species near extinction, and strategic responses focusing on the needs of maintaining whole ecosystems and ecological processes within those. There will be a need for better knowledge and understanding of biodiversity and conservation requirements, shared responsibilities for biodiversity conservation including the engagement of more people, better integration and coordination of efforts and the integration of biodiversity conservation into decision-making at all levels. There also is a growing need to develop industries that sustainably utilise biodiversity for both commercial and conservation benefits to ensure all ecosystems are sustainably managed for the future.

An important tool that can be used in planning and priority setting for biodiversity conservation is the development of the terrestrial biodiversity audit. This audit can also be

used in the establishment of a database system documenting the region's biological resources accessible to a wide range of user groups. This system should be expanded to include the marine environment.

Coastal and Marine

The Kimberley coast is one of the most contorted of anywhere on the Australian coastline and its history is unique in every respect – geologically, biologically and human. The coastline is approximately 2,500 kilometres long with in excess of 3000 islands (Zell 2003).

Access to remote coastal areas of the North Kimberley is restricted due to its isolation and rough terrain. Most access is achieved via boats, and this is gradually increasing the number of visitors. Currently there are in excess of 16 commercial boat operators offering cruises out of Broome, Derby and Wyndham along North Kimberley coastal areas.

The Region's coastal environment also provides habitat for many important fauna species, considered world-class assets including:

- Migratory waders, notably at Eighty-Mile Beach & Roebuck Bay.
- Breeding seabirds, notably at Adele Island & Lacepede Islands.
- Benthic intertidal fauna at Roebuck Bay.
- Breeding turtles, notably at Browse Island & Lacepede Islands.
- Pearl oysters (*Pinctada maxima*) at Eighty Mile Beach

Major Challenges for Natural Resource Management

Keeping Country Healthy

Actively recognizing and support Aboriginal values and perspectives for country will produce a dynamic and rich understanding of the natural resources of the Kimberley. In addressing Traditional Owners' indicators, values and actions to manage the Kimberley landscape, a continued healthy and vibrant natural environment can exist.

There are direct environmental impacts that require urgent attention. In order to support a long term process of natural resource management unique to the Kimberley, further community capacity building is needed.

Fire Management

Changed fire regimes since colonisation have seen a change in the landscape, as burning practices have changed considerably. Generally speaking, Aboriginal people no longer walk country, therefore most of the burning identified by some as being traditional is carried out along vehicle access tracks, often no longer in the country traditionally burnt and often without the cultural law linkage. A challenge is to, within a changed and changing environment, work to combine what is know about traditional burning practices with current research into fire behaviour and management.

The effects of frequent late dry season fires on populations of plants and animals is now seen as having a major impact on biodiversity and sustainable land management (Palmer et al 2002). Given that there is widespread agreement that many of the late dry season fires occurring today are harmful, management needs to reintroduce more traditional fire management to sustain our biodiversity. This will require coordination with other fire management agencies, local landholders, land managers and the general community.

Cane Toads

In 1935 about 101 Cane Toads were deliberately introduced from Hawaii in an attempt to control grey backed cane beetles that were considered a pest of the sugar industry in Queensland. Since then they have spread steadily across Australia

Cane toads are a real threat to the biodiversity of the Kimberley. Biodiversity surveys have only been conducted in a few areas, throughout the Kimberley resulting in a poor understanding of any areas of the Kimberley. With the seemingly inevitable arrival of the cane toad, the management of endemic species is becoming an even higher priority.

Weeds

Currently the Kimberley Region is fortunate to have large areas of relatively natural vegetation. Increased weeds and exotic vegetation where the impact of weeds is very slight or non-existent. Weeds are, however, entering the region either by spreading across Northern Australia or as a result of deliberate introductions. Some infestations have been spreading more quickly than they can be controlled.

Whilst the level of documentation of the extent and impact of weeds has been limited there are many significant sites that are impacted on by weeds. For example, access to the Fitzroy River is restricted by the increasing occurrence of Noogoora burr, Mimosa bush and Parkinsonia. Increased weeds and exotic vegetation have been recorded in the Ord River as a result of damming and changed hydrological processes (Doupe&Pettit 2002; WRC 2003).

Weed control management is essential in protecting the Kimberley's natural resources. Much work is currently underway in terms of educating the community about the importance of weed control. Additionally, many community groups are undertaking 'hands on' programs to control and manage weeds. Such work needs to continue and be built upon to ensure the threat of weeds to the Region's natural resources is controlled.

Current Weeds of National Significance (WONS) in the Kimberley are:

- *Lantana* (*Lantana camara*)
- *Mesquite* (*Propis* spp.)
- *Parkinsonia* (*Parkinsonia aculeate*)
- *Prickly Acacia* (*Acacia nilotica*)
- *Rubber Vine* (*Cryptostegia madagascariensis*)
- *Salvinia* (*Salvinia molesta*)

Other significant weeds in the Kimberley are:

- *Belly-ache bush* (*Jatropha gossypifolia*) - regionally significant, declared in the West Kimberley
- *Noogoora burr* (*Xanthium occidentale*) - regionally significant
- *Neem* (*Azadirachta indica*) - environmental weed
- *Leucaena* (*Leucaena leucocephala*) - environmental weed
- *Calotropis* (*Calotropis procera*) - environmental weed

Tourism

As noted previously tourism is one of the fastest growing industries in the Kimberley. Today many people are attracted to the Kimberley for a 'Wilderness' experience. Ensuring that this

attraction is maintained and appropriately managed is considered to be one of the most crucial challenges facing the Region's natural resources.

Currently there is little co-ordinated management of the increasing number of tourists accessing remote areas in the region by both vehicle and boat. Interagency discussions have recently started to develop a Gibb River Road Management Plan. Many more plans, strategies and policies will need to be developed in the near future to ensure appropriate protection of our important natural resources. There is also a lack of community based coastal management planning resulting in unregulated tourism pressures on coastal areas.

Climate Change/ Greenhouse Gases

Many human activities produce gases (called greenhouse gases) that can reduce the amount of infrared radiation from the sun that can escape from the atmosphere. Because the earth's climate system is finely balanced, increased temperatures can cause changes to the weather and climate. Over the last 100 years, there have been changes in Australia's rainfall and temperature. There seems to be reasonable agreement among scientists that climate change is already affecting species and ecosystems. There is however uncertainty as to how individual species might respond in the future.

Turning Ideas Into Action

There must be a considerable undertaking in the way that natural resource management is addressed. Attention must be giving to social change and capacity building of the community. Many proposals considered combine Traditional knowledge with western techniques. Proper protocols, negotiations and support mechanisms need to be put in place with all stakeholders working together to effectively manage the natural environment of the Kimberley in a socially unique setting of Australia.

The Pilbara

Introduction

The Pilbara covers more than 500,000 square kilometres and is bordered by the Gascoyne in the south, the Kimberley in the North, the Indian Ocean to the West and the Northern Territory border to the east. The sub-region can be separated into three distinct geographical formations:

- a vast coastal plain;
- breath-taking inland ranges; and
- an arid desert region extending into Australia's dry centre.

It comprises the local government authorities of Ashburton, East Pilbara, Roebourne and Port Hedland.

History and people

Aboriginal

The Pilbara is called Bilybarra by the many different Indigenous groups of the region, which means "dry country". Prior to the arrival of European settlers, there were at least 28 languages spoken in the sub-region. Kariyarra is the language that was (and is still) spoken in the Port Hedland region and the languages Ngarla and Nyamal are spoken just north and south of the area.

Marapikurrinya (Hedland) as well as being the home for the establishment and maintenance of many rich traditional customs, is also well known for a recent historical event - the 1946 Strike, which was organized by Aboriginal pastoral workers attempting to improve their working conditions. Some of the strikers are still alive today and are living in the area.

European

In 1818, Captain Philip Parker King was commissioned by the Admiralty to travel to the neighbourhood of Rosemary Island "to discover whether there be any river in that part of the coast likely to lead to an interior navigation into this great continent". King, arrived in the Dampier Archipelago, named the Intercourse Islands, Lewis and Enderby Islands and Nickol Bay.

Francis Thomas Gregory on the 'Dolphin' arrived at Nickol Bay in 1861, naming Hearson's Cove, the Maitland and Fortescue rivers, the Hamersley Ranges, Mt Samson and Mt Bruce. Following him, Walter Padbury, inspired by reports from the Gregory expedition, decided to start a sheep station on the "uninhabited" north-west coast. His party landed at Tien Tsin, named after the barque captained by JT Jarman, in 1863, with stock and supplies. Later that same year John Wellard followed this example and the managers of these parties, Charles Nairn and William Shakespeare Hall, are remembered as the pioneers of the northwest.

With the beginning of the iron ore industry in the early 1960s, Dampier was chosen as the Port for Hamersley Iron's operations and this signalled the beginning of major development in the Shire. With the introduction of jet aircraft, regular passenger flights to the unsealed Roebourne airport were discontinued and in 1966 Hamersley Iron constructed a sealed airport, then the Dampier Airport.

Planning for the construction of Karratha began in 1968 and land was excised from Karratha Station pastoral lease. Wickham's first permanent buildings were begun in 1970 and in 1975 Karratha became the administrative centre for the Shire of Roebourne.

Local Government

Town of Port Hedland

Once a port for the fledging pearling and pastoral industries, today Port Hedland is a thriving town with a population of 12,785 and major industries including iron ore export, salt, tourism and pastoralism. In 1965 Port Hedland's development program started and the small town began expanding to its present 11,844 square kilometres. During this time the satellite community of South Hedland was established.

The original inhabitants, the Kariyarra people, call the place Marapikurrinya for the hand shaped formation of the tidal creeks coming off the natural harbour.

Shire of Roebourne

The Shire of Roebourne covers 15,197 square kilometres, with its main settlement being Karratha, now recognised as the administrative centre of the Pilbara and home to 15,281 people. A further five townsites being the industry-based Dampier and Wickham, the historic towns of Roebourne and Cossack, the coastal retreat of Point Samson surround Karratha, all within a 50 square kilometre radius.

Like Port Hedland the main industries are iron ore export, salt, tourism, pastoralism and light industry.

Shire of East Pilbara

The Shire of East Pilbara is the largest in the world, with an area of 378,533 square kilometres (larger than Victoria). Most of the Shire's 5,681 people live in Newman, Marble Bar and Nullagine. The Shire also contains numerous Aboriginal communities, the largest being Jigalong, Punmu and Parngurr. Aboriginal communities are also located in Nullagine (Irrungadji community) and Marble Bar (Pipunya and Goodabinya communities).

Most towns and cattle stations are located in the western section of the Shire, with one boundary being the high water mark of the Indian Ocean around Cape Keraudren, and the eastern border being the boundary of the Northern Territory, taking in the Great Sandy and Gibson Deserts.

The major industries in the shire are mining, pastoralism and tourism.

Shire of Ashburton

The Shire of Ashburton, at nearly half the size of Victoria (105,647 square km), has some of the world's largest open cut mines, largest pastoral leases and cattle stations and a thriving fishing industry all set against a beautiful and ancient, arid, tropical landscape.

The majority of the Shire's 105,647 square kilometres is divided into pastoral properties and spread amongst these are the towns of Onslow, Pannawonica, Paraburdoo and Tom Price.

The region's 5,781 residents are employed in a variety of industries including oil, gas, mining, cattle, fishing and tourism.

Population

The Pilbara's population totalled 39,441 in 2002, with most people residing in the western third of the Region. The Pilbara makes up seven and a half per cent of regional Western Australia's population and two per cent of the State's. Most residents live in the sub-region's towns of Karratha, Roebourne, Onslow, Port Hedland, South Hedland, Newman, Tom Price.

POPULATION DISTRIBUTION				
Local Government Area	2001	2002	2003	percent of Region 2003
Ashburton	5,945	5,808	5,781	14.63
East Pilbara	5,843	5,765	5,681	14.37
Roebourne	15,058	15,099	15,281	38.65
Port Hedland	12,615	12,713	12,785	32.35
Total	41,462	39,385	39,529	100percent

Source Australian Bureau of Statistics

Industry and economy

The Pilbara's economy is dominated by the mining and petroleum industries and is considered Western Australia's primary mining region. In 2001/ 2002 it contributed 56 per cent of the value of Western Australia's mineral and petroleum production.

Mining

The production value of the sub-region's mining and petroleum industries was \$15.9 billion in 2002/ 2003, with exported iron ore valued at approximately \$2.2 billion (Ashburton) \$2.9 billion (East Pilbara), Domestic Iron Ore \$200 million, and petroleum (Oil & Gas) valued at \$9.5 million. Other minerals extracted in the sub-region include salt, silver, gold, manganese and base metals.

Iron Ore

The Pilbara contains iron ore bodies that are estimated to total 34,000 million tonnes, which at current rates of mining would be sufficient for another 300 years. More than 95 percent of Australia's iron ore exports come from the Pilbara. There are some 22 iron ore mining and processing operations, employing almost 9,000 people. These operations are owned between the Pilbara's three iron ore producers – Hamersley Iron, Robe River Iron Associates and BHP Billiton Iron Ore.

Oil and Gas

The Pilbara's oil and gas industry is the sub-region's largest export industry earning almost \$10 billion per annum and employing more than 1,000 people. In 2001, the sub-region produced \$4.2 billion of crude oil, \$2.9 billion of LNG, \$1.7 billion of condensate, \$600 million of natural gas and over \$400 million of LPG products.

The major oil and gas project in the Pilbara is the \$12 billion North West Shelf Joint Venture (NWSJV) located on the Burrup Peninsula, which currently has a production capacity of over 7.5 Mt/a of LNG. Natural Gas is piped 1,530 kilometres from the Carnarvon Basin to

customers in the Pilbara, Carnarvon, Geraldton, Perth and Bunbury areas along the Dampier to Bunbury Natural Gas Pipeline.

Salt

The hot dry climate of the Pilbara makes it ideal for salt production and it has the largest solar salt fields in Australia and the second largest in the world. In 2001, the Pilbara produced over six million tonnes of salt, representing 70 per cent of the total salt produced in Western Australia. The value of salt production during this period was estimated to be \$179.5 million. More than 400 people are employed in the sub-region's salt industry.

Pastoralism

The majority of the sub-region is under pastoral leasehold tenure (58 per cent), with leases being between 200,000 and 300,000 hectares, although smaller on the more productive coastal areas. The Pilbara was founded on the pastoral industry, when settlers recognised the environmental conditions as being generally unfavourable to producing crops, and prior to the resources boom of the 1960s, the pastoral industry was the mainstay of the economy.

Cattle Industry

In 1999/ 2000, there were about 209,000 cattle in the Pilbara and cattle disposals for meat were valued at \$22 million per annum. During the last ten years, the annual value of cattle disposals has fluctuated although there has been an upward trend for most of this time, with the trade in live cattle exports providing a boost for the industry. In 1996, 12,891 head of cattle were exported through Port Hedland. By 1998 this had increased to 27,115 and by 2001 to 62,294. Most cattle are exported to Egypt, followed by Indonesia, Malaysia and the Philippines.

Sheep Industry

In 1999/ 2000 there were about 87,000 sheep in the sub-region, with the value of sheep for meat estimated to be \$2.4 million, which is a substantial improvement from \$757,000 seven years earlier. In 2000, Port Hedland exported 8,494 head of live sheep.

The value of wool production was \$1.7 million in 1999/ 2000, and similar to other areas prices that have fluctuated in recent times due to trends in global markets.

Fishing & Aquaculture

The Pilbara's three major commercial fisheries are the Nickol Bay Fishery, the Onslow Prawn Fishery, and the Pilbara Fin Fish Trawl Fishery. Established fishing operations are located at Onslow, Dampier, Point Samson and Port Hedland.

The total catch in the 1999/ 2000 season was 3,356 tonnes and was estimated at \$18.6 million. The major types of fish stock in the Pilbara include fin fish (snapper, red emperor, mackerel, job fish and shark), prawns, molluscs and limited quantities of beche der mer.

Diving for pearl oyster also occurs however, the majority of pearl species farmed are pearl oysters harvested from land based aquaculture sites. The value of pearling in the sub-region is estimated to be more than \$28 million per annum.

Tourism

Tourism is a small but valuable contributor to the Pilbara's regional economy. The total number of domestic visitors to the sub-region in 2000/ 2001 was 330,000, which contributed a total of \$160 million to the Pilbara economy. Some of the Pilbara's most popular natural attractions are the Karijini and Millstream/ Chichester National Parks and the 45 islands of the Dampier Archipelago. The sub-region is also well known for its heritage assets and especially for Aboriginal rock art, of which there are spectacular examples.

Energy

Due to the highly energy dependent nature of the Pilbara's mining sector, a cost competitive energy market is essential. Western Power provides electricity to residential and commercial customers (excluding resource companies) by purchasing power from private generators in the region.

Water

Port Hedland obtains its water supply from borefields at the Yule and de Grey Rivers, and the towns of Karratha, Dampier, Roebourne and Wickham obtain water from the Millstream natural aquifer and Harding Dam. The capacity of these sources exceeds the current demand substantially.

For cooling purposes, seawater is accessible for industries with large water requirements.

Transport

The Pilbara's ports handle tonnages far in excess of any ports in the State, dominated by export trade. The sub-region's three large industrial ports are located at Dampier, Port Hedland and Port Walcott (Cape Lambert).

The Pilbara is easily accessible by road from Perth by two major highways and several transport companies provide daily freight to major Pilbara centres.

The Pilbara's rail network totals 1,264 kilometres in length and is owned and operated by the sub-region's three major iron producers, which use it to transport ore from their inland operations to major ports for shipping.

The sub-region is also serviced by an international airport at Port Hedland aerodromes at Karratha, Newman and Paraburdoo.

Climate

The Pilbara is a semi arid region characterised by high temperatures, low and variable rainfall and high evaporation. Between October and April the temperature throughout the Pilbara reaches or exceeds 32 degrees Celsius almost everyday. Summer temperatures average 39 degrees Celsius during the day, dropping to 26 degrees Celsius during the evening. Inland temperatures average higher due to the absence of a cooling sea breeze. During the winter months the average temperature falls to 25 degrees Celsius.

The sub-region's average annual rainfall is 254 – 305 millimetres per year, which falls mostly in the summer months.

The region is characterised by large tides (up to three metres at the northern end) and warm sea surface temperatures (up to 28 degrees Celsius). Variations in ocean temperature in the sub-region influence the extent of cloud build-up and rainfall across southern Australia.

The region is affected by a large El Nino Southern Oscillation signal, which cause climate variations that are known to impact on local fish resources.

Surface and internal waves, winds, cyclones and tsunamis are major natural disturbances affecting the sub-region's habitats and species. The coast from Port Hedland to Exmouth Gulf is the most cyclone prone area in Australia with three to four tropical cyclones expected every year.

Natural Resources

Water

Pilbara Rivers

Two Drainage Divisions fall within the Pilbara sub-region – Indian Ocean Drainage Division and the Western Plateau Drainage Division. Most of the Pilbara's rivers fall within the Indian Ocean Drainage Division, which covers 518 000 square kilometres and includes fractured rock provinces and wide coastal plains. The five drainage basins that fall within it are the Ashburton, Fortescue, De Grey, Onslow Coast and Port Hedland Coast basins. The main drainage features of the Division include the Hamersley and Chichester Ranges, which feature spectacular gorges (such as those within Karijini National Park). Nearly all streams arise from within these ranges and generally build in size as they cross the wide coastal plain to the ocean. Many Pilbara rivers disappear before reaching the ocean, into coastal lagoons, large expanses of tidal flats or into the deep coastal basin sediments.

The few watercourses in the Western Plateau Drainage Division usually disappear into flat lands or shallow lakes. Flow within this Division follows cyclonic rainfall events and occurs only for short periods of time. Internal drainage is uncoordinated with almost no major riverine landform features.

Throughout the Pilbara, river flow is highly variable and dependent on rainfall from cyclonic activity. Rivers are generally either in drought or flood with periods of three years or more without flow common. Floods provide much needed flushing to pools, which often become stagnated and experience poor water quality during no flow events. Floods often cause severe damage to floodways, infrastructure and pastoral land, and can substantially alter channel morphology.

During periods of no flow, rivers such as the Fortescue and Sherlock feature rocky pools. The permanent rivers pools have significant ecological, social and cultural values and are generally sustained by local bank storage and aquifers (spring fed).

Wetlands in Pilbara

The Pilbara has a combination of seasonal, intermittent and permanent wetlands. The larger rivers generally support wetlands along their valley tracks for longer periods in the dry season following any flood. They can be grouped into playas, damplands, lakes, sumplands, creeks, rivers, wadis, floodplains, and barkarras.

Wetlands in the region are generally maintained by surface water flows, expressions of the groundwater and ponding/ perching of water.

Biodiversity

Terrestrial and Aquatic Biodiversity

The Hamersley-Pilbara area was identified by the Department of Environment and Heritage as one of Australia's 15 biodiversity hotspots. It provides habitat for a number of threatened, endemic and fire-sensitive species and communities, for example, the ghost bat, mulgara and spectacled hare-wallaby. In addition, the coastal islands are refuges for species that are vulnerable or extinct on mainland Australia, as well as being important breeding sites for turtles and seabirds. There are many endemic reptile species and the aquifers support endemic and rich stygofauna communities.

The Pilbara is divided through the Interim Bio-Regionalisation of Australia (IBRA) into bioregions and sub-regions that describe broad areas of similar vegetation/ soil/ landscape associations. There are seven IBRA bioregions (Pilbara, Great Sandy Desert, Little Sandy Desert, Gibson Desert, Gascoyne, Carnarvon and Dampierland) and 14 sub-bioregions that occur either wholly or partly within the Pilbara NRM. Within these sub-bioregions, there are:

- **Numerous landscapes** such as catchments, ranges, coastal plains, (dry) cave systems. Across these landscapes there are a total of 116 vegetation associations, of which 61 (53 per cent) occur only within the Pilbara. The representation of vegetation associations on conservation estate is poor;
- **Waterscapes** comprising:
 - rivers and permanent pools, and small river systems with permanent pools of high ecological value;
 - wetlands that are important water sources and refuges for migratory birds and other wildlife. The only RAMSAR listed wetland in the Pilbara is the very southern edge of Eighty Mile Beach. There are 15 wetlands of National Significance and 33 wetlands of subregional significance in the Pilbara; and
 - aquifers that support endemic stygofauna communities;
- One **threatened ecological community**, and a second – Dragon Tree Soak, in the Great Sandy Desert just north of the sub-region's boundary. In addition, 57 communities that are considered at risk, and 14 communities that act as refugia;
- **Rare Flora:** two Declared Rare Flora (DRF), thirty Priority One and twenty three Priority Two; and
- **Rare Fauna:** seven Schedule One mammals; two Schedule One birds; One Schedule One reptile, and Five Schedule Four fauna.

Marine Biodiversity Assets

There are four sub-regional ecosystems classified through the Interim Marine and Coastal Regionalisation for Australia (IMCRA) that occur wholly or partly in the sub-region: (Pilbara nearshore; Pilbara offshore; North West Shelf; and a small part of Eighty Mile Beach). These habitats include:

- discrete mangal systems that contribute significantly to marine nutrient resources;
- intertidal mud and sand flats supporting abundant and species-rich invertebrate faunal communities that are important food sources for the migratory birds;
- seagrasses & algal beds that support a diverse fauna of herbivorous fish, turtles and dugong;
- well developed and species-rich coral reefs;
- important nesting sites for turtles and seabirds;

- important marine species include: five species of sea turtles; dugong, whale shark;
- vulnerable species of marine mammals;
- invertebrate communities, including endemics, seabirds and waders/ shorebirds; and
- fish; and
- marine reptiles; rare species are included in counts listed above.

It is important to note that there has been very little comprehensive survey and research work done on the marine ecosystems in the Pilbara and hence there are significant knowledge gaps.

Coastal

The Pilbara coast is characterised by deltas, barrier islands, and associated lagoons with extensive development of mangroves (mangals), backed by wide supra-tidal flats and long stretches of sandy beach in the eastern section (Wilson, 1994). This sector of the coast is undergoing considerable change, with both depositional and erosional processes presently operating, the resulting geomorphological variability creates a variety of coastal habitat types, each characterised by distinctive community structure.

Mangroves

The Pilbara's tropical arid-zone mangroves have international scientific importance (Wilson, 1994), providing nursery and habitat for commercial fish species, increased inshore productivity, sediment trapping and protection from coastal erosion (Department of Conservation and Land Management, 2000 and Wilson, 1994).

Rocky Shoreline

Formation of these coastal structures is from wave attack, biological erosion, undercutting and rockfalls. The habitat has medium productivity due to its harsh environment.

Intertidal Mudflats

Intertidal mudflats are a feature of the mainland shores of the Pilbara, usually associated with fringing mangals in bays and lagoons. Intertidal sandflats are also a dominant feature of the coastline on the mainland and islands, due to the large tidal range experienced in the region (Wilson, 1994). The flats are well recognised as supporting rich and diverse faunas of burrowing invertebrates (Department of Conservation and Land Management, 2000 and Wilson, 1994).

Sandy Beaches

Sandy beaches, although less expansive than rocky shoreline in the Pilbara, provide nesting sites for sea turtles and wedge tailed shearwaters (Department of Conservation and Land Management, 2000 and Wilson, 1994). Beaches also often have varied organic content and in turn varied biological activity. Many of the species living in these habitats are once again, living in the substrate such as bivalve shells, worms, crabs and sea urchins (Department of Conservation and Land Management, 2000 and Wilson, 1994).

Other

The islands, sand shoals and mainland of the Pilbara, rise above submarine plains. These sub-tidal plains are characterised by extensive limestone pavements, large sheets of shell

gravel, sand and muddy sand/ gravel. Within these habitats there are also rocky reef platforms, sand shoal and filter feeding communities that cover a much lower percentage of the study area (Department of Conservation and Land Management, 2000 and Wilson, 1994).

Marine

Coral communities in the Pilbara have generally not been adequately surveyed. However, some research has been conducted in the Dampier Archipelago and Montebello/ Barrow Island areas. There are high diversities of coral in specific parts of the Pilbara, with 54 genera and 150 species recorded in the waters surrounding the Montebello Islands and over 229 species of hard corals in the Dampier Archipelago. As biodiversity research is continued, this figure is expected to rise in both areas (Department of Conservation and Land Management, 2000 and Wilson, 1994).

Of the 76 species of whales and dolphins in the world, 36 are known to visit Western Australia's tropical and subtropical coastline. The other group of marine mammals found in the Pilbara is the group called 'Sirenia,' which is represented by one species, the dugong (*Dugong dugon*). Dugongs are shy, herbivorous and relatively long-lived (70 plus years). Current knowledge on the size, distribution and migratory habitats of dugong populations in the sub-region is limited and requires further research.

Marine birds are also found in the sub-region and can be subdivided into seabirds and waders/ shorebirds. From the 93 species of seabirds that occur along the West Australian coast, 17 species are known to nest in the Montebello/ Barrow Island and Dampier Archipelago areas.

No surveys have been conducted in the island areas during the spring and autumn months, which is the peak time for sighting migratory waders. Therefore there is limited information on the migratory seabird and waders. Research is therefore required in this area.

Marine reptiles are well represented in the Pilbara region, with 11 species of sea snake, five species of marine turtle and the saltwater crocodile. Australia is one of the few countries in the world to still have relatively large turtle populations. The five species found in the Pilbara are the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), flatback (*C. depressa*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*).

One of the most sought after assets in the Pilbara, from a commercial and recreational aspect, is its fish species. Approximately 600 have been recorded in the Dampier Archipelago/ Cape Preston area, although no specific research work has been done.

Land

Pastoralism in the Pilbara

The Pilbara pastoral industry was established in the early 1860s based on wool production with a few cattle. However, now only four pastoral leases run sheep in conjunction with cattle. All remaining leases run cattle, driven predominantly by economics, sheep mortality rates caused by predation and minimal wool production.

Pastoral stations occur throughout the western third of the Pilbara (Department of Local Government and Regional Development, 2003) covering some 14.6 million hectares or 28 per cent of the Pilbara's land area. The median lease area is 198,000 hectares (Department of Planning and Infrastructure, 2004) and currently there are 55 pastoral enterprises in the sub-region. There are currently 10 Indigenous pastoral leases in the Pilbara.

Lease information for the Pilbara

Region	<i>Family & Co.</i>		<i>Aboriginal</i>		<i>CALM</i>		<i>Mining</i>		<i>Special</i>	<i>VCL</i>
	No.	Area ('000ha)	No.	Area ('000ha)	No.	Area ('000ha)	No.	Area ('000ha)	Area ('000ha)	Area ('000ha)
Pilbara	43	9907	10	1687	3	552	9	2291	3114	2847

Source: Department of Agriculture Western Australia (DAWA) (2002a)

The industry is well situated for access to a variety of markets. Live export through Port Hedland is well established to provide cattle to Malaysia and Indonesia. Stock are also in demand by southern feedlotter, graziers and exporters. Further advancements in genetics, significant investments made in infrastructure, new technologies for water delivery and an on-going commitment to sustainable management have only strengthened the long-term viability and stability of this well-established industry.

Stock rely on the native vegetation present although the introduction of buffel and birdwood grass species 70 years earlier has definitely enhanced the productivity of the rangelands for pastoralists. The actual grazing value and appropriate stocking of a particular pasture at any time vary enormously with seasonal conditions, fire history, perennial pasture condition and degree of recent use (Payne and Mitchell 2002).

Pastoralists value highly the natural assets upon which their industry is based. Grazing management strategies, monitoring sites, drought strategies, training, research and development are all common components of the modern pastoral industry. There is a greater awareness amongst pastoralists of the need for 'pre-emptive' management in response to seasonal variations and an enhanced capacity to implement actions.

The Gascoyne-Murchison

History and people

The British explorer Lieutenant George Grey, and his party, first sighted Bernier Island (30 miles west of Carnarvon) on February 25th, 1839. Continuing to sail away from the coastline in a north-easterly direction, Grey came upon a very wide opening, quite obviously a river mouth, officially 'discovering' the Gascoyne River on March 5 1839. In his journal, Lt. Grey noted: "The country here was ...well adapted for either agricultural or pastoral purposes....I .. feel conscious that within a few years of the moment at which I stood there, a British population rich in civilization Would follow my steps".

The Murchison River was also named by Lt Grey in 1839 after Roderick Impey Murchison, President of the Geographic Society in London. Like many other pastoral areas in Western Australia, the district assumed its name from the river.

Robert Austin, also explored the Murchison District concluding it was fertile and that there were almost certainly vast gold deposits in the area. Despite this glowing report, little settlement took place in the area until the Murchison gold rushes of the 1890s. Subsequent development of Mount Magnet was rapid and by 1902 it was booming with some 14 hotels, two newspapers and 30 goldmines.

Francis Thomas Gregory surveyed the Gascoyne to locate suitable grazing land and followed the 764 kilometre Gascoyne River down to its mouth. Along the route he encountered many of the wild Aboriginal tribes then occupying its banks. Early pastoral settlement relied almost entirely on natural surface water and consequently, was concentrated along major water courses.

The nomadic Indigenous peoples of the sub-region saw their timeless existence vanish before them. As lands were fenced and stocked with foreign animals, the Aboriginals were forced away from their traditional hunting and ceremonial sites. With tribal disintegration, fragmented family groups tended to congregate on pastoral properties to follow an adapted life style. Aboriginal people were highly valued and respected workers and were in fact the backbone of the cattle industry, building it up from scratch. During the late nineteenth and early twentieth century many stations only employed a sprinkling of whites, with all the essential tasks and services performed by local Aboriginal men and women.

In 1908 Mr McLeod put a pump into the bed of the Minilya River and found good water. He reasoned that underground supplies along the Gascoyne River should be similarly available and that orange orchards, or similar could be established on a commercial basis at Carnarvon. By 1931 there were plantations on both sides of the river and the new Gascoyne River bridge was open and access to and from town was generally assured.

Peak sheep numbers in the pastoral region were reached in 1934. The Gascoyne area carried some 1.4 million and the Wiluna, Meekatharra and Murchison areas 2.25 million head. At that time, sheep numbers in the pastoral areas of Western Australia accounted for about half the State's total. Prosperity in the wool industry peaked in 1950/ 1951 when the average greasy wool price reached 144.2 pence per pound, (equivalent to around \$37 per kilogram in today's prices, compared to around \$3.20 per kilogram being achieved in mid 2002).

Today the Gascoyne takes in the Shires of Carnarvon, Exmouth, Shark Bay and Upper Gascoyne and has a total population of 10,300. Its largest town is Carnarvon with a population of approximately 7,100, which is the regional service centre for the whole

Gascoyne-Murchison. (Gascoyne Development Commission). The Gascoyne currently contains about two per cent of the people living in regional Western Australia and half a per cent of the State's total population (Regional Trends and Indicators, Gascoyne Region, June 2003).

The average taxable income of workers in the Gascoyne is approximately \$34,347, compared with a State average of \$35,406. It has an unemployment rate of 5.7 per cent, compared to a State unemployment rate of 5.9 per cent (Regional Trends and Indicators, Gascoyne Region, June 2003).

The Murchison is located within Western Australia's Midwest region and contains the Shires of Murchison, Yalgoo, Meekatharra, Cue and Mount Magnet. Its resident population is estimated at 3,800, with the largest town being Meekatharra where 2,195 people reside (Midwest Economic Perspective, MWDC). Meekatharra also contains the Midwest region's second highest indigenous population, representing 13.4 per cent of the Midwest's total indigenous population (Midwest People and Population, MWDC, 13).

With the exception of the Shire of Murchison, the population levels of all other shires in the area have decreased, however it should be noted that the population levels in Meekatharra, Cue, Mount Magnet and Yalgoo can fluctuate significantly according to minerals and commodity prices (Midwest People and Population, MWDC, 5-6).

Industry and economy

Pastoralism

Pastoralism is the most geographically significant industry in the Gascoyne and Murchison areas with 231 pastoral leases spread from the Gascoyne coast to the Meekatharra Shire boundary. Other major industries in the region are horticulture, mining, tourism and fishing.

With regard to the pastoral industry, 11 of the total number of leases are held by indigenous groups, 13 by mining entities and 18 by the Department of Conservation and Land Management. The remaining leases are held by pastoral companies, partnerships or individuals, which generally run operations based on merino sheep, beef cattle or both. On average stations run 11,000 sheep or 1,500 cattle, but in some cases run up to 40,000 sheep and 6,000 cattle. Given the vast distances involved, managerial input is often low and stock may only be handled once or twice a year. Although grazing is the predominant pastoral activity in the sub-region, there has been increasing interest by pastoralists to diversify into other pursuits such as aquaculture, horticulture, tourism and eco-tourism.

Pastoralism in the Gascoyne is estimated to be worth \$20 million (Gascoyne Development Commission).

Horticulture

Horticulture is the other significant agricultural pursuit in the Gascoyne-Murchison, taking place almost entirely along the banks of the Gascoyne River between five and 18 kilometres from the River mouth at Carnarvon (Gascoyne Economic Perspective, 9). There are also some emerging, inland horticultural activities in the Gascoyne based on the use of artesian water.

The horticultural precinct at Carnarvon relies on irrigation from aquifers, and covers an area of approximately 1,500 hectares. The industry produces crops such as bananas, mangoes, capsicum, tomatoes and a wide range of vegetables. It takes advantage of the area's climate, producing out-of-season commodities for the Perth market, as well as exporting

produce to the eastern states, Asia and the Middle East (Gascoyne Economic Perspective, 9).

It is generally the Gascoyne's highest value agricultural industry however, seasonal factors and commodity prices can significantly influence the annual value of production. For example, production was valued at \$19.4 million in 1999/ 2000, which was down 31.2 per cent on the 1998/ 1999 value of production of \$28.2 million due to heavy rainfall associated with a cyclone in 1999 causing severe crop damage (Gascoyne Economic Perspective, 9). However, in 2002/ 2003 the industry was valued at \$56 million (Farmnote – Carnarvon District).

Mining

Land in the Gascoyne-Murchison is also increasingly being used for mining, particularly in the Murchison where it provides the largest source of income for the area. For example, gold production in the Murchison is valued at approximately \$600 million (Midwest Economic Perspective) however, fly in – fly out operations tend to limit the social benefits of this activity to local communities (Midwest Geographic Perspective). In recent times the east Murchison has raised considerable interest due to its high mineral prospectivity, with a surge in exploration being stimulated by the completion of the Dampier-Kalgoorlie gas pipeline (Midwest Geographic Perspective, MWDC).

Mining is less prevalent in the Gascoyne however, it has increased during the past three years, primarily due to the increase in the value of salt. As well as salt, mining for gypsum takes place in the region, and exploration drilling for petroleum, oil and natural gas is taking place both on and off-shore in the vicinity of Exmouth. There are a number of commercial deposits being developed by major companies, Woodside and BHP Billiton. The mining industry in the Gascoyne is valued at approximately \$91 million (Gascoyne Economic Perspective, GDC, 11).

Tourism

Tourism is also a vital and growing industry in the Gascoyne and Murchison areas. In the Gascoyne it is largely based on the area's unique natural environment, including Cape Range National Park, Ningaloo Marine Park and the Shark Bay World Heritage Area, and on inland icons such as the Kennedy Ranges and Mount Augustus National Parks. Tourism in Gascoyne is valued at approximately \$149 million.

Outback tourism is also increasing in popularity throughout the Gascoyne-Murchison, with the Murchison in particular being home to Kalbarri, spectacular Murchison River Gorges and a number of station stay properties. Wildflowers abound throughout the Murchison, blooming between July and October and are also a popular tourist attraction. Additionally the outback areas are associated with a rich cultural and indigenous heritage (Midwest Economic Perspective, 12).

This rich heritage is highlighted by the Outback Pathways project, linking the Gascoyne and Murchison areas through a series of self-drive tours. The tours demonstrate the region's history through the "Wool Wagon Pathway", "Kingsford-Smith Mail Run" and "Miners Pathway".

Fishing and Aquaculture

The Gascoyne-Murchison's coastal and marine areas also contribute to the regions economic wealth through a fishing industry worth an estimated \$54 million. The sub-region has some of the State's major trawl fisheries, with managed fisheries for prawns and scallops

occurring in Shark Bay and the Exmouth Gulf. Additionally, it supports the important Shark Bay Snapper Fishery and Shark Bay Beach Seine and Mesh Net Managed Fishery, which respectively provide most of the pink snapper and whiting catch for Western Australia (Gascoyne Economic Perspective, GDC, 8).

The sub-region also supports an aquaculture industry with pearls and pearl oysters being the primary activities, with other activities including the establishment of tiger prawns and rock lobsters. A pilot project also exists at Lake McLeod in Carnarvon focused on the production of the highly valued beta-carotene. In addition, inland production of fish has advanced with the licensing of several ornamental growers and the establishment of an aquaculture research facility in Carnarvon (Gascoyne Economic Perspective, GDC, 8). The Exmouth region has a number of land based aquaculture operations ranging from Sea Cucumbers to Mahi Mahi. With the proposed development of the Ningaloo Ocean and Research Center, the marine and terrestrial research and monitoring capabilities will be enhanced throughout the sub-region.

Climate

The Gascoyne-Murchison has a semi-arid to arid climate characterised by hot summers and mild winters. Most of the rainfall in the region occurs in two “seasons” – May to July and January to March.

The sub-region’s climate is strongly influenced by a band of high pressure known as the sub-tropical ridge, and in the warmer months by a trough of low pressure that extends from a semi-permanent heat low in the tropics to southern parts of the State. For most of the year the ridge is located to the south allowing east to southeast winds to prevail. During the cooler months the ridge moves north allowing cold fronts to pass over the sub-region. Whilst most fronts bring little rain to the Gascoyne-Murchison, they occasionally interact with tropical middle-level moisture to form northwest cloud bands which can occasionally interact with tropical middle-level moisture to form northwest cloud bands, which can produce widespread significant rainfall over the sub-region.

Whilst the average annual rainfall is relatively uniform at between 190 and 250 millimetres throughout most of the sub-region, rainfall is highly variable particularly in central and eastern parts. Summer rainfall, whilst less reliable than that from May to July, can be very significant especially when produced by tropical lows or cyclones. A large percentage of the annual total may come from just a few events. Flooding, whilst uncommon, usually affects the sub-region by making roads impassable for several days and by causing property damage. Tropical cyclones occasionally threaten the coastline with gale force winds and a potential storm surge.

Long dry periods are a feature of the climate particularly from September to December. Maximum temperatures are highest in January and February when inland averages generally exceed 37 degrees Celsius. Temperatures towards the mid 40s are not uncommon in northern inland areas. In contrast, reliable sea-breezes moderate temperatures near the coast, keeping summer maxima well below those inland. Average winter maximum temperatures range from below 18 degrees Celsius in the far south to over 23 degrees Celsius in the north. Overnight minima in July, whilst averaging over 10 degrees Celsius in coastal parts, average less than six degrees Celsius in the far east and are occasionally recorded below zero degrees Celsius.

Relative humidity levels are typically low for much of the year except along the coast, where moist onshore winds predominate. Average 9:00am relative humidity is highest from May to August, with levels exceeding 50 per cent across most of the sub-region. The predominance of dry sunny days throughout the Gascoyne-Murchison for much of the year results in high

evaporation, even near the coast (Bureau of Meteorology, Gascoyne-Murchison Climate Survey, 1998).

Natural Resources

Landscape

The Gascoyne-Murchison is contained within the State's southern rangelands, which is characterised by a hot dry climate in northern areas and a more moderate climate in the south. Rainfall is winter dominant throughout much of the zone, with mean annual rainfall ranging from 200 to 250 millimetres for most of the zone. The north-western part of the zone drains to the coast, whilst the middle area generally drains internally.

Vegetation is predominantly chenopod and Acacia shrublands and woodlands, but many vegetation types can be found. Much of the area can be broadly described as the "mulga zone". Mulga is very well adapted to areas of low rainfall and low fertility, with its branches and leaves that slope upwards to channel water to its stem and deep roots to help overcome lengthy dry periods by tapping underground soil moisture. Soils in the mulga zone are generally non saline, shallow and of uniform consistency. Mulga zone soils also tend to be stable to erosion from water or wind but may be susceptible to track erosion on tracks and in "washes" that carry concentrated flow (Burnside *et al*, 38-39).

The soils of the Gascoyne near the coast are often sandy and calcareous, and lightly coloured due to littoral shell fragments and oxide leaching. The browner calcareous earths tend to differ in colour due to high concentrations of carbonates and lower concentrations of iron oxide. Organic matter is low and generally concentrated within the top few millimetres of the soil. The alluvial soils of the Carnarvon plantation area are loamy fine sands, which are highly fertile, well drained and alkaline (Gascoyne Geographic Perspective).

The region is also typified by the yellow earths of the Murchison, deep sandy duplex in the Gascoyne and rocky and stony soils throughout. Ancient drainage lines have wet soils, saline loams, associated with red shallow sands (Midwest Geographic Perspective, 26).

Good quality underground water is frequently available through bores or wells less than 10 metres deep and this has made the country easy to develop for pastoralism. In fact mulga country was often the first land to be developed due to the availability of water and most mulga shrublands have been grazed by cattle and sheep, sometimes heavily for a century or more (Burnside *et al*, 39).

Pastoralism is still the dominant land use throughout the Gascoyne-Murchison today with lease sizes typically between 100,000 and 250,000 hectares. The average carrying capacity per lease is about 16 hectares/ dry sheep equivalent (DSE), or 110 hectares/ Cattle Unit, which is approximately one-third that of the Kimberley. Cattle stations dominate towards the north, whilst sheep stations dominate towards the south and west, and many stations run sheep and cattle together. In recent years an increasing number of stations are drawing income from sales of goats (Watson, 2004).

The biodiversity of the Gascoyne-Murchison is rich and varied across extensive terrestrial ecosystems and an exceptional marine and coastal zone that includes the Shark Bay World Heritage Area and the Ningaloo fringing reef.

The terrestrial area of the sub-region includes most of seven bioregions (Carnarvon, Murchison, Gascoyne, northern half of Geraldton Sandplains and Yalgoo) as defined in the Interim Bio-regionalization of Australia (IBRA). The Geraldton Sandplains has been identified as a major biodiversity hotspot in Australia. It includes the transition zone from the

South West Botanical province to the Acacia dominated Arid Shrublands of WA, an area that supports many species of flora and fauna at the limits of their geographical distribution. The remainder of the subregion supports vegetation that is primarily acacia (mulga) woodlands and acacia, saltbush and chenopod shrublands with areas of hummock grasslands on sandplains.

The Gascoyne-Murchison has supported pastoral grazing activities for a long period of time - in excess of 100 years on some pastoral leases. The combined grazing impact of sustained high stock numbers, elevated kangaroo numbers as a result of the introduction of artificial waters and feral animals such as goats has led to significant impacts on the composition and structure of native vegetation across the whole of the sub-region. Few areas were set aside for other than pastoral purposes and so only isolated pockets of un-grazed vegetation remain in the landscape as reference areas. Some upland sites have provided refugia for less common plant species. In general, vegetation mapping at the scale available for the for the sub-region is inadequate for operational needs.

Overall the flora of the sub-region is poorly known because of limited systematic surveys having been conducted. Whilst there is a list of threatened flora it is considered to be very deficient in many areas.

Grazing impacts on habitat (vegetation removal and trampling) and the introduction of feral predators such as the fox and cat has resulted in a 30 to 50 per cent reduction in native vertebrate fauna across the sub-region. A number of threatened species, no longer existent on the mainland, are found on Bernier and Dorre islands in Shark Bay and are the focus of reintroduction strategies on Peron peninsula, Heirisson Prong and some other Shark Bay islands.

Shark Bay has a rich birdlife with a high occurrence of migratory and breeding seabirds. Elsewhere avian fauna appears intact although abundance of many species has been affected by pastoral land use.

Despite the cumulative impacts of grazing there remains a rich reptile fauna across much of the Gascoyne-Murchison. As with flora, the available information on the distribution and abundance of fauna is generally quite patchy and limited.

Until recently the area of land included within the conservation reserve system in the Gascoyne-Murchison was very low due to the early historical release of leasehold land for pastoral activities. Purchase of pastoral land for addition to the reserve system was a key environmental outcome of the Gascoyne Murchison Strategy and significantly improved the area of representation in the reserve system. In addition, such activities as the 2015 pastoral lease renewal process has provided for the exclusion from some leases of additional areas identified by the State as requiring protection in the reserve system.

Whilst the major threats to long term biodiversity conservation in the sub-region are the cumulative impacts of unsustainable grazing regimes (including surface water management) and predation by feral animals, ecological restoration of degraded landscapes is critical to allow these threats to be addressed at the scale necessary to effect change. Support to land managers through programs such as the EMU project initiated by the GMS has demonstrated the desire of pastoralists to better understand and interpret the landscape in which they operate. There is a real opportunity to protect biodiversity at the broad landscape scale outside of the reserve system by the development and incorporation of management practices over pastoral and other lands that can contribute to both sustainable pastoralism and real improvement in the long term viability of ecosystems, communities and species of special interest.

Waterscape

All watercourses in the Gascoyne-Murchison are ephemeral, which is to say that the rivers dry up for at least part of the year. The lack of flow can extend for periods of up to twelve months, with the Gascoyne River for example having a 60percent probability of not flowing in any given month.

Whilst much of the region's surface water is ephemeral, there are a number of permanent pools and soaks that survive the hot summers as wetlands. Wetlands are an integral component of waterways management, providing very efficient biological filters within river systems and catchments, important refugia for biodiversity, high recreational values, and historical and cultural significance.

Groundwater is a very important resource throughout the region, as there is little or no surface water storage or runoff due to high temperatures and evaporation, geomorphology and low overall rainfall.

The Carnarvon Basin is a major physiographic area of subsurface storage comprising the Exmouth Gulf, Lyndon/ Minilya Catchment, Gascoyne and Wooramel systems, and Shark Bay. It is overlaid by unconfined, relatively young sedimentary silts and sands, with underlying, much older, consolidated sandstones, such as the Birdrong formation, which is a confined aquifer. This system covers 50,000 square kilometres and forms the most extensive aquifer in the Gascoyne Groundwater Area.

The groundwater of the Cape Range region, an area just north of the Lyndon/ Minilya Catchment, is very significant as a karst environment (cave system) supporting a suite of subterranean fauna of significant conservation value. The town of Exmouth and the surrounding infrastructure also draw water from this groundwater resource.

Most towns, tourist centres, industry and agriculture in the region rely on groundwater as the only reliable supply and it is also used for irrigation in the lower Gascoyne horticultural region. The pastoral industry is also almost entirely reliant on subsurface groundwater.

Since European settlement almost 1,000 shallow bores and 100 artesian bores have been constructed for pastoral use throughout the Carnarvon Basin. Recently the Carnarvon Artesian Basin Rehabilitation Project has been implemented to rehabilitate, reticulate and decommission artesian bores that are not needed or not in use. As bores are progressively brought under control, the pressure of the Carnarvon Basin confined aquifer will stabilise and ultimately increase, bringing with it environmental and socio-economic benefits.

Seascape

The Gascoyne-Murchison contains exceptional marine biodiversity values. Shark Bay is Australia's largest enclosed marine embayment and its unusual geomorphology has produced a diverse ranges of marine communities including coral communities, seagrass meadows, mangroves and hypersaline communities. Assemblages of marine fauna and flora are rich and diverse often with an overlap of tropical and temperate species.

The largest seagrass meadows in the world occur at Shark Bay with an unusually high number of seagrass species. The wide sheltered bays provide habitat for an as yet little studied mollusc, crustacean, and other invertebrate fauna. Shark Bay supports significant populations of sharks, rays, manta rays and sea snakes and the area is utilised by at least 12 species of marine mammals and is also a gathering site for migrating Humpback whales. The population of Dugong in Shark Bay is one of the largest and most secure in the world.

The hypersaline embayments of Shark Bay such as Hamelin Pool are characterised by unique microbial communities (including those that form stromatolites) and massive deposits of coquina shell which are found nowhere else. A large part of Shark Bay is contained within the Shark Bay Marine Park and the Hamelin Pool Marine Nature Reserve.

The Ningaloo Reef is the only fringing reef coral reef in Australia and supports a complex coral reef system with high species diversity. It is the only Australian coral reef of a large size and quality which is easily accessible to visitors. The reef is bathed by clear oceanic waters relatively free of any land based pollutants which make an almost pristine environment for much of its 290 kilometre length. The reef system includes a biogeographic transitional zone between the widely distributed tropical fauna of the Indo West Pacific Faunal Region and the highly endemic temperate fauna of the Southern Australian Faunal Region. A large proportion of the tropical species are at the limit of their range.

The Ningaloo coast and reef system supports a great diversity of fish, coral, invertebrate and mollusc species as well as eight marine mammal species, turtles dugongs sharks and manta rays. Charismatic fauna such as the Whaleshark and Humpback whale are seasonal features of this coast.

A large part of the reef has been incorporated within the Ningaloo Marine Park and a proposal to extend the Marine Park to include most of the remaining reef is currently under consideration as part of the review of the Ningaloo Marine Park Management Plan.

The Gascoyne delta, littoral landforms and near shore marine environments close to Carnarvon and extending north and south from the town are important mangrove and seagrass habits. Extensive mangroves and inter-tidal flats are found around the coastline of Exmouth Gulf and these provide critical nursery areas for many species

Major challenges for NRM

The major challenge affecting NRM in the Gascoyne-Murchison is social decline. There is an ever decreasing population base limiting the number of people to affect NRM. This is compounded by the harsh economic realities facing many managers and users. With the limited number of managers and users and a need to spend money to survive, NRM often can become a low priority. This is again compounded by the uncertainty of land tenure for the largest proportion of land managers in the region, pastoralists.

This uncertainty of land tenure is being driven by a number of competing resource uses. Pressure for natural resources used by other major industries of the region are also under pressure by alternative resource uses, predominately tourism and conservation.

The pressures placed on the environment from tourism and current conservation practises also pose a number of major NRM challenges. Predominately the pressures from tourism relate to increasing pressure from visitation on fragile and sensitive scenic areas. Some areas, such as the Ningaloo Coast, of the Gascoyne-Murchison have received a focus to manage the future impacts of tourism.

There is no doubt that conservation is a value and use of natural resources in the Gascoyne-Murchison. However, as there is an increasing percentage of the region managed for conservation use there are a number of issues arising. These include the lack of personnel and funds to allow management consistent with conservation and the surrounding uses. For example, the lack of management on conservation lands can lead to a build up of feral animals such as goats and wild dogs. This results in the conservation value of the area declining and impacts on surrounding resource users.

Another major shift required for conservation in the Gascoyne-Murchison region is the recognition and encouragement of off-reserve conservation. Many of the other users and managers of the region have and will continue to manage for conservation values. A number of pastoral leases have been obtained by conservation groups who are working towards conservation outcomes. Many pastoralists have identified fragile areas of their properties that are being managed for conservation. These types of conservation uses need to be recognised and encouraged through stewardship programs as it removes the burden from government for management.

Additional NRM challenges in the Gascoyne-Murchison are in the form of pest species present and those that are likely to occur. A number of pest species including weeds and feral animals are impacting negatively on the natural resources of the environment. Examples of these include the growing infestations of mesquite, the spread of tilapia through the Gascoyne and Lyndon River systems, cats, foxes and introduced marine pests.

The Goldfields-Nullarbor

Introduction

The Goldfields-Nullarbor sub-region has a population of around 44,000 in nine local government areas (Wiluna, Ngaanyatjarraku, Laverton, Leonora, Sandstone, Menzies, Coolgardie, Kalgoorlie-Boulder and Dundas) covering 930,000 km² (Figure 1). The local government areas vary widely in demography, especially the proportion of the population of Indigenous origin (Table 1). Approximately two thirds of the sub-region's permanent residential population lives in Kalgoorlie-Boulder, which is the major service centre and transport hub for the sub-region.

Table 1 Human geography attributes of Local Government Areas (LGAs) within the Goldfields-Nullarbor sub-region. (Source: ABS, 2001 Census)

LGA	Area (km ²)	Census Count § (Aug 7, 2001)	% of Census Count 'At Home'	% of Sub-regional population	Population density (km ² per person)	% Identifying as Indigenous	Median Age (Years)
Coolgardie	30,116	4,241	90.8	9.7	7.1	10.3	29
Dundas	93,186	1,646	66.9	3.8	57.0	9.4	37
Kalgoorlie-Boulder	95,576	28,818	92.6	66.0	3.3	6.3	30
Laverton	179,798	2,077	55.6	4.8	86.6	19.4	28
Leonora	32,89	2,950	58.1	6.8	10.9	9.5	33
Menzies	124,627	496	63.7	1.1	251.3	34.7	33
Ngaanyatjarraku	160,701	1,562	87.2	3.6	102.9	83.7	27
Sandstone	32,882	235	45.5	0.5	139.9	10	43
Wiluna	182,156	1,644	51.9	3.8	110.8	22.3	33
TOTAL	931,231	43,669	-	-	-	-	-
WA	2,528,000	1,851,252	93.7	-	1.4	3.2	34

§ Including 'fly-in fly-out' workers and other non-permanent residents on census night can significantly affect some figures- as indicated by relatively low 'At Home' percentages in places such as Laverton Shire.

Economic activity in the sub-region is overwhelmingly dominated by mining (principally for gold and nickel), with lesser contributions from tourism and primary production activities such as pastoralism and sandalwood harvesting (

Table 2).

Table 2. Selected economic characteristics of Local Government Areas (LGAs) within the Goldfields-Nullarbor sub-region.

LGA	Local Industries ◇	Value of Mining Activity 2001/02 (\$m) *	Value of Agricultural Production 2000/01 (\$m) *	Average 1999/00 taxable income for individual taxpayers (\$) #	Unemployment rate June 2003 Quarter†
Coolgardie	Gold & nickel mining; pastoralism; tourism; commercial/retail light industry	677.5	4.2	45,926	3.4%
Dundas	Gold mining, granite mining, pastoralism	100.0	4.6	33,002	4.6%
Kalgoorlie-Boulder	Gold & nickel mining, engineering and service industries, pastoralism, tourism	1,205.0	3.5	41,218	3.3%
Laverton	Gold & nickel mining, pastoralism, tourism	565.1	0.4	43,020	5.3%
Leonora	Gold & nickel mining, pastoralism, tourism	1,154.2	3.1	47,907	2.1%
Menzies	Gold & nickel mining, pastoralism, tourism	57.3	2.1	Not available	5.2%
Ngaanyatjarraku	Mining exploration, tourism, brickworks, indigenous art	0.0	0.0	40,857	13.6%
Sandstone	Gold mining, pastoralism, tourism	62.1	3.5	Not available	3.9%
Wiluna	Mining, pastoralism, horticulture	873.0	6.9	37,473	5.7%
TOTAL		4,694.2	28.3		

◇ Source: WA Local Government Directory 2003 – 2004

* Source: ABS

Source: ATO

† Except for the Shire of Ngaanyatjarraku, the figure for which is for the 2000 March 2000 quarter Source for all: Department of Employment and Workplace Relations.

History and Peoples of the Goldfields-Nullarbor

Aboriginal History, Organisation and Issues

Prior to European contact, the Aboriginal population of the sub-region existed in a number of linguistically distinct groups (Figure 2). The people of the Western Desert occupied the mid-part and north of the sub-region, whilst the southern coastal areas were populated by Nyunga in the west and by Ngadjunmaia/ Mirning in the east.

Subsequent to European settlement, there has been frequent displacement from traditional areas and movement towards regional population centres. This movement has not been complete and, for instance, in parts of the Great Victoria and Gibson Deserts, Aboriginal people have maintained continual, strong cultural links to their lands. The majority of the sub-region's Aboriginal communities are in the Shire of Ngaanyatjarraku, including the population centres of Warburton, Tjirrkarli, Mantamaru, Papulankutja, Irrunytju, Tjukurla, Wanna, Patjarr and Waakurna. (Figure 2)

There are two Native Title Representative Bodies in the Goldfields-Nullarbor sub-region - the Ngaanyatjarra Council and the Goldfields Land and Sea Council. As well as being the Native Title Representative Body for the Central Desert Region, the Ngaanyatjarra Council is active in areas such as research and mediation, dispute resolution, mining negotiations, health, education, housing, financial services, cultural and heritage protection and policy development. It maintains a Land Management Unit for the 9,812,900 hectare Ngaanyatjarra Lands IPA, which includes large portions of the Gibson Desert, Central Ranges and Great Victoria Desert Bioregions. It has memoranda of understanding with CALM for joint management of two pastoral leases in the Wiluna area, is working with the Patjarr community and CALM to develop a joint management partnership for the Gibson Desert Nature Reserve. The Ngaanyatjarra Council has also facilitated the establishment of several substantial commercial enterprises that serve the Ngaanyatjarra Lands. The Goldfields Land and Sea Council services the remainder of the Goldfields-Nullarbor sub-region, including Nullarbor coastal areas and the Goldfields proper. The Goldfields Land and Sea Council is actively building its capacity to provide land management services within its area of responsibility.

Other local Indigenous entities operating in the sub-region include:

- Aboriginal Movement for Outback Survival Inc (AMOS)
- Bay of Isles Aboriginal Corporation
- Esperance Aboriginal Corporation
- Iragul Aboriginal Corporation
- Jigalong Community Council
- Leonora Aboriginal Corporation
- Menzies Aboriginal Corporation
- Ngaanyatjarra Pitjantjatjara Yankunytjatjara (NPY) Women's Council
- Nganganawilli
- Ninga Mia Aboriginal Corporation
- Nooda Ngulegoo Aboriginal Corporation
- Paupiyala Tjarutja Aboriginal Corporation
- Tjuluru Cultural Centre, Warburton
- Upurl-Upurlila Ngurratja Inc. (Coonana Community)
- Western Desert Puntukurnuparna Aboriginal Corporation (WDPAC)

- Western Desert Regional Council
- Wongatha Birni Aboriginal Corporation
- Wongatha Wonganarra Aboriginal Corporation

In addition to the universal NRM issues of the Goldfields-Nullarbor, some uniquely Aboriginal issues can be identified. These issues, which are grounded in the culture and history of the indigenous people of the sub-region, include:

- Maintenance and enforcement of laws, traditions and care customs
- Adoptions of sites, practices and species (including non-indigenous species)
- Care of ceremonial sites and sacred places
- Views of landscape elements- including certain panoramic scenery and features (including the rights to commercial use of these views and images)
- Special rocks and paintings on rocks (including cave sites)
- Special tree sites
- Song, dance, ceremony and drama associated with places, landforms, resources etc.
- Artefacts, symbols and designs and the natural materials used to make and store them (including discarded tools, artefacts, remnants and residues)
- Healing objects, songs, rights and behaviours which may be linked to herbal, spiritual and geographic resources
- Adult status, knowledge, ownership and obligations for the use and enjoyment of natural resource assets.
- Knowledge of food and medicine systems and associated species
- Belonging to and rights in country (both with and without continuity of residence) principally by virtue of birth, but sometimes through residency, migration, marriage, adoption or gifting.

The assets associated with these exclusively Aboriginal issues are largely known and intact, including those in areas affected by pastoralism and mining, but action is needed to document and protect them.

European Settlement and Economic History

European development and economic exploitation of the region commenced late in the nineteenth century with the establishment of Noondoonia (1880), Balladonia (1883) and Nanambinia (1883) pastoral stations in the south of the sub-region, but pastoralism was overshadowed by the discovery of gold. Gold discoveries in the 1880s and 1890s led to the establishment of most of the settlements (e.g. Coolgardie, Kalgoorlie, Kambalda, Sandstone and Wiluna) that are the principal population and service centres today.

The first peak in a series of booms and busts in mining activity was reached in the early 1900s, and drove the provision of infrastructure such as telegraph, railway links and water supply. During this time Esperance was the principal port serving the sub-region. These developments stimulated and supported the establishment of pastoral enterprises in the north and west of the sub-region. In the Laverton/ Leonora area, Nambi Station was established in 1899, and Banjawarn in 1903. Laverton Downs was taken up in 1918, followed by Eristoun and Bandy in 1921. Yelma, Earraheedy, Windidda and Carnegie were established in the Wiluna area between 1901 and 1921.

The gold mining industry declined after 1908, but was revived after the deregulation of gold prices in 1931 and remained buoyant through the Great Depression, supported by increasing gold prices. In contrast, very high profitability of pastoralism between 1900 and 1930 led to

the take-up of most of the pastoral leases in the Goldfields. Sheep numbers in the Goldfields reached 440,000 in 1933, only to collapse during a subsequent major drought.

Another general decline in gold mining from the 1960s to the early 1980s was partly offset by the discovery of substantial nickel deposits, leading to the 'Nickel boom' of the late 1960s (and the re-establishment of Kambalda by the Western Mining Company). Rising gold prices and improved economic viability based on advances in mining and processing technology drove another rise in gold mining during the 1980s and 1990s.

Once again, the fortunes of the pastoral industry contrasted with those of gold mining. The 1960s saw the establishment of most of the Nullarbor pastoral stations and the return of high stocking levels in the sub-region. Total flock size peaked at around 410,000 in the late 1960s. In a repeat of the 1930s experience, these numbers were driven down sharply by a major drought. The total flock fell to around 150,000 in the early 1970s, before stabilising at around 250,000. The combined effects of the granting of equal minimum wages in 1966 and the general economic downturn of the early 1970s saw a major reduction in the size of pastoral station labour forces, and the displacement of many Aboriginal people from pastoral stations to towns such as Kalgoorlie, Norseman and Leonora.

Industry, Economy and Land Use

Although mining is the sub-region's dominant activity in monetary terms, the most extensive economic land-use is pastoralism. Pastoral leases cover 25% of the sub-region, predominantly on the Nullarbor and in the west of the sub-region. The more arid lands in the north and east are Unallocated Crown Land, Aboriginal lands, conservation reserves and other Crown Reserves or Special Crown Leases (Figure 1). Overall, 50% of the sub-region is Unallocated Crown Land, 11% is Conservation Estate, and 14 % is Aboriginal Land.

Pastoralism

There are 107 active pastoral leases in the sub-region. A traditional emphasis on merino sheep and wool growing is decreasing due to economic and environmental factors, and pastoralists are increasingly turning to other stock types such as meat-sheep (e.g. Dorper or Damara breeds), cattle and goats. One pastoral lease in the sub-region runs no domesticated livestock, but instead is devoted entirely to kangaroo harvesting.

Some pastoral lease holders now derive a significant proportion of their total income from non-pastoral activities such as support services for mining operation or tourism. In addition, a substantial and growing number of pastoral leases are held by mining companies (Figure 1) whose principal focus is not pastoralism *per se*. Mining companies sometimes acquire pastoral leases to secure access to subterranean water and/or to gain more-or-less unfettered control of the land surrounding their mining operations. Mining companies currently hold 29 pastoral leases in the sub-region.

Mining

The sub-region's mining industry is based on gold and nickel, but cobalt, platinum, palladium, silver, rare earths and uranium are also found in the area. Whilst precise levels of activity vary in response to world prices and economic activity, the sub-region typically accounts for around two thirds of the State's total gold and nickel production.

Whereas the early mineral booms were associated with local population and economic growth, the trend to fly-in fly-out operations has reduced the impact of new mining ventures on local populations, and local economies. For instance, Coolgardie had a population of 15,000 in 1898 - more than triple its current level.

The sub-region also has substantial manufacturing capability in Kalgoorlie-Boulder, principally to serve the needs of the mining industry.

Tourism

Tourism is a growing activity in the sub-region, but is still undeveloped, with much scope for future growth based on outback cultural- and eco- tourism. No estimate of the gross value of tourism in the Goldfields-Nullarbor is available. However, estimated total visitor spending in Tourism WA's Goldfields Region for 2003 was approximately \$180M². (Tourism WA's Goldfields Region differs from the Goldfields-Nullarbor sub-region by the exclusion of Sandstone and Wiluna, and the inclusion of Esperance and Ravensthorpe. This figure is therefore likely to be an overestimate of expenditure in the Goldfields-Nullarbor).

The Eyre Highway is the major road freight route connecting Western Australia to the east, as well as a significant tourist route. Its potential to bring tourism *into* the sub-region rather than *through* it is yet to be realised. This under-developed potential includes natural assets such as the world's largest arid-zone karst system, biodiversity assets (e.g. the Eyre Bird Observatory, unique arid woodlands and wildflowers displays) and significant heritage sites, that are easily accessible from the Eyre Highway.

Additional tourism opportunities also exist in other parts of the sub-region along relatively less accessible routes such as the Gunbarrel, Anne Beadell and Connie Sue 'Highway', the Canning Stock Route and the Great Central Road. These all offer an 'outback adventure' 4WD route for appropriately equipped travellers.

Cultural tourism, whether based on European heritage (e.g. the Gwalia townsite, or the Australian Prospectors and Miners Hall of Fame) or on Aboriginal culture (e.g. the Warburton Cultural Centre) also holds the promise of a more widely dispersed tourism industry.

Sandalwood Harvesting

The sub-region's sandalwood (*Santalum spicatum*) industry is based on the harvesting of naturally occurring rather than cultivated vegetation. Harvesting is performed under contract to the Forest Products Commission which allocates annual harvest targets within overall quotas. Harvesting mainly occurs on Unallocated Crown Land and pastoral leases.

Commercial Fishing

A small amount of commercial fishing activity occurs in the coastal waters of the Nullarbor Plain, but the precise extent and nature of the activity are not well documented.

Natural Resources

Climate, Landforms and Soils

The climate of the Goldfields-Nullarbor is arid to semi-arid. There is a rainfall gradient from a winter rainfall regime of around 300 mm annual rainfall in the south-west to a non-seasonal regime of approximately 150 mm in the northern Nullarbor area. The influence of tropical cyclones, in the form of rain-bearing depressions, can result in large rainfall events, especially in the north of the sub-region.

Four broad areas of distinctive landforms and associated geology can be identified within the sub-region.

² Source: Goldfields Tourism Perspective 2003, Tourism WA

The Nullarbor Plain and its surrounds in the south-east is characterised by the gently sloping limestone plateau of the Bunda Plateau with shallow calcareous loams and loamy earth soils. This large karst system has developed from sedimentary deposits of the Tertiary Period.

The arid areas of the north-east are dominated by the deep sandy and sandy earth soils of the Great Victoria Desert, Little Sandy and Gibson Desserts. The Great Victoria Desert is essentially a broad sandbelt, with patches of east-west trending longitudinal dunes, occasional low hills, breakaways and salt lakes. The sandy soils are interrupted in the western edge of the Gibson Desert, by an expanse of gravelly soils and loamy earth soils, before again becoming the dominant soil type in the Little Sandy Desert. The Central Ranges provide a small area of increased topographic relief, and small areas of clayey and loamy earth soils.

In the central west and north-west of the sub-region, the deep sandy soils give way to a complex mosaic of shallow earthy loams interspersed with areas of texture contrast soils and deep sands. The landscape features low hills, strike ridges and broken slopes formed from greenstone belts and areas of granite, as well as extensive sandplains. The greenstone belts weather to form relatively rich soils capable of supporting productive pastures; the granite-derived soils are generally less fertile and the sandplains are of limited pastoral productivity.

In the south-west of the sub-region, an area of deep sandy and sandy earth soils is separated from the shallow calcareous soils of the Nullarbor Plain by a broad belt of loamy earth soils, with smaller areas of gravelly, rocky or stony soils and texture contrast soils. Relief is higher than in adjacent areas, but variable, featuring residual sandplains, salt flats and broad valleys as well as abrupt hills, elongated ironstone ridges and breakaways.

Water

The majority of the Goldfields-Nullarbor sub-region is located within the Western Plateau Drainage Division, although there are also small portions of the South West and Indian Ocean drainage divisions. The Western Plateau Division is typified by uncoordinated internal drainage and is almost completely devoid of major riverine landform features.

One of the watercourses drain into the ocean but rather disappear in flat areas or shallow lakes. Most river systems within the division are short and all are ephemeral, flowing infrequently and briefly following large episodic rainfall events such as tropical cyclones and associated rain bearing depressions. During such events large areas are flooded as local basins fill and overflow, followed by an explosion of productivity by previously dormant organisms and mobile water bird populations. Flood events also flush accumulated organic matter (and associated nutrients) from permanent and semi-permanent pools and facilitate the movement of genetic material (i.e. gene flow) between pools or refuge sites.

Permanent or semi-permanent pools are vital to sustaining terrestrial and aquatic ecosystems between flood events. However, pools of this nature are very limited in their occurrence in the sub-region, and are threatened by disturbance by feral animals (e.g. camels) and by reduced levels of maintenance.

Three 'wild rivers', protected by their isolation, have been identified within the sub-region- Savory Creek, Herbert Wash and Ponton Creek. Savory Creek, which runs into Lake Disappointment from the west, bears some evidence of disturbance from livestock in its western parts, but otherwise is more or less pristine³. A recent study⁴ also found Herbert

³ May, J. E. and N. L. McKenzie (2003). A biodiversity audit of Western Australia's biogeographical subregions in 2002. Perth, Department of Conservation and Land Management.

Wash, Ponton Creek and their catchments to be in near pristine condition, with limited evidence of human activity. Other biologically significant catchments include the Rebecca and Giles creek systems in the Central Ranges Bioregion, and the West Clutterbuck Hills creek system of the Gibson Desert bioregion. These systems provide important refugia in the form of permanent and semi-permanent waterholes.

The sub-region has a number of ancient river systems that previously drained eastwards into the Eucla Basin beneath what is now the Nullarbor Plain. These paleochannels are now occupied by discontinuous chains of intermittently filled salt lakes underlain by sediments up to 70m thick and one kilometre wide⁵. They contain numerous wetlands (salt lakes) and considerable groundwater resources.

The sub-region contains significant amounts of groundwater. Several types of aquifer occur including:

- Fractured rocks aquifers (difficult to model, reserves poorly quantified)
- Paleochannel aquifers (major aquifer type, frequently saline or hypersaline)
- Unconfined alluvial aquifers (associated with paleochannels, varying salinity, reserves not quantified)
- Calcrete aquifers (generally brackish, with yields from bores highly variable)
- Sedimentary basin aquifers (Officer and Eucla Basins, variable salinity.)

These underground water bodies are important for the pastoral and mining industries, as well as directly and indirectly supporting significant biodiversity (e.g. stygofauna, troglodytic fauna, phreatophytic vegetation and wetland communities). Some significant towns of the sub-region, including Wiluna, Leinster, Leonora and Laverton derive town water supplies from groundwater.

Coastal & Marine Zone

All 3750 km² of Goldfields-Nullarbor coastal waters are within the Eucla IMCRA, while the coastal lands fall within the Hampton, Mallee and Esperance IBRA regions. The coastal climate is semi-arid, with average annual rainfall of 250 – 300 mm, decreasing from west to east. The offshore topological gradient is shallow, and the waters have a micro-tidal range of 0.8 – 1.2 m. The warm, temperate coastal waters are dominated by the Leeuwin Current.

The marine environment is poorly researched, although it is known that offshore areas feature deep seagrass meadows and algal beds, and the area is an important habitat for marine mammals. A number of species of commercial and/or recreational value occur in the coastal waters, including Southern Rock Lobster (*Jasus edwardsii*), several abalone species, scallops, snapper, trevally, cod and leatherjackets⁶.

⁴ Williams, P. J., L. J. Pen, et al. (1999). Wild rivers of Western Australia - the findings of the GIS preliminary identification and field verification phases of the Wild Rivers Project (Unpublished Draft), The Water and Rivers Commission, WA

⁵ Commander, D. P. (1993). Groundwater in the goldfields in Kalgoorlie as a regional industrial centre. Proceedings of the National Conference of the Australasian Institute of Mining and Metallurgy and the Institution of Engineers, Kalgoorlie 1993: 11-13.

⁶ WA Department of Fisheries (2004). A quality future for recreational fishing in the south coast- a five year strategy for managing the recreational component of the catch. Fisheries Management Paper no. 182. Perth

Biodiversity

The sub-region contains part or all of 13 IBRA bioregions (Figure 3), and, as noted above, all its coastal waters are within the Eucla IMCRA bioregion. The Coolgardie region is especially important as a biogeographic interzone (Beard's Southwestern Interzone for vegetation) between the arid interior and the moister south-west of the state. This area contains elements of the flora of both zones and consequently exhibits high levels of species and ecological community diversity.

Four broad types of vegetation community occur within the sub-region (Figure 3.) The Nullarbor Plain and its surrounds are dominated by low halophyll and sarcophyll communities (e.g. samphire, saltbush and bluebush communities), sometimes with trees such as *Eucalyptus gongylocarpa*, *E. youngiana*, western myall or mulga. The arid regions of the central north and north-east consist of large areas of hummock grasslands with varying tree and shrub associations, and low open mulga woodlands. The central west and north-west of the sub-region are predominantly mulga woodlands interspersed with smaller areas of tall shrubland and hummock grasslands. In the south-west there is a complex mix of vegetation types, including tall woodlands, with distinctive species such as the salmon gum (*Eucalyptus salmonophloia*) and gimlet (*E. salubris*), as well as areas of tall shrubland and shrub-heath. These woodlands are globally unique for such a dry area, and the trees they contain have attracted worldwide interest for use in arid-zone re-forestation and rehabilitation. Economically important areas of sandalwood (*Santalum spicatum*) also occur in the sub-region.

There are 266 listed flora (declared rare, threatened or priority plant species) and 63 threatened or priority animal species within the Goldfields-Nullarbor. There are also several ecological communities that are of interest either because they are facing particular threatening processes (e.g. granite rock pool communities are potentially threatened by reduced pool maintenance activity) or because they are peculiar to the sub-region and likely to contain highly unusual or biologically interesting species (e.g. troglobites and trogliphiles within the Nullarbor caves). Mammal extinctions since European settlement represent a particularly significant loss of the sub-region's biodiversity, with extinction rates of 40% - 60% being typical for Goldfields-Nullarbor IBRA regions.

The most widespread and serious threats for the region's biological resources include feral herbivores and carnivores, altered fire regimes, excessive total grazing pressure and weeds.

Major Challenges for NRM

There is no shortage of NRM issues in the Goldfields-Nullarbor sub-region. Specific issues among a host of pressing concerns include species and community conservation, weed and pest animal control, fire regimes, the availability and use of water resources, repairing the heritage of landscape damage from historical overgrazing, deficiencies in the state of biological survey, and the promotion of a 'sense of community'.

The most fundamental matter, however, is the capacity of a thinly spread community to muster the human resources to act effectively across a vast landscape – a basic lack of time to think and act – coupled with declining or erratic returns from traditional (non-mining) land uses which can erode the sense of community and belonging in rangeland populations. Without concurrent change in the institutional model of land administration and management, these factors leave the most important actors in rangeland Natural Resource Management caught between the immediate demands of economic survival and the need to invest resources in NRM activities for long term sustainability, which offer limited short-term returns.

FIGURE CAPTIONS

Figure 1. Major population centres, Local Government Areas and land tenure in the Goldfields-Nullarbor.

Show mining and non-mining controlled pastoral leases, major roads and tourist 4WD routes - Connie Sue, Gunbarrel etc

Figure 2. Aboriginal lands, communities and Tindale language group boundaries of the Goldfields-Nullarbor.

Show major roads and major population centres

Figure 3. IBRA Bioregions and major vegetation types in the Goldfields-Nullarbor sub-region.

Show simplified veg types from the EAGLE map – Halophyll and sarcophyll communities, Hummock (i.e. spinifex) and Bunch grasslands, Mulga Woodlands, Other woodlands, Shrublands, Vegetation mosaics