

**THE DEVELOPMENT, STATUS AND SOCIO-ECONOMIC  
LINKAGES OF KEY INDUSTRIES WITHIN AND ADJACENT TO  
THE NORTH-WEST MARINE REGION**

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## TABLE OF CONTENTS

<b>FIGURES AND TABLES</b>		v
<b>LIST OF ABBREVIATIONS</b>		viii
<b>EXECUTIVE SUMMARY</b>		ix
<b>1</b>	<b>INTRODUCTION</b>	1
	<b>1.1</b> Background and project rationale	1
	<b>1.2</b> Methods	3
<b>2</b>	<b>HISTORY OF THE REGION’S SETTLEMENT</b>	4
	<b>2.1</b> Indigenous history	4
	<b>2.2</b> Early European settlement and development	5
	<b>2.3</b> Pearling and fishing	6
	<b>2.4</b> Mineral resources	7
	<b>2.5</b> Oil and gas	8
	<b>2.6</b> Agricultural development	9
<b>3</b>	<b>DRIVERS OF CHANGE AFFECTING THE INDUSTRIES OF THE NORTH WEST MARINE REGION</b>	11
	<b>3.1</b> Global macroeconomic trends	11
	<b>3.2</b> International politics and policy	12
	<b>3.3</b> National and statewide economic conditions	13
	<b>3.4</b> National and statewide politics and policies	15
	<b>3.5</b> Regional and local conditions	16
<b>4</b>	<b>PORTS AND SHIPPING</b>	17
	<b>4.1</b> State and Commonwealth policy objectives	17
	<b>4.2</b> Activity at the State and National level	18

<b>4.3</b>	<b>Regional activity</b>	20
	<i>4.3.1 Trading activity</i>	20
	<i>4.3.2 Investment activity</i>	23
<b>4.4</b>	<b>Socio-economic dimensions</b>	23
	<i>4.4.1 Drivers of change</i>	23
	<i>4.4.2 Socio-economic linkages</i>	25
<b>5</b>	<b>OIL AND GAS</b>	28
<b>5.1</b>	<b>State and Commonwealth policy objectives</b>	28
<b>5.2</b>	<b>Activity at the State and National level</b>	29
<b>5.3</b>	<b>Regional activity</b>	31
	<i>5.3.1 Basin characteristics</i>	31
	<i>5.3.2 Basin access</i>	33
	<i>5.3.3 Title releases</i>	34
	<i>5.3.4 Production</i>	36
<b>5.4</b>	<b>Socio-economic dimensions</b>	37
	<i>5.4.1 Drivers of change</i>	37
	<i>5.4.2 Socio-economic linkages</i>	38
<b>6</b>	<b>COMMERCIAL FISHING</b>	49
<b>6.1</b>	<b>State and Commonwealth policy objectives</b>	49
<b>6.2</b>	<b>Activity at the State and National level</b>	51
<b>6.3</b>	<b>Regional activity</b>	53
	<i>6.3.1 Fish catches</i>	53
	<i>6.3.2 Employment</i>	58
<b>6.4</b>	<b>Socio-economic dimensions</b>	60
	<i>6.4.1 Drivers of change</i>	60
	<i>6.4.2 Socio-economic linkages</i>	61

<b>7</b>	<b>RECREATIONAL FISHING</b>	67
	<b>7.1 State and Commonwealth policy objectives</b>	67
	<b>7.2 Activity at the State and National level</b>	68
	<b>7.3 Regional activity</b>	69
	7.3.1 <i>Participation</i>	69
	7.3.2 <i>Location of activity</i>	72
	<b>7.4 Socio-economic dimensions</b>	74
	7.4.1 <i>Drivers of change</i>	74
	7.4.2 <i>Indigenous fishing activity</i>	76
	7.4.3 <i>Socio-economic linkages</i>	76
<b>8</b>	<b>MARINE TOURISM</b>	80
	<b>8.1 State and Commonwealth policy objectives</b>	80
	<b>8.2 Activity at the State and National level</b>	81
	<b>8.3 Regional activity</b>	83
	8.3.1 <i>Visitor numbers</i>	83
	8.3.2 <i>Tourism activity</i>	85
	8.3.3 <i>Tourism expenditure</i>	86
	8.3.4 <i>Employment</i>	88
	8.3.5 <i>Infrastructure</i>	90
	<b>8.4 Socio-economic dimensions</b>	90
	8.4.1 <i>Drivers of change</i>	90
	8.4.2 <i>Socio-economic linkages</i>	94
<b>9</b>	<b>PEARLING AND AQUACULTURE</b>	97
	<b>9.1 State and Commonwealth policy objectives</b>	97
	<b>9.2 Activity at the State and National level</b>	98
	<b>9.3 Regional activity</b>	100
	9.3.1 <i>Pearling</i>	100
	9.3.2 <i>Aquaculture</i>	103
	<b>9.4 Socio-economic dimensions</b>	103

	9.4.1 <i>Drivers of change</i>	103
	9.4.2 <i>Socio-economic linkages</i>	106
<b>10</b>	<b>EMERGING INDUSTRIES</b>	<b>110</b>
	10.1 <b>Agriculture</b>	110
	10.2 <b>Mineral processing</b>	111
	10.3 <b>Energy, oil and gas</b>	112
	10.4 <b>Manufacturing</b>	113
	10.5 <b>Tourism</b>	114
	10.6 <b>Aquaculture</b>	114
	10.7 <b>Indigenous-owned businesses</b>	115
<b>11</b>	<b>FUTURE DIRECTIONS AND ISSUES FOR INDUSTRIES OF THE NORTH-WEST MARINE REGION</b>	<b>116</b>
	11.1 <b>Oil and gas</b>	116
	11.2 <b>Ports and shipping</b>	117
	11.3 <b>Commercial fishing</b>	119
	11.4 <b>Recreational fishing</b>	121
	11.5 <b>Marine tourism</b>	123
	11.6 <b>Pearling and aquaculture</b>	124
	11.7 <b>Developing industries</b>	124
	11.8 <b>Development hotspots and trends over the next two decades</b>	125
<b>12</b>	<b>CONCLUSION</b>	<b>128</b>
<b>13</b>	<b>REFERENCES</b>	<b>130</b>

## FIGURES AND TABLES

### FIGURES

Figure 1.1	Location of the North-west Marine Region	2
Figure 4.1	Location of ports in Western Australia	18
Figure 5.1	Petroleum basins in the North West of Western Australia	32
Figure 5.2	Area of exploration and production titles released in the North West of Western Australia, 1985-2007	35
Figure 5.3	Location of titles released in the North West of Western Australia, 2005-2007	36
Figure 5.4	Direct employment in the minerals and petroleum sector, Western Australia 1995-2004	41
Figure 8.1	Regional Tourism Organisations within Western Australia	81
Figure 9.1	Zonation of the Western Australian pearl oyster fishery	101

### TABLES

Table 4.1	Trading activity in ports adjacent to the North-west Marine Region	21
Table 4.2	Tonnage of commodities traded through Port Authority ports adjacent to the North-west Marine Region 2005-06	22
Table 5.1	Quantity of petroleum production in Western Australia 1997-2006	30
Table 5.2	Value of petroleum production (\$m) in Western Australia 1997-2006	31
Table 5.3	Access to petroleum production basins in and adjacent to the North-west Marine Region, 2007	34
Table 5.4	Employment in the petroleum sector 2000 and 2001	39
Table 5.5	Employment in the petroleum sector 2004-05 and 2005-06	40
Table 5.6	Building activity in North West Western Australia, 2000-2004	43
Table 5.7	New dwelling unit construction in North West Western Australia, 2000-2004	44
Table 5.8	Committed oil and gas projects as of August 2007	47
Table 5.9	Oil and gas projects under consideration as of August 2007	48

Table 6.1	Volume (tonnes) of commercial fish catch in Western Australian state waters 2000-01 to 2005-06	52
Table 6.2	Value of production (\$'000) of commercial fish catch in Western Australian state waters 2000-01 to 2005-06	53
Table 6.3	Estimated catch and value of major commercial fisheries within and adjacent to the NWMR, 2000-2005	54
Table 6.4	Employment in commercial fisheries within and adjacent to the NWMR, 2005	58
Table 7.1	Projected total recreational fishers based on resident local population in statistical local areas adjacent to the NWMR 2001-06	70
Table 7.2	Projected total recreational fishers based on location on census night in statistical local areas adjacent to the NWMR 2001-06	71
Table 7.3	Attributable fishing expenditure by Western Australian recreational fishers by item category 1999-2000	77
Table 8.1	Visitor summary for Western Australia, 2006	82
Table 8.2	Distribution of all visitors to Western Australia by tourism region 2000-06	83
Table 8.3	Average number of annual overnight visitors to locations adjacent to the NWMR 2003-2006	84
Table 8.4	Location of tourism-related services along the coastline adjacent to the North-west Marine Region	85
Table 8.5	Direct and indirect economic impacts for tourism regions in Western Australia, 2001-02	87
Table 8.6	Employment in tourism in areas adjacent to the North-west Marine Region, 2004	88
Table 8.7	Numbers employed in tourist accommodation sector for the Coral Coast Tourism Region 2005-07	89
Table 8.8	Numbers employed in tourist accommodation sector for the North West Tourism Region 2005-07	89
Table 8.9	Tourism accommodation projects under construction in areas adjacent to the North-west Marine Region 2006	90
Table 9.1	Value of aquaculture produce in Western Australia, 2000-01 to 2005-06	99
Table 9.2	Volume of aquaculture produce in Western Australia, 2000-01 to 2005-06	99

Table 9.3	Value of pearl and aquaculture production in the NWMR 2002-2005	100
Table 9.4	Predicted future value of aquaculture in Western Australia, 2015	104

## LIST OF ABBREVIATIONS

AAPMA	Association of Australian Ports and Maritime Authorities
ABS	Australian Bureau of Statistics
ABARE	Australian Bureau of Agricultural and Resource Economics
ACWA	Aquaculture Council of Western Australia
AFMA	Australian Fisheries Management Authority
ATC	Australian Trade Commission
BRS	Bureau of Rural Sciences
BTRE	Bureau of Transport and Regional Economics
DAFF	Department of Agriculture, Fisheries and Forestry
DEW	Department of Environment and Water Resources
DFAT	Department of Foreign Affairs and Trade
DITR	Department of Industry, Tourism and Resources
DLGRD	Department of Local Government and Regional Development
DoIR	Department of Industry and Resources
DOTARS	Department of Transport and Regional Services
DPI	Department of Planning and Infrastructure
EPA	Environmental Protection Agency
FRDC	Fisheries Research and Development Corporation
MCE	Ministerial Council on Energy
WAFIC	Western Australian Fishing Industry Council

## EXECUTIVE SUMMARY

This Report identifies the current status of key sectors of economic activity within and adjacent to the North-west Marine Region (also referred to as the NWMR and the Region) of Australia and their linkages to the socio-economic characteristics of communities adjacent to the Region, commenting upon policies at various administrative levels and the likely scenarios of future development. This underlines the significance of the onshore minerals sector and the offshore oil and gas industry with respect to port and industrial development and the evidence for continued growth, particularly with regard to iron ore extraction and the production of liquefied natural gas. However, the Report also highlights the significant locational constraints which have restricted diversification of the North West's industrial base and are likely to continue to do so into the future.

There are a diverse range of tourism, recreational fishing and aquaculture activities which constitute important sources of income and employment to a number of dispersed communities throughout the North West and benefit to a large extent from the relatively undisturbed condition of the natural environment. The pearling sector is one example of an activity specific to the North-west Marine Region which represents a significant source of income and employment to settlements adjacent to the Region. Various new and developing industries also offer potential for further diversification of the North West's economy, although their future rests upon continued external investment in supporting infrastructure.

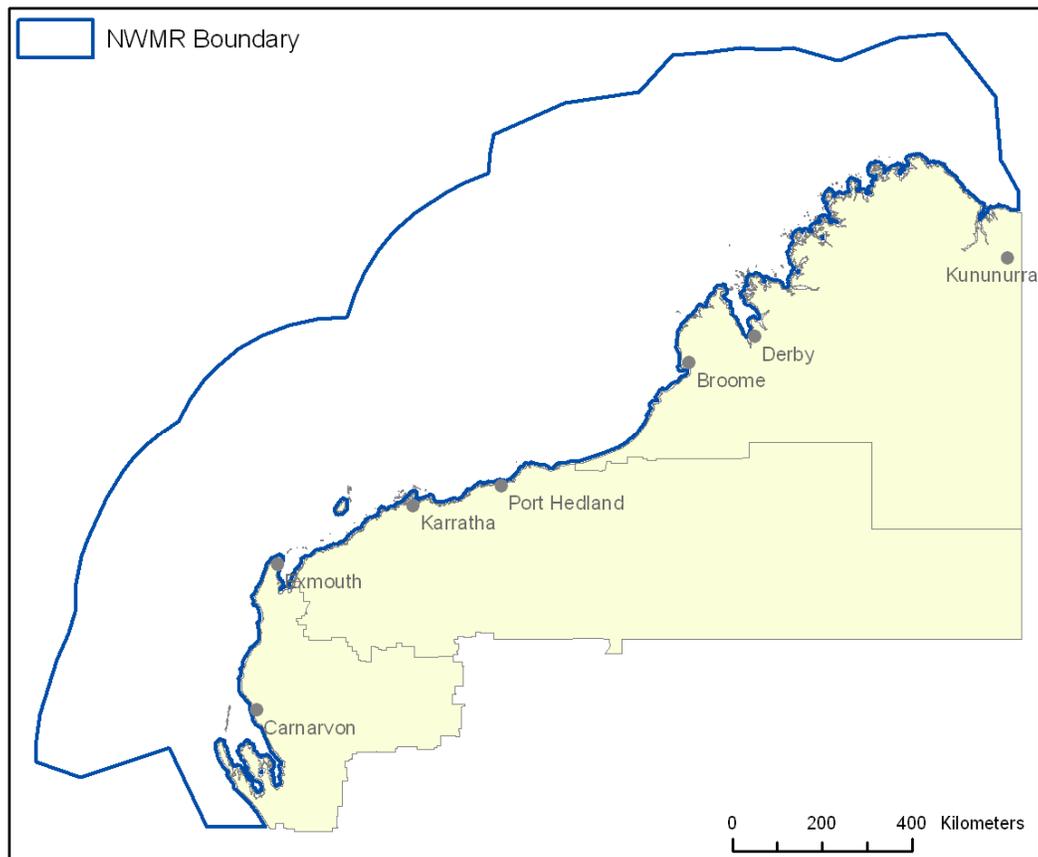
## 1 INTRODUCTION

### 1.1 Background and project rationale

The launch of *Australia's Oceans Policy* by the Australian Government in 1998 signalled the Commonwealth Government's commitment to the sustainable management of ocean resources. In 2005, the Australian Government brought its programme of regional marine planning, which was initially outlined in *Australia's Oceans Policy*, directly under the Environmental Protection and Biodiversity Conservation (EPBC) Act. Under this new approach Marine Bioregional Plans will be developed under section 176 of the EPBC Act.

Marine Bioregional Plans are intended to consolidate available knowledge to provide the best possible basis for decision-making about the conservation of the marine environment. Marine Bioregional Plans are being developed for 5 marine regions – the South-west, North, North-west, East and South-east. This report will focus on the North-west Marine Region, which stretches from Kalbarri in Western Australia to the WA/Northern Territory border and encompasses Commonwealth waters which stretch from the 3nm State boundary to the 200nm limit of the Australian Exclusive Economic Zone (Figure 1.1).

**Figure 1.1 Location of the North-west Marine Region**



This report has been commissioned by the Department of Environment and Water Resources to provide an assessment of the key industries within and adjacent to the North-west Marine Region, their inter-linkages and their likely future development in order to aid the process of marine bioregional planning in this Region. Specifically, the Report:

- Summarises the historical development of human settlement and resource usage in locations adjacent to the North-west Marine Region
- Provides an overview of the contemporary key drivers of change at the macro-economic scale affecting the coast and hinterland adjacent to the North-west Marine Region

- Summarises policy objectives at the national and State level for sectors of economic activity within the North West
- Describes the key aspects of economic activity for each sector within the North West
- Analyses the principal drivers of change and socio-economic linkages within each sector
- Identifies possible trajectories of growth and hotspots of development within the North West

## **1.2 Methods**

The key sectors of interest to this Report were identified through consultation with the National Oceans Office and were deemed to comprise the following:

- Ports and shipping
- Oil and gas
- Commercial fishing
- Recreational fishing
- Marine tourism
- Pearling and aquaculture
- Emerging industries

There are areas of overlap between these sectors, particularly with regards to ports and shipping and the oil and gas sector, as well as aspects of marine tourism which overlap with recreational fishing, which are recognised in the relevant chapters of this Report.

Information relating to each sector was collated primarily through analysis of secondary sources in the form of Commonwealth and State government documents, peak industry reports, academic journals and news websites. These were used to provide an up to date overview of each sector and as a basis for comment regarding the future projections of activity in each sector.

## 2 HISTORY OF THE REGION'S SETTLEMENT

### 2.1 Indigenous history

The North West coast of Australia has been inhabited by Aboriginal groups for at least 40,000 years. The socio-cultural structure of Aboriginal groups in the region was extremely complex, with at least 35 different language groups in the area between Kalbarri and the Western Australian- Northern Territory border. In simple terms, the Yamatji people occupied much of the area between Kalbarri and the Pilbara, while the Kimberley peoples (including Garadjeri, Bardi and Ungarin) tended to occupy the areas between Eight Mile Beach and the area to the east of the Western Australian-NT border. Given the complexity of Aboriginal society across the region prior to European settlement, it is difficult to make generalisations about the way in which coastal and marine environments were used. Nevertheless, it is clear that across much of the region there was extensive interaction with coastal and marine environments. In the dryer months, life tended to be centred on coastal areas and rivers, notably the Murchison, Fortescue, De Grey, Fitzroy and Ord. Consequently, there was a high dietary dependence on fish, turtles, frogs, crocodiles, birdlife and plant foods, though the spatial pattern of use varied considerably according to availability. During wetter months, groups often moved inland, exploiting alternative terrestrial food resources, notably kangaroos, wallabies, emus and birdlife. While sea level change has destroyed many sites, there is considerable evidence of the close relationship between Aboriginal groups and coastal and marine resources. Indeed, the first European contacts with the Region during the 1600s note the hunting and fishing activities of people along the coast (Battye, 1978).

Prior to European settlement, Aboriginal groups were not alone in their use of coastal and marine resources of the North West of Australia. Fishers from the area around contemporary Makassar in South Sulawesi visited the Kimberley, and perhaps as far south as Port Hedland, from at least the early 1700s (Mitchell, 1994), though some scholars have suggested contact with the coast may have been made as much as 300 years earlier. Initially, Makassarese fishers collected trepang, a genus of edible holothurians found in abundance on the seabed in shallow tropical waters of the Region (Stacey,

2007). Trepan was a valuable commodity amongst the Chinese where it is regarded as a culinary delicacy. The trade gradually extended to other marine resources, including turtle, turtle shell and shark fin. The archaeological record suggests a considerable degree of interaction between Makassarese fishers and Aboriginal peoples in the region. Stacey (2007) suggests that Makassarese use of the marine resources in this area was followed by other groups emanating from the Indonesian archipelago, with numerous visits to the Kimberley coast and offshore islands. Voyages from Indonesia to northern Australia began to decline in the latter part of the nineteenth century and had petered out by the onset of World War I, largely as a result of increasing regulation and protection of Australian waters.

## **2.2 Early European settlement and development**

The first European exploration of the North West coast of Australia was by the Dutch, notably Willem Janszoon (1606), Dirk Hartog (1616), Frederick de Houtman (1619), and Willem de Vlamingh (1697). The British explorer William Dampier made a thorough assessment of much of the coast between Dirk Hartog Island near Shark Bay and Roebuck Bay in 1699, while more than a century later expeditions by Baudin (1801) and Philip Parker King (1817) further improved knowledge of the Region. The enduring message of these visits was that the Region lacked the necessary resources and environmental conditions to make settlement a worthwhile proposition.

British colonisation of Western Australia began further south at King George's Sound (1826) and the Swan River Colony (1829), with virtually no interest in the North West coast. The primary activities in the waters off Western Australia during the period between the late 1830s and the 1860s were whaling and sealing, which was dominated by vessels from the United States (Paterson, 2006). Settlement began in earnest in the 1860s, following an expedition by Francis Gregory that reported extensive grazing land in the North West. From the mid 1860s, pastoral leases were granted over large areas of the Region between Geraldton and the Pilbara. Further surveys in the North West, notably by Alexander Forrest in the Kimberley in 1879, laid the basis for the ongoing expansion of the pastoral industry.

The emergence of the pastoral industry was followed by the establishment of small ports and service centres along the North West coast, with towns emerging at Carnarvon, Roebourne, Cossack, Point Samson, Port Hedland, Onslow, Broome and Wyndham during the latter 19<sup>th</sup> century. The Kimberley town of Wyndham also became a service centre and port for a short-lived gold rush in the Halls Creek area in 1886, though the rapid exhaustion of this resource saw it quickly decline. Limited downstream processing of livestock occurred in the region, although significant meatworks were established in Wyndham in 1919 and Broome in 1940.

### **2.3 Pearling and Fishing**

While pearling of various forms existed prior to European settlement, the industry has its modern origins in the 1850s at Shark Bay, when natural pearls were found in the *Pinctada albina* oyster. During the 1860s, the larger *P. maxima* oyster and high quality mother of pearl shell was discovered further north in the area around Nickol Bay, leading to an expansion of the industry in the Pilbara. The centre of the industry was Tien Tsin harbour, later renamed Cossack, which was established in 1863. The discovery of *P. maxima* and mother of pearl shell in Roebuck Bay underpinned the development of Broome, and by 1910 nearly 400 pearling luggers and more than 3,500 people were fishing for shell in waters around the town, making it one of the world's largest pearling centres. The majority of the workers were Japanese and Malaysian, but also included were Chinese, Filipino, Amborese, Koepanger (Timorese) and Makassarese, as well as Indigenous Australians.

The emergence of cheaper plastic options for buttons, belts and other shell products saw the price of mother of pearl shell drop considerably around the time of World War I. By the onset of World War II, the pearling industry had virtually collapsed in the North West. The industry was gradually revived in the 1950s with the emergence of cultured pearls. In 1956, a joint Australian-Japanese venture was established at Kuri Bay, north of Broome as Pearls Proprietary Ltd. The success of this venture led to the establishment of further enterprises, and by the early 1980s there were five pearl farms in the Broome

area. By 2005, almost all of Australia's cultured pearl farms were in the Kimberley region, collectively employing more than 1,000 people.

In addition to pearling, fishing has been widespread through the Region since the 1860s. Most coastal communities hosted small fishing fleets that serviced local markets, with remoteness being a major barrier to the establishment of large commercial industries. Improvements in transport and storage technology helped facilitate the gradual expansion of the industry from the start of the twentieth century. Inshore prawn trawling emerged as one of the more important fisheries in the twentieth century, particularly in the Shark Bay and Exmouth areas. Demersal finfish also consistently contributed to the commercial catch. The emergence of the Northern Prawn Fishery in the 1960s further expanded commercial fishing activity in the far north of the NWMR although effort is generally concentrated off the coast of the Northern Territory in the Gulf of Carpentaria.

#### **2.4 Mineral resources**

While discoveries of minerals (notably gold and blue asbestos) and isolated mining activities occurred in the terrestrial environments adjacent to the NWMR from the 1880s, it was not until the 1960s that the mineral resource potential of the Region began to be realised. Discoveries of large bodies of iron ore in the Pilbara during the 1950s were not exploited largely due to the embargo on the export of the resource which was lifted in 1960. Throughout the 1960s, agreements were made between the Western Australian government and mining companies to develop the Pilbara iron fields. Mines at Mount Goldsworthy and Shay Gap railed the ore to Port Hedland, while mines at Tom Price and Paraburdoo were linked to the port of Dampier.

The rapid expansion of the mining industry in the Pilbara led to considerable development along the coast, with the construction of large port facilities at Port Hedland and Dampier, and new coastal towns built at Dampier, South Hedland, and Wickham. A new regional centre was also established at Karratha. By the mid 1970s, more than 10,000 people were employed in the Pilbara's iron ore industry (Jarvis, 1979), with the majority of the resource exported to Japan.

During the 1970s, a number of other minerals in the North West were also extracted, including copper, tin, manganese, and gold. The past three decades has also witnessed the emergence of a diamond industry. Diamonds were first found in the Pilbara during the 1890s, though not in commercial quantities (LISWA, 2007). Other minor finds were made elsewhere, but it was the Kimberley area which was identified as a likely location for diamond bearing rock in the late 1960s. The first significant deposits were discovered in the Ellendale 'pipes' in 1976, followed by the Argyle deposit in 1979 (LISWA, 2007). Production at Argyle began in 1983. Economic concentrations of diamonds were also discovered at the adjacent Bow River in 1983, with production commencing in 1987.

Salt is also an important commodity in the region, produced using solar salt farms in a number of coastal locations. In the Pilbara, high temperatures and evaporation rates, impervious soils and low rainfall were recognised as ideal for salt farming in the 1960s. The first major salt producer was established in 1972 near Dampier, with further farms developed at Port Hedland and Onslow. The salt is mainly used in chemical industries, most commonly the chlor-alkali industry which produces chlorine, hydrochloric acid and caustic soda.

## **2.5 Oil and gas**

The exploration for oil in the north of Western Australia began in the 1920s, with much of the activity focussed on the Canning Basin, though limited success saw activity wind up in the 1940s. During the 1950s, the West Australian Petroleum Company (WAPET) commenced exploration in the Carnarvon Basin, with the first discoveries of non-commercial quantities of oil at Rough Range in 1954. In 1964, WAPET struck commercial quantities of oil on Barrow Island, with production commencing in 1967. By the 1970s, the Barrow Island fields had become the second largest oil producer in Australia.

Alongside oil, there was considerable interest in the potential natural gas reserves off the coast of North West Australia in the 1960s. WAPET was actively involved in gas exploration in the Exmouth Gulf, while Woodside Burmah Oil secured exploration

permits for 367,000 square kilometres off the Pilbara coast. A major gas field was eventually discovered by Woodside in 1971 in the northern Carnarvon Basin (on what is widely known as the North West Shelf). In 1977 the Western Australian State government approved the development of the North Rankin field by guaranteeing the domestic consumption of natural gas from the project. Delivery of North West Shelf natural gas began in 1984 under long-term contracts with the Western Australian public energy utility. The remainder of gas produced was to be exported as Liquefied Natural Gas (LNG). This began in 1989 under 20 year contracts with eight power and gas utilities in Japan. In addition, recent sales of LNG have been made to a number of countries, notably China as well as South Korea and the United States.

WAPET also made a major gas discovery at West Tryal, near Barrow Island, in 1973. Over the next two decades five fields were discovered - Gorgon, Chrysaor, Dionysus, West Tryal Rocks and Spar - called collectively, Greater Gorgon (LISWA, 2007). These deep offshore fields have been extensively appraised, including eight wells in Gorgon itself. The final two appraisal wells were drilled and tested in late November 1998. The Greater Gorgon gas fields contain resources of about 40 trillion cubic feet of gas, Australia's largest-known undeveloped gas resource.

## **2.6 Agricultural development**

While pastoralism has dominated the areas adjacent to the NWMR, more intensive forms of tropical agriculture are also present. During the 1920s, banana and pineapple production became an important industry on the Gascoyne River at Carnarvon, where irrigation channels allowed farmers to grow tropical and sub-tropical crops for both domestic consumption and export markets. Irrigation expanded further in the 1950s, and with improving road transport and food storage, accessing markets in Perth became a reality. The outcome was an increase in the production of vegetables such as beans, capsicums, pumpkins and cucumbers.

The Ord River in the Kimberley is the location of the other main area of intensive agricultural production adjacent to the Region. The Ord River Irrigation Scheme was

established in the 1960s as a means of facilitating development in the Kimberley. Stage 1 of the project, completed in 1966, involved developing 30 farms on about 10,500 hectares of irrigated land. Stage 2 saw the development of a further 2000 hectares in 1972. To service the new industry, the town of Kununurra was built. In the early years of the scheme, cotton was the main commodity being produced, though rising costs in insect control, fertilizers and freight brought commercial cotton to an end in 1974. The demise of cotton saw the introduction of crops such as sorghum, sugar, fruits and vegetables.

### **3 DRIVERS OF CHANGE AFFECTING THE INDUSTRIES OF THE NORTH WEST MARINE REGION**

The structure and dynamics of industries operating in or adjacent to the NWMR are affected by a range of processes operating at the global, national and regional/local scales. In reality, however, these are often interlinked and difficult to separate. These factors include:

- global macroeconomic trends such as world economic growth, trade patterns, commodity prices, energy prices, exchange rates, interest rates and demand;
- international politics and policies, such as industry protection, development policy, and geopolitical instability;
- national macroeconomic conditions, including economic growth, consumption patterns, and labour markets;
- domestic politics and policies, including taxation, industry protection, environmental policy, industry assistance and development;
- international and national population dynamics, including changes in population growth and distribution, migration and age structures;
- regional specific trends, including land supply, native title claims, views on the environment, regional development policy, demographic and labour market change.

#### **3.1 Global macroeconomic trends**

The performance of the North West's economy is, in large part, determined by wider international economic trends. As a trading nation, Australia is linked to other economies through trade, international financial markets and capital flows. Of particular importance is the economic growth rate of those nations that import commodities from the North West such as China, Japan, South Korea, the United States and the countries of South East Asia. Over the past three decades, the growth of these economies has impacted directly on the Region through rising demand for natural gas, iron ore, salt, agricultural commodities, diamonds, and fisheries products. While for much of the period between 1960s and 1980s it was Japanese markets for iron ore and other minerals that

underpinned the economy, the late 1990s saw China emerge as the major player with expanding regional exports of natural gas, iron ore and salt. The outcome has been a major expansion of production capacity, with concomitant increases in shipping and port activity, employment and population.

One of the apparent risks to the North West is that any economic slowdown in major export nations is likely to negatively impact on development. However, a downturn is unlikely in the short to medium term with recent forecasts from the OECD (2007) suggesting that over the next five years China's growth rate is likely to remain close to 10% and imports to Japan are projected to rise in 2008-2009. In terms of the broader world economy, the International Monetary Fund (2007) has forecast growth rates of around 5 per cent in the short to medium term. Continued growth in the world economy will influence the industries of the North West indirectly through its effect on the Australian economy, and in some cases directly through world markets for specific commodities. Of course, there is always a need for some caution, since broader growth forecasts cannot account for unexpected events, such as the recent credit squeeze in the United States.

International exchange rates also impact indirectly on the Region, largely through their impact on the cost of commodities to overseas buyers. Between 2000 and 2007, the value of the Australian dollar has increased steadily against the United States dollar, rising from a value of US\$0.58 to US\$0.84. Recent forecasts project a depreciation in the value of the Australian dollar over the coming five years (The Economist, 2007). Any depreciation against the currencies of major trading partners is likely to further strengthen exports of key commodities from the North West, particularly petroleum products and minerals, since these will become more competitive on the world market.

### **3.2 International politics and policy**

The international political and policy environment plays an important role in shaping the economic characteristics of the North West. Of particular significance over the past few decades have been international trade policies, and particularly the question of free trade.

For a number of agricultural, fishing and minerals sectors, protectionism in potential export markets impacts negatively on Australia. However, the increasing liberalization of global trade has improved market penetration, which has had indirect benefits for the North West export industries. Of particular note are the free trade agreements between Australia and New Zealand, the United States, Thailand and Singapore. Agreements are also being discussed with China, the United Arab Emirates and Malaysia. While there is considerable evidence to suggest that free trade agreements will increase international market penetration for certain industries (e.g. agriculture), it is important to note that the benefits will not always be in Australia's favour. Indeed, in some cases goods and services that are produced at a lower cost elsewhere are likely to have significant competitive advantages over those produced by local industries. Free trade agreements are likely to benefit the oil and gas, minerals, fisheries and agricultural sectors of the North West, since these can all be produced at a relatively low cost for international markets and are based on particular local environmental conditions. However, under free trade conditions, downstream processing of commodities might be diminished as a result of higher labour and other input costs than those elsewhere, particularly in developing nations.

All export oriented industries are susceptible to geopolitical instability. While the majority of the nations to which the Region's industries export are politically stable, broader international political upheaval can contribute to market instability, and erosion of investor and consumer confidence. However, predicting the risk of geopolitical instability to the industries of the North West is almost impossible. In some cases, instability can contribute to increasing investment and activity. For example, recent political upheaval in the Middle East has contributed to rising oil prices, which has resulted in increasing exploration in the NWMR and rising levels of investment in the major producers operating in the North West.

### **3.3 National and statewide economic conditions**

Given the economic structure of the North West, the main driver of investment and economic activity is global demand and related economic trends. Nevertheless, domestic

economic conditions also play a role. The past decade has seen Australia maintain relatively strong economic growth. The International Monetary Fund (2007) expects this to continue at between 3.5 – 4.0 per cent per year. Between 2000 and 2006, the Western Australian economy grew at more than 6 per cent per annum, with growth as high as 8.5 per cent in 2005-06 (WA Department of Treasury and Finance, 2007). Much of this growth was linked to the strong trading conditions in oil and gas and minerals. The main driver of this growth was business investment, which grew by 37% in 2005-06 (State Training Board, 2007). The rapid rate of expansion in the Western Australian economy has fuelled considerable investment in new projects, with over \$35.2 billion committed in the September quarter in 2006 alone (State Training Board, 2007). In the 12 months to September 2006, the value of projects under construction alone increased by 58 per cent.

While this general pattern of expansion is not restricted to the North West, it is clear that the range of resource related activities in the North West is a major driver of growth. This has generated significant demand for labour, infrastructure, land and materials. Moreover, it has the capacity to spill-over into a range of other sectors, including housing and social services.

Of particular note have been the impacts of strong economic growth on the labour force. Growth in employment directly related to mining and construction has been particularly vigorous, amounting to 19.3% and 13.1% respectively over 2005-06 (State Training Board, 2007). This compares to a State average employment growth rate of 4.4% over the same period (Department of Employment and Workplace Relations, 2007). During this period, the labour force of the NWMR grew strongly across a range of sectors related to mining, manufacturing, construction and other allied sectors (Clifton *et al.*, 2007). This growth is due not only to the number of jobs available, but also to the high wages paid by those industries operating in the North West. Increasing levels of employment have underpinned strong population growth. Alongside this has been a growth in fly-in/fly-out working operations in the mining and offshore oil and gas sectors, whereby workers live in the metropolitan centre or other large towns, flying in to work in the mining areas of

the North West for periods of two to three weeks at a time, which tends to disperse the economic and social impacts of growth.

The vibrant State economy contributes to strong domestic consumption of a range of commodities produced in the North West, including fish and other seafood, pearls, agricultural commodities and, of course, petroleum and mineral products. In addition, rising levels of affluence are contributing to increasing domestic tourism to the Region, with visitor numbers increasing in many coastal locations, notably the Ningaloo coast, Shark Bay World Heritage Area, Broome and environs, and the Kimberley coast (see Chapter 8).

### **3.4 National and statewide politics and policies**

Domestic politics and policies are an important driver of change in the North West. While it is not possible to provide a comprehensive overview of the various ways in which domestic policies at Commonwealth and State levels affect the Region, there are a number of policy arenas that are significant:

- Economic policy, particularly in relation to taxation, employment and industry assistance. These policy areas have the potential to affect the economic environment of the Region through their impacts on specific industry sectors, local and regional economies, and the broader State and national economies.
- Public infrastructure, particularly investment in ports, railways, roads, tourism facilities and telecommunications services.
- Environmental policy, notably the implementation of marine bioregional plans, the *Environmental Protection and Biodiversity Conservation Act, 1999*, various State government environmental regulations (e.g. marine area protection, recreational and commercial fishing regulations) and local government planning schemes.
- Land policy, in relation to both the release of land for commercial development and native title claims and negotiations.
- The relationships between the different tiers of government. One of the challenges facing Commonwealth, State and local governments is ensuring a degree of cross-

institutional consistency in policy approach when managing particular regions. The absence of policy integration and coordination not only has the potential to impact on the economic performance of the region, but also the condition of its natural environment.

### **3.5 Regional and local conditions**

The industries of the North West are not simply shaped by a range of global, national and state forces. Specific local economic, political and social conditions also affect the performance and structure of activity in the Region. These include:

- Local demographic change, including net migration rates, natural increase and age/sex structure (see Clifton *et al.*, 2007).
- The availability of economic resources, such as fish stocks, minerals, oil and gas, agricultural land, and tourism resources.
- Local views on development and the environment, which can affect the characteristics of individual projects, industries or localities. This is particularly important in the local planning and environmental approvals process, where views on issues such as Aboriginal heritage, environmental amenity and access to crown lands can have significant impacts on the nature of development.
- The local availability of infrastructure, labour skills and services, which can act to hinder or facilitate local growth. For example, significant housing shortages and high rental charges in many North West coastal towns are a major barrier to the attraction of labour for local industries.

There are a multitude of other local and regional conditions that can shape the nature of development and that are relevant to marine and coastal planning, although many of these are context specific and require detailed local investigation.

## **4 PORTS AND SHIPPING**

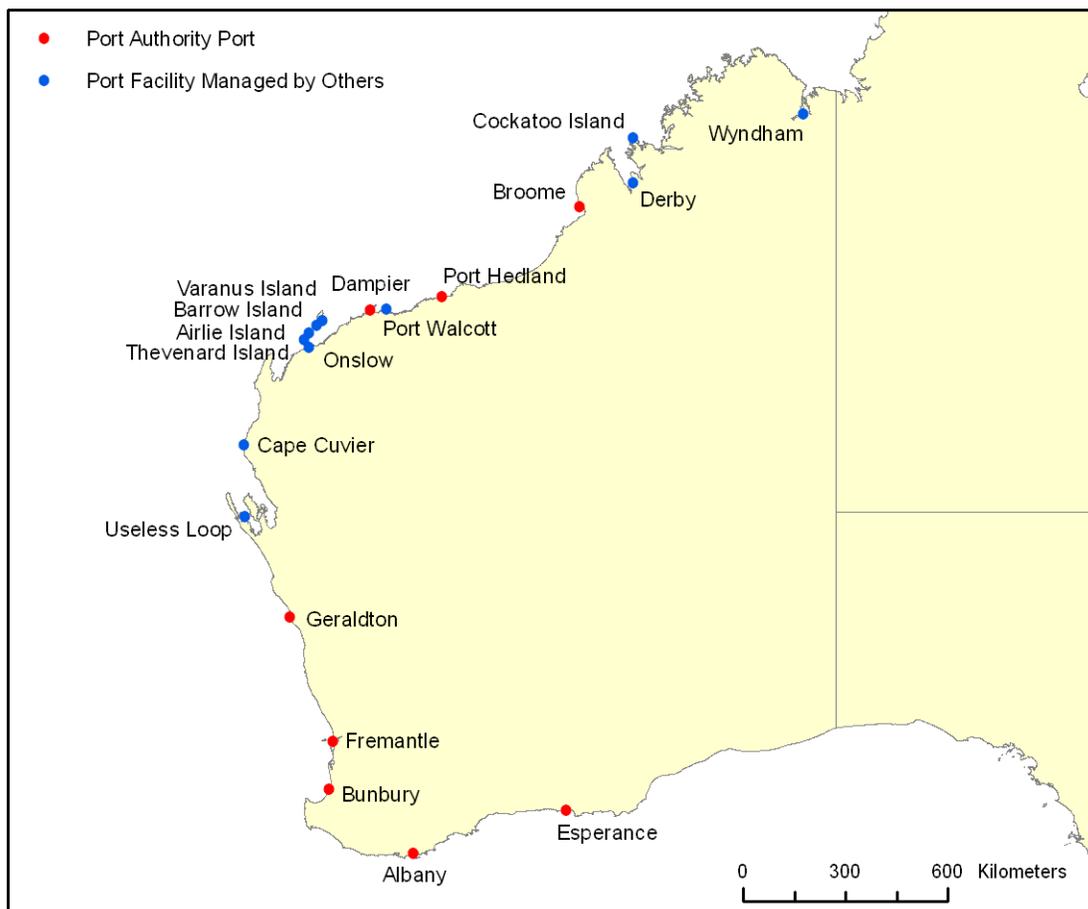
### **4.1 State and Commonwealth policy objectives**

There are a range of both Commonwealth and State departments associated with the operation of ports within Western Australia. At the Commonwealth level, the Department of Transport and Regional Services (DOTARS) acts to enhance Australia's infrastructure performance through the promotion of integrated transport development and provide funding for transport infrastructure, amongst other programmes of activity. Within DOTARS, the Australian Transport Safety Bureau and the Office of Transport Security have responsibility for matters relating to safety and security within ports, while the Bureau of Transport and Regional Economics (BTRE) acts to provide research analysis and data to aid decision-making and to inform public debate relating to transport issues including the maritime sector. Other relevant Commonwealth government departments include the Department of Industry, Tourism and Resources (DITR), whose portfolio includes matters relating to the freight industry and port development. The Australian Maritime Safety Authority is a separate Government agency with responsibility under the Australian Maritime Safety Authority Act 1990 for maritime safety and environmental protection including port-related activities.

At the State level, there are eight ports which are operated by autonomous commercial Port Authorities reporting to the Department of Planning and Infrastructure (DPI) and are represented at the national level by the Australian Association of Port and Maritime Authorities (AAPMA). There are also eight non-port authority ports which contain privately run export facilities. These are operated under agreements with the DPI which retains ownership of each port. The locations of these ports are provided in Figure 4.1. The Maritime Policy section of the DPI has oversight of policy issues and the provision of infrastructure for all of the State's ports. The DPI has established two industry bodies within Western Australia. The Western Australian Port Operations Task Force has responsibility for ensuring efficient movement of goods and vessels through the State's ports from an operational perspective, whilst the Sea Freight Council of Western

Australia is responsible for strategic policies involving the State's ports from a national perspective.

**Figure 4.1 Location of ports in Western Australia**



## 4.2 Activity at the State and National level

Data are published by the BTRE relating to the performance of Australia's ports at the national level, with the latest full financial year dataset relating to 2005-06. These data indicate that total international freight through Australia's ports amounted to 693 million tonnes in 2005-2006 with a total value of \$247 billion. Although 90% of this trade involved exports, the value of imports and exports were almost equal at \$120.5 billion and \$126.4 billion respectively (BTRE, 2007a). Data for domestic coastal freight is not available for 2005-06, but amounted to an additional 53.4 million tonnes in 2004-05,

which has remained stable since 2000-01 (BTRE, 2007b). In 2005-06, iron ore and coal were Australia's leading export commodities by weight, amounting to 255.9 million tonnes and 232.9 million tonnes respectively, whilst the main import commodities by weight were petroleum oil and refined products totalling 31.8 million tonnes and chemicals totalling 5.8 million tonnes. The leading export commodities in terms of value were coal and iron ore, totalling \$24.4 billion and \$12.8 billion respectively, whilst the main import commodities by value were machinery and road vehicles, amounting to \$26.9 billion and \$21.7 billion respectively. Imports of petroleum oil and refined products amounted to \$21.2 billion (BTRE, 2007a).

Western Australia is the leading export State in Australia, with total international freight moved through the State's ports amounting to 327.9 million tonnes in 2005-06, representing 47% of the national total. This State total comprised 316.6 million tonnes of export trade, amounting to 51% of the national export tonnage, and 11.3 million tonnes of imported goods, representing 16% of the national import tonnage. In terms of value, the total international freight handled by Western Australian ports amounted to \$52.1 billion in 2005-06, representing 21% of the national total. Of this, exports were worth \$38.8 billion and imports were valued at \$13.4 billion, amounting to 30% and 11% of the national value of exports and imports respectively (BTRE, 2007a). Western Australia's share of the national tonnage of international freight primarily reflects the activity in the ports of Dampier, Port Hedland and Port Walcott (also known as Cape Lambert), which are in the top five national ports in terms of tonnage, whilst Dampier and Port Hedland are the only ports in Australia handling more than 100 million tonnes per annum.

In terms of commodities traded through the State's ports, the northern ports generally handle mineral exports such as iron ore whilst the southern ports have focused on agricultural products, although the expansion of the minerals sector has resulted in southern ports such as Bunbury, Esperance and Geraldton recently exporting commodities such as iron ore and coal. The Pilbara ports of Dampier and Port Hedland remain the principal iron ore exporters, handling 88.7 and 100.1 million tonnes of iron

ore respectively in 2005-06 (DPI, 2007). Fremantle port handles almost all of the State's containerised trade, with minor activity at Geraldton.

The DPI is engaged in an ongoing programme of investment in the State's ports, reflecting the need to develop port infrastructure and dredging to accommodate increasingly large bulk cargo vessels as well as an increasing volume of containerised trade at Fremantle. This amounted to a total of over \$173 million being approved in 2005-06, with a further \$487 million being approved for expenditure over the period 2006-2010 (DPI, 2007).

### **4.3 Regional activity**

#### ***4.3.1 Trading activity***

Table 4.1 summarises the most recent data available relating to the volume of trade activity in the ports adjacent to the North-west Marine Region. This highlights the dominant position of Dampier and Port Hedland in terms of volume and value of trade as well as ship visits. The port of Broome handles a much lesser volume of throughput yet caters for a relatively large number of smaller vessels. Data related to the non-port authority operated ports is limited as these privately operated ports are not obliged under the same reporting requirements as the port authorities. Port Walcott is by far the busiest non-port authority port in the NWMR, exporting iron ore under the ownership of the Robe River Mining Company Pty Ltd. Barrow Island and Varanus Island are offshore terminals exporting crude oil and are operated by Chevron Australia Pty Ltd and Apache Energy Ltd respectively. Cape Cuvier and Useless Loop are salt exporting facilities operated by Dampier Salt Ltd and Shark Bay Salt Pty Ltd respectively. Wyndham Port exports general agricultural produce to domestic markets and is run by the Ord River District Cooperative. Yampi Sound exports iron ore under the operation of Portman Mining Ltd. The port of Derby was inactive with regards to exports in 2005-06.

**Table 4.1 Trading activity in ports adjacent to the North-west Marine Region**

	Value		Weight		Vessel calls <sup>a</sup>
	<i>Imports</i> \$ '000	<i>Exports</i> \$ '000	<i>Imports</i> (tonnes)	<i>Exports</i> (tonnes)	
<i>Port Authority ports</i>					
Broome	24,599	43,615	45,427	25,037	128
Dampier	1,315,323	13,194,072	521,030	110,003,781	3,062
Port Hedland	402,457	5,832,761	566,693	105,936,670	924
<i>Non-Port Authority ports</i>					
Barrow Island	n/a	n/a	n/a	n/a	64 <sup>b</sup>
Cape Cuvier	-	51,189	-	2,689,345	3 <sup>b</sup>
Carnarvon	669 <sup>b</sup>	2,940 <sup>b</sup>	28 <sup>b</sup>	286 <sup>b</sup>	n/a
Derby	22 <sup>b</sup>	-	95 <sup>b</sup>	-	n/a
Onslow	n/a	n/a	n/a	n/a	4 <sup>b</sup>
Port Walcott	66,608	2,455,132	73,566	55,233,299	306 <sup>b</sup>
Useless Loop	-	16,376	-	854,930	5 <sup>b</sup>
Varanus Island	n/a	n/a	n/a	n/a	108 <sup>b</sup>
Wyndham	52,849	285,411	69,352	325,933	5 <sup>b</sup>
Yampi Sound	780	62,027	714	1,109,412	2 <sup>b</sup>

(Sources: BTRE, 2007a; 2007b)

<sup>a</sup> Data refers to total number of calls by all ships involved in coastal and international shipping

<sup>b</sup> Data for 2004-05

More detailed data are available concerning the trading activity of the Port Authority operated ports adjacent to the Region. These are given in Table 4.2 in tonnes for the financial year 2005-06.

These data underscore the significance of iron ore exports from the Pilbara to the port industry at Dampier and Port Hedland, with exports being focused on the rapidly growing North-east Asia and Chinese market. Annual growth in total tonnage throughput from 2004-05 to 2005-06 reached over 15% in the case of Dampier and amounted to 2% with regard to Port Hedland, the expansion of trade in Dampier reflecting the increased production of iron ore and exports of liquefied natural gas as well as diversification into new products such as ammonia.

**Table 4.2 Tonnage of commodities traded through Port Authority ports adjacent to the North-west Marine Region 2005-06**

Commodity	Broome	Dampier	Port Hedland
<i>Exports</i>			
Ammonia	-	62,171	-
Chromite	-	-	259,458
Condensate	-	3,373,302	-
Copper concentrate	-	-	169,856
Copper ore	-	14,955	-
Iron ore	-	89,301,284	105,105,905
Liquified natural gas	-	11,762,093	-
Livestock	22,306	-	2,627
Manganese	-	-	1,058,844
Oil and petroleum	16,123	-	-
Salt	-	3,212,634	3,346,372
Other products	17,676	1,736,351	51,697
<b>Total</b>	<b>56,105</b>	<b>109,462,790</b>	<b>109,994,759</b>
<i>Imports</i>			
Oil and petroleum	89,454	412,654	433,807
Other products	16,821	193,702	195,517
<b>Total</b>	<b>106,275</b>	<b>606,356</b>	<b>629,324</b>
<b>TOTAL THROUGHPUT</b>	<b>162,380</b>	<b>110,069,146</b>	<b>110,624,083</b>

(Source: AAPMA, 2007)

In addition to iron ore and petroleum exports, salt mining is another significant sector in the North West. Already a well established industry, the Pilbara contains two of the largest salt mines in the State located at Dampier and Onslow. In areas adjacent to the NWMR, salt mining was valued at over \$210 million in 2004/05, representing over 95% per cent of the State's total salt production (Gascoyne Development Commission 2006; Pilbara Development Commission 2006). With close proximity to major export markets for this commodity, namely Japan, South Korea, Taiwan and Indonesia, the scale of production and value of salt is expected to continue to increase into the future. As mentioned above, the main ports utilised for salt exports include Useless Loop, Point Cuvier, Dampier and Port Hedland. The proposed expansion of the industry in the Pilbara has led to some conflict with other marine resource users, particularly pearl farmers around the Exmouth Gulf (ABC News, 2007a), which is discussed further in Chapter 9.

### **4.3.2 Investment activity**

With continual increases in export activity expected into the future, investment in port facilities in the region is of utmost importance. The two largest ports in the Region at Dampier and Port Hedland are set to receive \$7.6 million and \$4 million respectively for capital works projects from the State government for the 2007 financial year (Pilbara Development Commission, 2006). The Dampier Port Authority has assigned \$677 million for the development of facilities up to 2040, including improvements in wharf facilities, capital works, fuel storage and distribution, as well as road works and housing (Dampier Port Authority, 2007). A bulk liquids berth was completed at the port in late 2005 as part of the \$80 million investment in gas-liquid facilities for the future expansion of LPG and LNG trade. At Port Hedland construction of a new Panamax berth to the west of the port is well underway, expected to be operational in late 2008. The aim of the development is to significantly reduce minerals traffic through the town centre (Port Hedland Port Authority, 2006). These facilities are expected to enable greater trade of general cargo, containers, oil and acid imports, exports of copper and zinc concentrate and facilitate exports of iron ore by smaller operators. The port of Broome, on the other hand, services a greater range of industries including commercial fishing, marine charter tourism and the pearling industry as well as offshore oil, gas and petroleum industries. Broome has recently undergone expansion of facilities including an extension of the jetty and additional dredging to accommodate vessels up to 50,000 tonnes, particularly as a result of increasing use by the oil and gas sector in servicing exploration and development activities (DPI, 2007). Future investment in the port is anticipated to focus particularly around the needs of the offshore oil and gas sector and the marine charter industry which are discussed in more detail in Chapters 5 and 8 respectively, as these two areas of activity are predicted to continue developing at the greatest rates (DPI, 2007).

## **4.4 Socio-economic dimensions**

### **4.4.1 Drivers of change**

Due to the importance of the minerals trade to ports adjacent to the Region, the major drivers of change in ports and shipping are related to the macro level factors driving global economic activity. The strength of demand for Australia's mineral resources

particularly in East Asian markets has led to sustained demand and elevated prices for Australia's mineral exports on the world market (Minerals Council of Australia, 2006a). Statistics forecasting growth in the export price for 2006-07 relative to 2005-06 range from 0.5% to 60% depending on the commodity in question (Minerals Council of Australia, 2006b). Demand for Australian exports of coal, iron ore, petroleum products, natural gas and minerals contributed towards increased annual trade with China, Taiwan and Japan in the order of 41%, 32% and 24% respectively in 2005 (Department of Foreign Affairs and Trade, 2006). This has been underpinned by continued rapid economic expansion in China, which recorded a growth in GDP of 10.6% in 2006 (Minerals Council of Australia, 2006a). Demand for minerals and other natural resources in China and Japan is expected to continue into the future, given China's continued growth and the renewed strength and stability of the Japanese yen (Minerals Council of Australia, 2005a). The establishment of the ASEAN Economic Community over the period 2010-2020 also has the potential to increase minerals exports from the North West, as it represents Australia's single biggest trading partner, accounting for 15% of Australian foreign trade.

When projected growth trends are examined for the largest ports in the North West, anticipated development reflects the continuing demand for mineral commodities. Dampier for example has seen steady increases in trade throughput since 1990, particularly in the volume of iron ore passing through the port. A number of new projects being developed by Pilbara Iron are predicted to drive future growth in iron ore throughput, with an expected increase of around 4% per annum up to 2040 (Dampier Port Authority, 2007). While iron ore is currently the largest export commodity at the port in terms of tonnage, the most rapid rates of increase are predicted to involve exports of LNG, LPG and condensate, which are projected to increase at annual average rates of between 5.8% and 6.1% from 2006 to 2040. The increase in LNG reflects the investments by Woodside Energy Ltd in a fifth LNG train and the onshore LNG facility linked to the Pluto gas field detailed in Chapter 5, with a commensurate increase in condensate production. Overall, this would result in annual throughputs in the port of Dampier over the period 2006-2040 increasing from 11.7 million tonnes to 35 million

tonnes for LNG, from 3.4 million tonnes to 10.4 million tonnes for condensate and from 1.5 million tonnes to 4.4 million tonnes for LPG. Salt trading is predicted to become more significant in the ports of the North West, with an annual increase in throughput of 1.4% driving annual throughput from 3.2 million tonnes in 2006 to a projected total of 5.9 million tonnes in 2040 (Dampier Port Authority, 2007). Similar trends are anticipated at Port Hedland with iron ore throughput increasing by over 68% to 2020, particularly with the development of a new mining project at Hope Downs (Port Hedland Port Authority, 2003).

In this respect, demands on land and coastal infrastructure are one of the main factors promoting or constraining port development in the North West. Global trends of increasing vessel size mean port investment is needed in order to accommodate larger bulk and container vessels into the future. The requirements of Panamax and Capesize vessels in terms of approach channel and harbour depth, the ability to move cargo or containers through the port efficiently and stacking or storage requirements will all dictate that ports must plan ahead in order to retain their position on international trading routes (Port Operations Task Force, personal communication). Expansion of the iron ore trade in particular is likely to place increasing pressure on the ports of Dampier and Port Hedland, which are already in the planning stages of further development. There are however, some concerns as to the environmental impacts of ongoing port development, in particular impacts of further dredging and increased road and rail traffic on urban infrastructure.

#### ***4.4.2 Socio-economic linkages***

Representing the final destination of the supply chain for raw export commodities, port activity is a direct reflection of the intensity in activity of other industries in the hinterland. Given the positive outlook for the Australian economy as well as increasing demand for mineral commodities in Asian markets, the future stability of port operations seems assured. Compared to other marine based industries, ports are not major employers in regional areas, largely servicing industries outside of their immediate locations (Gripaios and Gripaios, 1995). This is reflected in the North West, with current full time

employment at the ports of Broome, Dampier and Port Hedland numbering 24, 26 and 23 respectively (Broome, Dampier and Port Hedland Port Authorities, personal communication, October 2007). However, these represent an increase in full time employment over the past three years in all cases. The port of Broome currently employs an additional 46 individuals on a part time basis, which has caused the total full time and part time employment to increase from 30 in October 2006 to 70 in October 2007.

Being relatively small employers in the area, there are certain multiplier effects of port activity which flow onto the surrounding hinterland. From a study undertaken of Fremantle Port, the multiplier effects were the most significant in terms of employment generated in the wholesale and retail trade sectors as well as in finance and business services (Bureau of Transport Economics, 2000). It is anticipated that these two industries would also benefit the most in the north of the State as a result of expanded port activity. From this study undertaken in Fremantle in 1999, for every ship call at the port an estimated \$785,000 of indirect benefit and 3.3 jobs (full time equivalent) were generated in the Western Australian economy (Bureau of Transport Economics, 2000). Assuming certain variables remained constant, an estimated value of \$2.6 billion and 11,000 jobs would have been generated in the State's economy as a result of ports and shipping activity in locations adjacent to the NWMR in 2004-05. However, it should be noted that, whilst there are no other studies detailing the regional economic impact of the ports adjacent to the NWMR, it should not be assumed that there is a direct correspondence between the impact of a port such as Fremantle with ports such as Dampier and Port Hedland, given the contrasting characteristics of trade through each port. Bearing this caveat in mind, the localised flow-on benefits of the port sector are amplified during construction and development phases, particularly if major redevelopments of port infrastructure are required (Gripaios and Gripaios 1995). Increased spending as a result of tourism is also a flow-on benefit from ports and shipping, particularly if commercial charter vessels utilise facilities of regional towns to restock supplies or as stop over destinations.

While not directly promoting regional development, the need for port facilities often acts as a node for community development, for example in the town of Point Samson. Originally established to service the local port, expansion of facilities and movement of shipping traffic to Dampier has resulted in Point Samson developing as a popular tourist destination with existing port facilities used largely by commercial and recreational fishing vessels. In this respect, establishing port facilities plays a vital role in the development of the entire North West.

Whilst the minerals sector in the North West is the major driver of port and shipping activity, this can also have undesirable impacts on local communities. Port Hedland is a primary example where some services in the local community have suffered as a result of mining and ports activity, particularly relating to the high cost of housing and the degree of investment in community services required by employees in the mining sector such as childcare. The inability of other sectors to match the wages in the mining industry has led to numerous positions remaining unfilled (ABC News 2007b; DPI 2004). In this respect, the benefits of continued port expansion fuelled by the minerals sector must be weighed against the potentially adverse socio-economic impacts on local communities and the inability of the regions to capture the benefits of resource development referred to as the 'fly-over' effect (Storey, 2001).

## 5 OIL AND GAS

### 5.1 State and Commonwealth policy objectives

With rising rates of global consumption and cost of petroleum, Australia's position within the global petroleum market can provide extensive economic gains for the nation's economy. In order to ensure profitable production and secure Australia's position on global markets, the government has been working with industry leaders in an attempt to secure Australia's petroleum future. In 2006 the State Department of Industry Tourism and Resources (DITR) announced a new government-industry partnership aimed at securing and increasing the nation's internal and external petroleum markets (Macfarlane, 2006). In coordination with the Australian Petroleum Production and Exploration Association (APPEA), the new Australian Upstream Oil and Gas Industry Strategy was announced in 2006 and is aimed at ensuring the long term sustainability of the industry on economic, social and environmental grounds.

In response to this, APPEA released the Strategic Leader's Report for the Upstream Oil and Gas Industry Strategy titled 'Platform for Prosperity' in 2007. The report outlines industry vision and targets for the next decade and identifies seven specific priorities including an improved fiscal framework for gas projects, improved framework for exploration, consistent and efficient national petroleum regulations, and promoting the greenhouse benefits of natural gas (APPEA, 2007). While these priorities are aimed at strengthening the petroleum sector as a whole in terms of its production, exploration and management, it is anticipated that future economic growth will predominantly come from increased LNG production.

In terms of national government oversight, DITR develops policy and administers legislation concerned with Australia's resources and energy industries (DITR, 2006). The Ministerial Council on Mineral and Petroleum Resources (MCMPR) mission is to contribute to the national wellbeing by promoting the progressive and sustainable development of the Australian mining, minerals and petroleum industry. In particular the Council's objectives include refining legislative and policy frameworks to ensure sustainable future development and encourage new and expanded investment in minerals

and petroleum development opportunities (DITR, 2006). Members of the council include Federal, State and Territory Ministers responsible for minerals and petroleum. The Ministerial Council on Energy (MCE) is the main governing body for the Australian energy market, providing oversight and coordination of policy development, and the integration of environmental impacts into energy sector decision-making.

In Western Australia, the Department of Industry and Resources (DoIR) is responsible for the development and management of the State's industry and resources. The DoIR reports to the Minister for State Development and administers State legislation concerned with the mineral and petroleum industries in Western Australia. Legislation oversight by DoIR includes petroleum production and exploration, resources access and availability, impacts on the natural environment and public interests. Currently Western Australia supplies over 80% of the nation's LNG exports and 8% of the world's consumable supply (APPEA, 2007). Most of this is exported from the Pilbara Region and as LNG exports increase over the next decade, North West Western Australia in particular is strategically positioned for significant economic development within the global petroleum sector.

## **5.2 Activity at the State and National level**

The oil and gas industries are major contributors to Australia's economy. From 2006 to 2007, 3.8% of the nation's total GDP, approximately \$40 billion, was attributed to petroleum production (ATC, 2007). Crude oil and other refinery feed stock dominate this sector of the economy, encompassing 50% of all petroleum exports in both 2005 and 2006. While crude oil exports are the mainstay of Australia's petroleum production, LNG is increasingly accounting for a significant percentage of petroleum exports, and comprised 33% in 2006 (ABARE, 2007). LNG is also viewed as providing the greatest potential for future growth in the industry, as exemplified by the 6% growth in exports in 2005-06. At present, Australian petroleum is predominantly destined for export markets.

In Western Australia, recent trends in the industry indicate fluctuating quantity and value of production, depending on the commodity in question. During the 2005-06 fiscal year, the value of petroleum in the state increased by 23% to over \$15 billion (DoIR, 2007a).

This growth can be largely attributable to LNG production as crude oil and condensate from 2000 have been experiencing declining productivity due to field maturity (see Table 5.1). Despite fluctuations in the production of certain petroleum products over the last five years, increasing prices on the global market have continued to augment the value of Western Australia's petroleum assets (Table 5.2). The most significant growth has been seen over the past three to four years particularly in the value of crude oil, LNG and condensate, all experiencing average growth of approximately 62% since 2003. In addition to production, Western Australia accounted for 48% of national expenditure on exploration in 2006, totaling around \$554 million (DoIR 2007a). In terms of international export, the Western Australian industry supplies over 11 nations globally with petroleum product. Japan provides the destination for over 45% of total exports, followed by South Korea (15%) and Singapore (11%). Crude oil and condensate in particular are aimed at South Korea (24%), Singapore (20%), Japan (13%) and Indonesia (12%). With the development of potential free trade agreements with Asian trading partners, currently in the stages of negotiation among others with Japan and China, these ratios are likely to change into the future.

**Table 5.1 Quantity of petroleum production in Western Australia 1997-2006**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Condensate (Gt)	6.4	6.4	5.6	6.2	6.0	6.9	6.4	5.9	5.9	5.6
Crude Oil (Gt)	9.5	11.0	8.5	13.7	14.1	12.3	14.1	12.3	13.2	12.0
LNG <sup>a</sup> (Btu x 10 <sup>12</sup> )	377.1	388.0	387.4	385.6	389.6	394.1	408.3	454.1	11.0	12.0
LPG-Butane <sup>b</sup> (kt)	320.4	384.5	390.1	450.6	475.3	458.2	425.2	398.8	870.7	862.2
LPG-Propane <sup>b</sup> (kt)	253.8	263.8	260.4	364.5	385.8	357.4	320.0	322.9		
Natural Gas (Gm <sup>3</sup> )	7.3	6.3	6.6	6.9	7.7	7.8	8.1	7.7	7.4	8.4

(Source: DoIR, 2007b)

<sup>a</sup>Expressed in million tonnes from 2005 onwards

<sup>b</sup>LPG Butane and Propane combined from 2005 onwards

**Table 5.2 Value of petroleum production (\$m) in Western Australia 1997-2006**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Condensate	1,103.3	887.1	1,013.3	1,946.4	1,787.9	1,928.6	1,765.5	2,011.1	2,576.9	2,940.3
Crude Oil	1,719.8	1497.6	1,559.3	4,472.4	4,246.7	4,502.7	4,034.6	4,211.6	6,168.8	6,646.8
LNG	2,037.6	2044.4	1,934.4	2,987.0	3,482.9	2,791.2	2,874.6	3,150.8	4,320.3	4,550.8
LPG- Butane <sup>a</sup>	93.2	86.3	116.6	225.4	217.5	197.6	182.8	189.3	544.2	613.8
LPG - Propane <sup>a</sup>	73.8	55.9	81.8	183.4	185.1	165.9	142.7	151.1		
Natural Gas	571.5	528.0	569.3	607.6	642.1	650.2	690.5	655.5	661.6	810.7
<b>Total Petroleum</b>	<b>5,599.2</b>	<b>5,099.1</b>	<b>5,274.7</b>	<b>10,422.1</b>	<b>10,562.1</b>	<b>10,236.2</b>	<b>9,690.7</b>	<b>10,369.4</b>	<b>14,397.9</b>	<b>15,562.5</b>

(Source: DoIR, 2007b)

<sup>a</sup>LPG Butane and Propane combined from 2005 onwards

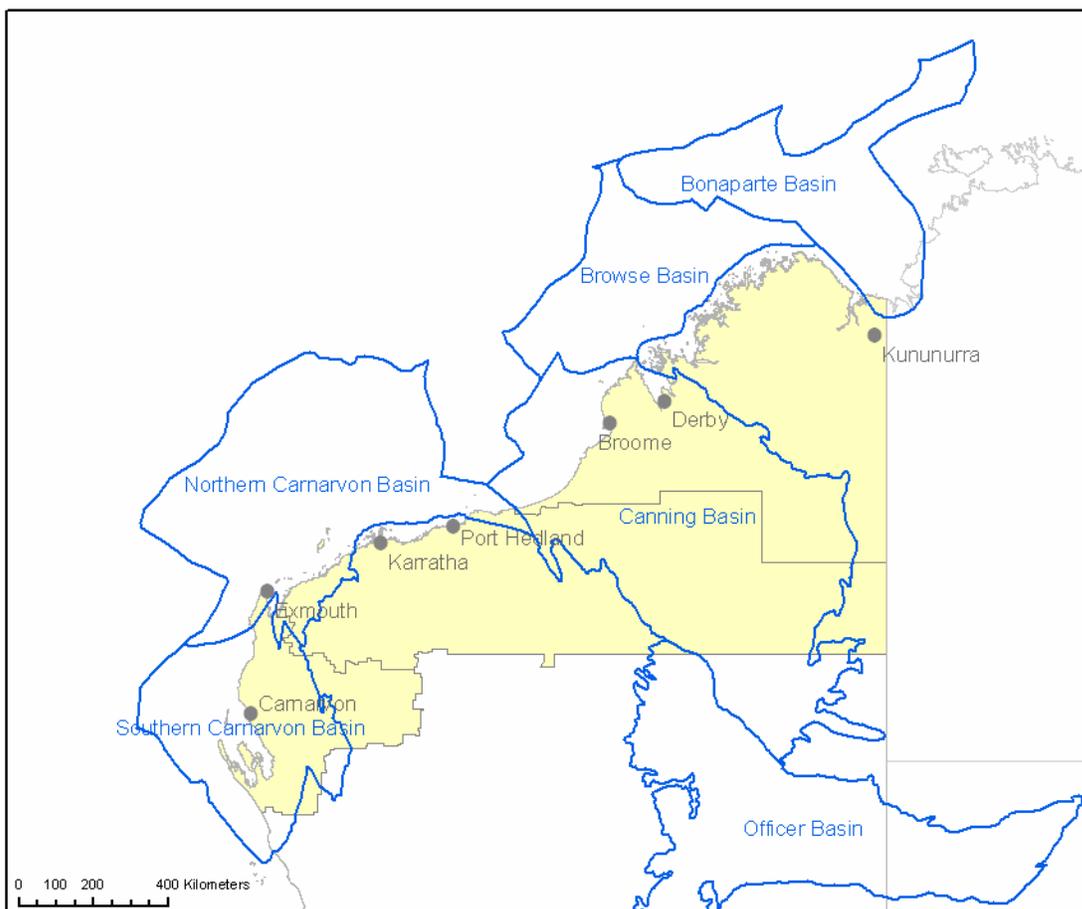
### 5.3 Regional activity

#### 5.3.1 Basin characteristics

Petroleum production in the North-west Marine Region and adjacent areas is focused on extraction from the six basins illustrated in Figure 5.1. Offshore production is centred in the Northern Carnarvon and Bonaparte Basins, while onshore, the Canning, Officer and Southern Carnarvon Basins provide the major locations for extraction (DoIR, 2007c).

One of the most heavily explored areas in and adjacent to the NWMR is the Carnarvon Basin, accounting for around 80% of total oil and gas wells drilled in Western Australia (APPEA, 2007). Forty six wells were in operation in 2006 extracting oil, gas and condensate, while the region is estimated to contain a further eight billion barrels of product of which only 10% have been discovered (DoIR, 2007c). Extensive gas reserves yet to be developed are located particularly off the coast of the Pilbara, including the Greater Gorgon, Scarborough and Macedon, as well as number of smaller fields in the North West Shelf Gas Venture's permit areas, extending around 130km off the Pilbara coastline (Chevron Corporation, 2007). The southern half of the basin has seen limited petroleum exploration, with the full extent of production potential yet to be determined. To date, two offshore wells have been drilled for testing purposes, while from the 75 drilled on land, no fields have yet been located (DoIR, 2007c).

**Figure 5.1 Petroleum basins in the North West of Western Australia**



(Source: Geoscience Australia, 2007)

The Canning Basin encompasses over 640,000 km<sup>2</sup> and has been a focus for exploration and development since the 1920s. Activity is predominantly located onshore, with 250 wells having been drilled to date, with a further 14 offshore. Minor production was recorded in 2006 primarily from the southern half of the basin, with ongoing exploration indicating that the region has great potential for further gas and oil production (DoIR, 2007c). With regard to the Western Australian portion of the Officer Basin, currently there is no oil and gas extraction in this area, however, exploration to date has identified some limited possibilities for future production. As a result of the basin's size and desert location, coupled with little industry infrastructure, many areas are yet to be explored (DoIR, 2007c).

The Bonaparte Basin extends across the northern reaches of Western Australian and bordering into the Northern Territory. Most production in the basin is based offshore with a total of 82 wells active in the area, and a further 10 located onshore in the basin. Current levels of production underline the Basin's capacity for further exploration particularly centred over the north-west Timor Sea. Seven gas accumulations have to date been located in Western Australia's portion of the Basin, as well as oil and gas accumulations and several extensive residual oil columns (DoIR, 2007c).

Finally, the Browse Basin encompasses approximately 140,000 km<sup>2</sup> and is located offshore north of Broome. Gas reserves in the Basin were discovered in the early 1970's, but development was considered to be too problematic due to its isolation and water depth. However, with rising global petroleum prices, sizeable resource discoveries and new exploration techniques, the Basin's reserves have attracted considerable interest from oil and gas companies to the point where petroleum production is considered viable. Large expanses of potential gas and condensate fields have been found on the outer and central portions of the basin with smaller discoveries along the eastern flank. The Caswell sub-basin contains a significant proportion of the petroleum in the Browse Basin, an estimated 101.4 GL of condensate and 860 Gm<sup>3</sup> of gas (DoIR, 2007c).

### 5.3.2 *Basin access*

The remote locations of many areas within and adjacent to the NWMR suggests that access to major reserves of petroleum and offshore infrastructure are major considerations for the industry (see Table 5.3). In terms of proximity and infrastructure, the Northern Carnarvon Basin is positioned optimally. Despite the majority of primary production fields being located offshore, the Basin can be accessed by road from several coastal towns including Exmouth and Coral Bay and via port facilities at Dampier and Port Hedland. The basin is also linked to Geraldton, Perth and Esperance via major pipelines. The southern half of the Basin is also linked by pipeline and contains additional port access available at Carnarvon. Fields located in the Browse and Bonaparte Basins can be accessed from the Port of Broome, however limited infrastructure has to date limited production levels. Facilities located at Darwin, including a pipeline to fields

in the Bonaparte Basin, make this town the more popular option. The Canning and Officer Basins contain the majority of the Region's terrestrial reserves and levels of access are varied, depending on the location of major highways and arterial roads, particularly those allowing access to port facilities in Broome. There is currently no pipeline access for the Officer Basin. Access into inland areas of both these Basins is problematic, and to date has influenced the level of exploration activity in this area.

**Table 5.3 Access to petroleum production basins in and adjacent to the North-west Marine Region, 2007**

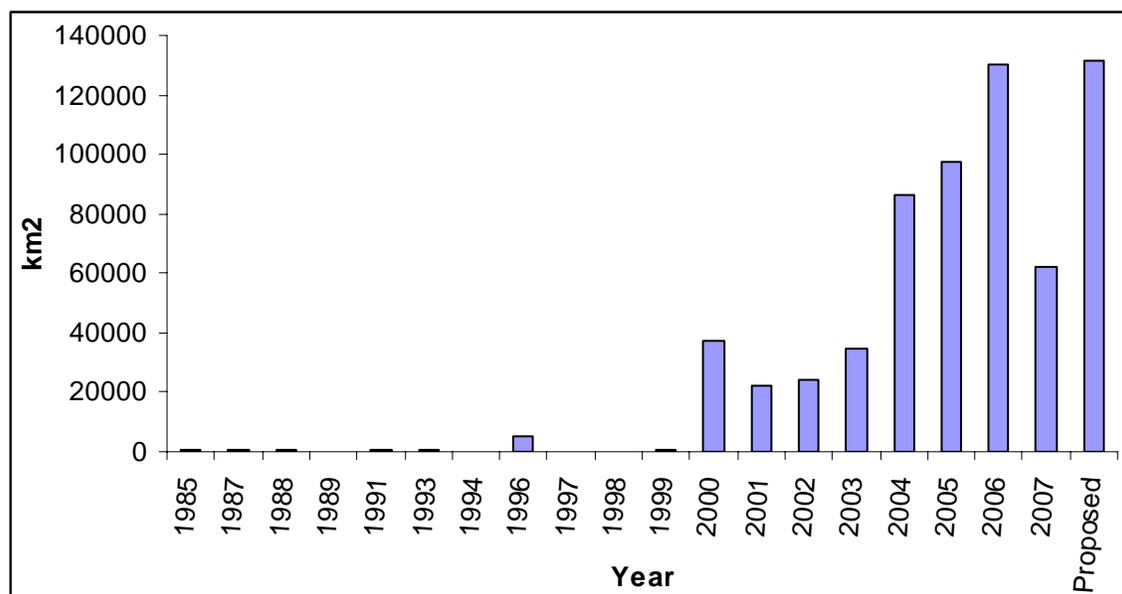
<i>Basin</i>	<i>Closest Communities</i>	<i>Onshore/Offshore</i>	<i>Transport Access</i>	<i>Pipeline Access</i>
Canning Basin	Broome Derby	Predominantly onshore	Major roads along coast; Port at Broome	Derby (minor)
Officer Basin	None	Onshore	Limited Major Roads	None
Southern Carnarvon Basin	Carnarvon Exmouth Coral Bay Denham	Both	Major roads along coast; Port at Carnarvon	Linked with Geraldton, Perth, Esperance (major)
Northern Carnarvon Basin	Carnarvon Exmouth Onslow Dampier Karratha Port Hedland	Predominantly offshore	Major roads along coast; Ports at Port Hedland and Karratha; Access from offshore islands	Linked with Geraldton, Perth, Esperance (major)
Bonaparte Basin	Kalumburu Wyndham Kununurra	Offshore	Limited; Port at Darwin	Darwin (major)
Browse Basin	Derby	Offshore	Limited; Port at Broome	None

### 5.3.3 Title releases

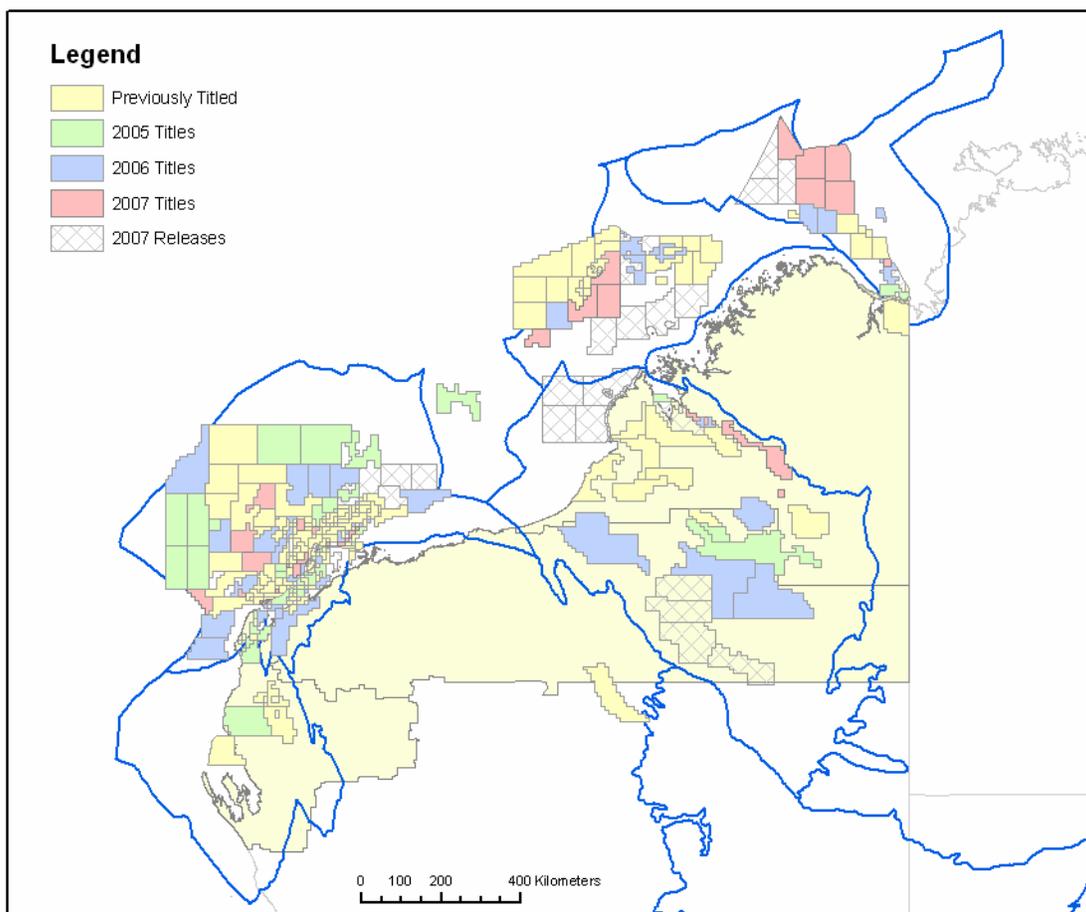
The spatial extent of petroleum exploration and the issuing of production titles in the North West have increased significantly since 2000, as illustrated in Figure 5.2. From 1985 to 1999 the exploration area of titles released per year was minimal, with a dramatic increase seen in 2000 when approximately 40,000 km<sup>2</sup> were titled for both production and exploration. This figure has continued to increase steadily with titles in 2006 accounting for a record 130,486 km<sup>2</sup>. Figure 5.3 illustrates the spatial distribution of petroleum exploration and production titles in the North West prior to 2005, and from

2005 to 2007. In the Bonaparte Basin, titles prior to 2005 tended to be distributed near the coast, however by 2007 five large tracts were titled further offshore and three more are pending release. Titles in the Browse Basin prior to 2005 extended much further offshore, while 2007 releases were predominantly adjacent to the coastline. A similar trend is visible in the Canning Basin where early land bound titles were located inland, while since 2005 titles have been extending further inland. In addition, 2007 releases will allow solely for offshore activity for the first time since reserves were found in this Basin. Petroleum exploration and production titles in the Carnarvon Basins were granted largely in central areas of the basin prior to 2005, however, since then, there has been substantial outward dispersion of titled tracts. Activity has been limited in the southern half of the basin with no new or pending releases.

**Figure 5.2 Area of exploration and production titles released in the North West of Western Australia, 1985-2007**



**Figure 5.3 Location of titles released in the North West of Western Australia, 2005-2007**



(Source: Geoscience Australia 2007)

#### 5.3.4 Production

Oil and gas production in the NWMR and adjacent inland areas is most significant in the coastal areas of the Pilbara. Crude oil and condensate produced in 2006 was valued at over \$9.2 billion, LNG at over \$4.5 billion, natural gas at \$781 million, with LPG butane and propane valued at over \$613 million (DOIR 2007b). In total, this equated to 49% of the value of the Pilbara's mineral and petroleum production for 2006 and 30% of Western Australia as a whole. Gas reserves in the Pilbara were estimated at 95.5 Tcf in the Carnarvon Basin, 30.3 Tcf in the Browse Basin and 29.5 Tcf in the Bonaparte Basin for the 2006 production year (DOIR, 2007a). In the Kimberley, the total value of crude oil produced in 2005 was \$3.4 million, while more recent data disaggregated to this level of

detail are unavailable (DOIR 2006). There are, however, significant reserves of both petroleum and gas in Kimberley offshore areas that have not yet been exploited, particularly in the Browse and Bonaparte Basins.

## **5.4 Socio-economic dimensions**

### *5.4.1 Drivers of change*

Several drivers affect petroleum production in the NWMR and adjacent areas. They include demand for oil and gas product, resource availability, the imminent national shift to a low carbon economy and associated community concerns with climate change, as well as workforce availability.

Petroleum production in the region is anticipated to continue well into the future, fuelled largely by demand from overseas markets. Links with the Chinese, Japanese and United States economies continue to be important drivers of the petroleum sector in Western Australia. The World Bank estimates that the Chinese economy grew by 9.9 percent in 2005 just slightly below the 10.1 percent growth witnessed in 2004 (DoIR, 2006). The United States economy grew by 3.5% in 2005, while in Japan growth of 2.9% was experienced (DoIR, 2006). Income growth has influenced consumer spending and increases in merchandise imports which are likely to have positive repercussions for energy consumption and imports of Australian petroleum. However, recent issues in the US housing market underline the volatility of the global economy and the difficulties in projecting future trends.

With decreasing reserves of oil and condensate in Western Australia and peak oil production expected to be reached in 2008-2009, gas will be increasingly important for the industry in the future. Currently, exports of LNG are worth more than \$2 billion annually and State reserves are expected to last until the end of this century, with unexplored fields potentially extending this into the next century (Combes, 2003). There are also a number of positive implications as a result of increasing reliance on natural gas for the future of the Australian economy. Natural gas is the most attractive transitional fuel available for Australia before renewable sources of energy such as solar or hydrogen

fuel cells become widely available. The combination of availability and lower carbon emissions than current energy sources makes it an attractive option for the future (Combes, 2003). This would allow Australia to be able to trade or restrict carbon emissions in order to reduce the potential impacts of climate change. Associated with this, increased public awareness and acknowledgement of global warming and urban air pollution is one of the main drivers of change. Consumer choice and awareness of the issues related to carbon emission and climate change could potentially play a vital role in LNG production for the domestic market.

Another significant driver for the activities of the petroleum sector in the North West of Western Australia is workforce availability. The industry is currently already experiencing bottlenecks in labour availability and this is anticipated to intensify into the future. Estimated labour needs for the next decade or so are around 16,000 positions in construction and operation, and the timing and number of projects play a critical role in the short term labour supply (Figgs and Standen, 2005). With a significant number of projects due to commence production within the next five to ten years (see Section 5.5.1), finding appropriately skilled staff is likely to be a challenge. Some analysts predict stunted future growth of the industry due to reduced labour availability, potentially leading to the consolidation of projects among major operators in order to meet the demand for skills (Donaldson, 2006).

#### *5.4.2 Socio-economic linkages*

##### *Employment*

Employment in the oil and gas sector has fluctuated but increased overall in recent years. With the development of various new oil and gas fields in and adjacent to the NWMR, the construction, ongoing maintenance and operation of these projects has generated significant demand for labour. Employment in the petroleum sector increased from 1,280 to 4,656 from 2000 to 2006, representing growth of over 260% (DOIR 2007; 2001). Tables 5.4 and 5.5 detail the levels of employment in the petroleum sector by operating site for 2000-2001 and 2004-2006 respectively. Due to the presence of the offshore petroleum sector in the North West of the State, communities in the area have also

benefited from indirect employment. The most recent figures of the multiplier effect of the petroleum industry are from 2003, when an estimated 17,000 jobs were generated indirectly as a result of the petroleum sector and 900 firms across Western Australia were dependent on the industry for their operations (Combes, 2003). However, the multiplier effect of this industry is more widely dispersed, with fly in fly out commuting to regional centres adjacent to the NWMR. This has a number of significant implications for these regional communities including a narrow demographic base and the majority of income expenditure being outside the region (White, 2004).

**Table 5.4 Employment in the petroleum sector 2000 and 2001**

<b>Company</b>	<b>Operating Site</b>	<b>2000</b>	<b>2001</b>
Apache Energy Ltd	Campbell, Agincourt/Wonnich, East Spar, Harriet, Sinbad, Tanami, Stag, Chervil, North Herald, South Pepper	190	208
ARC Energy NL	Dongara	6	6
BHP Billiton Petroleum (North West Shelf) Pty Ltd	Griffin	93	45
ChevronTexaco Australia Pty Ltd	Barrow Island, Cowle, Roller-Skate, Saladin, Yammaderry	114	158
Empire Oil & Gas NL	Rough Range	6	0
Hardman Oil & Gas Pty Ltd	Woodada	8	5
Kimberley Oil NL	Lloyd	4	4
Mobil Exploration & Producing Australia Pty Ltd	Wandoo	34	29
Nexen Petroleum Australia Pty Ltd	Buffalo	0	20
Origin Energy Resources Ltd	Beharra Springs, Tubridgi	10	10
Petro Energy Pty Ltd	Mt Horner	3	2
Woodside Energy Ltd	Cossack, Goodwyn, Hermes, Lambert, Legendre, North Rankin, Wanaea	812	759
<b>TOTAL</b>		<b>1,280</b>	<b>1,246</b>

(Source: DOIR 2001)

**Table 5.5 Employment in the petroleum sector 2004-2005 and 2005-2006**

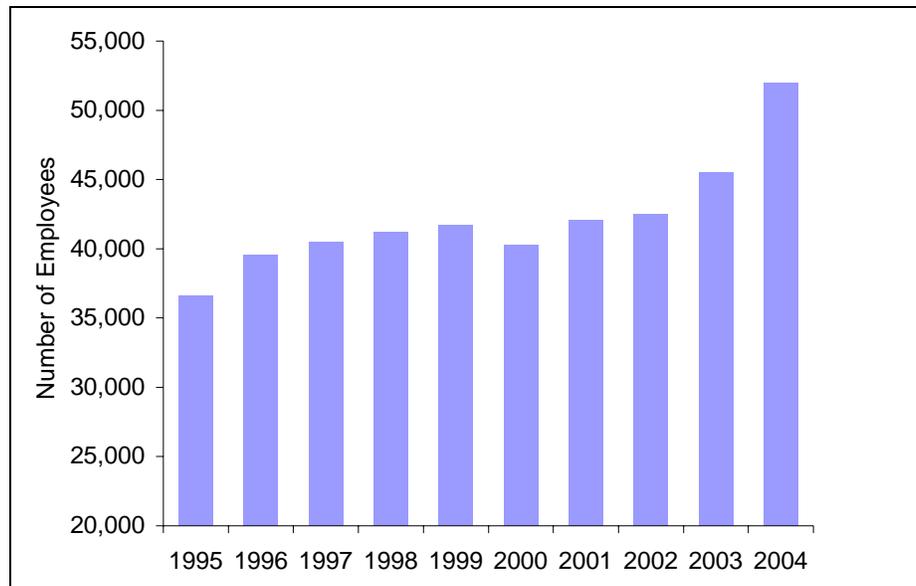
COMPANY	Operating Site	2004-2005	2005-2006
Apache Energy Ltd	Agincourt, Albert, Artreus, Bamba, Double Island, East Spar, Endymion, Gipsy, Gudren, Harriet, Hoover, John Brookes, Linda, Little Sandy, Mohave, Monet, North Alkimos, North Pedirka, Pedirka, Rose, Simpson, Sinbad, South Plato, Stag, Tanami, Victoria, Wonnich	383	214
ARC Energy NL	Dongara, Hovea-Eremita, Mt Horner, Xyris	27	20
BHP Billiton Petroleum (North West Shelf) Pty Ltd	Griffin, Chinook-Scindian, Tubridgi	125	90
ChevronTexaco. Australia Pty Ltd	Barrow Island, Cowle, Crest, Roller, Skate, Saladin, Yammaderry	817 (estimated)	848
Eni Australia Limited	Woollybutt	65	65
Kimberley Oil NL	Blina, Boundary, Lloyd, Sundown, West Terrace	4	4
Origin Energy Resources Ltd	Beharra Springs, Jingemina, Tarantula	39 (estimated)	30
Santos Ltd	Exeter, Mutineer	74	45
Vermillion Energy	Wandoo	28	43
Woodside Energy Ltd	Athena, Cossack, Echo-Yodel, Goodwyn, Hermes, Laminaria East, Legendre, North Rankin, Wanaea	3,054	3,297
<b>TOTAL</b>		<b>4,616</b>	<b>4,656</b>

(Source: DOIR, 2007)

The rapid expansion of the industry, particularly over the past five years, has placed significant strain on labour availability in the Region, as there is additional competition from other inland mining sectors which experienced growth at an equally rapid pace. Figure 5.4 shows employment in the minerals and petroleum industry across Western Australia and illustrates the rapid acceleration of employment generated from 2000 onwards as opposed to more gradual growth prior to this date. In addition, the average age of employees in the petroleum sector suggests imminent retirement for a large percentage of the workforce within the next decade or so. These factors have placed increasing strain on a labour market already facing difficulties in recruiting staff. Currently, oil and gas companies are sourcing skilled labour from overseas in an attempt to alleviate the shortage of workers, however, with skill shortages in the sector being a global trend, this approach is unlikely to provide a long-term solution. In addition, high wages in the sector in attempts to retain and attract workers have contributed to competition for labour resources across other industries in the region, contributing to the

overall labour shortage in the State. Particular occupations that are currently experiencing shortages include tradespersons and related workers, engineers and different occupations in the hospitality and health industries (ABS, 2006).

**Figure 5.4 Direct employment in the minerals and petroleum sector, Western Australia, 1995-2004**



(Source: DOIR, 2005)

### *Infrastructure*

Infrastructure development to support the needs of the oil and gas industry in terms of exploration and production is most evident in the Kimberley and Pilbara regions. Development of port facilities across the region will increase the capacity of potential throughput by the petroleum sector. This is particularly significant for the port of Broome with anticipated development of the Ichthys, Scott Reef and Brecknock fields in the Browse Basin in the near future. The development of the Ichthys field is planned to include offshore semisubmersible facilities and a subsea pipeline to a proximate offshore location. As the latter two projects are still in the appraisal stages, there are no definitive figures on investment or conclusive plans for required infrastructure.

In the Pilbara, development of the Australia's largest resource project, the North West Shelf Venture, since 1984 has provided the catalyst for infrastructure development in the area. Currently the project has three offshore facilities comprising the North Rankin Gas Platform, the Goodwyn Gas Platform and the Cossack Pioneer floating production, storage and offtake (FPSO) facility. Australia's largest onshore gas plant close to Karratha includes four LNG processing trains, a natural gas plant supplying to the State, LPG and condensate production facilities, and storage and loading facilities for LNG, LPG and condensate (Woodside 2006). Most recently, development of a fifth LNG train has been commissioned enabling production to increase by 8.4 million tonnes per year (Pilbara Development Commission 2006).

Further developments on the North West Shelf are expected in the near future. One example of upcoming development is Woodside's Pluto Project, which will involve the construction of an onshore gas processing plant and storage facilities on the Burrup peninsula and is anticipated to supply 3.75 million tonnes of LNG per annum to Japan. Due to commence production in late 2010, the project includes \$300 million investment in additional infrastructure in light of future expansion of the gas sector, and to allow the onshore plant to operate as an open-access facility with additional LNG trains (Woodside 2006). The Gorgon Project has recently been granted Ministerial approval to develop gas fields located around 200km west of Karratha. Associated with this project, two new LNG trains and an LNG processing plant on Barrow Island with a liquefaction capacity of 10 million tonnes a year are anticipated (Chevron Corporation, 2007).

In addition to industry specific infrastructure, the development of communication networks and other capital works are also anticipated as a result of activities of the oil and gas sector. Upgrades to Broome's waste water treatment plant and the Wyndham town water supply are likely to attract investment of over \$3 million. Additional investment will be made to improve road networks including stage one to three of the Broome Bypass, the Karratha-Tom Price Link and sealing the road linking Carnarvon and Gascoyne Junction. Upgrades to power infrastructure include extending and improving remote area power supply in the Kimberley and developing an extensive underground

power network in Port Hedland as a result of recent cyclone activity. An additional \$2.2 million has been provided to develop flood mitigation works along the North West Coastal Highway through the Gascoyne sub-region. All these projects will ensure the standard of living and ease of transport to remote areas servicing the oil and gas sector are maintained and improved into the future.

### *Residential Development*

The pace of development in the North West of Western Australia, largely as a result of the minerals boom, has resulted in pressure for residential and non-residential building developments. These are illustrated in Table 5.6, which indicates that, with the exception of 2001, new building units have been constructed at a rate of around 500 per year in the Gascoyne, Kimberley and Pilbara regions with a value approaching \$100 million each year. The short-lived decline in housing construction in 2001 reflects the period of economic uncertainty following the events of September 11 that year. Table 5.6 also underlines the rising value of non-residential building developments which will be largely associated with the minerals and oil and gas sectors.

**Table 5.6 Building activity in North West Western Australia, 2000-2004**

	2000	2001	2002	2003	2004	<b>TOTAL</b>
Number of total dwelling units	541	338	550	513	505	<b>2,447</b>
Value of total residential building (\$M)	84.0	55.3	96.0	99.3	101.0	<b>435.6</b>
Value of total non-residential building (\$M)	50.7	59.7	40.3	57.9	94.1	<b>302.7</b>
Value of total building (\$M)	134.7	115.1	136.2	157.3	195.1	<b>738.4</b>

(Source: ABS, 2004)

Table 5.7 provides further detail on the distribution of new dwelling units within the North West over this time period. This indicates that the rate of new dwelling unit construction in the North West represented from 2.1% to 2.7% of all new dwellings in the state between 2000 and 2004. Furthermore, these data underline the relatively slow rate of new unit construction in the Gascoyne as compared to the Kimberley and, more recently, the Pilbara, the latter two regions accounting for 94% of all new dwelling units constructed in the North West in 2004.

**Table 5.7 New dwelling unit construction in North West Western Australia, 2000-2004**

	2000	2001	2002	2003	2004
Gascoyne	98	38	64	60	31
Kimberley	349	219	335	316	249
Pilbara	94	81	151	137	225
Western Australia	22,937	15,293	20,387	21,799	23,709

(Source: ABS, 2004)

Due to the minerals boom in the north of the State, the cost of housing has been increasing rapidly over the past decade due to growing demand. For example, the value of residential and non-residential properties in the Pilbara fluctuated from approximately \$55 million to over \$112 million between 1995 and 2005 (Pilbara Development Commission 2006). Rental prices and the cost of land have deterred many employees in the oil and gas sector from relocating with their families to regional areas, in turn having socio-economic consequences for these communities (White 2004).

#### *Prospective future development*

Potential petroleum areas within and adjacent to the NWMR can be divided into onshore and offshore fields. Onshore, the Canning Basin may contain one of the most viable fields in the region, particularly around the Fitzroy Trough, although the size of this basin has left many areas still to be explored. The Officer Basin also has potential for both oil and gas production, however exploration is difficult due to remote locations and limited roads networks. The potential of the Southern Carnarvon Basin still remains largely undiscovered however preliminary exploration has yielded promising results (DoIR 2007c).

Offshore, the Northern Carnarvon Basin will continue to dominate petroleum production as currently an estimated 10% of the basin's reserves have been discovered. The Gorgon Joint Venture project between Chevron (50%), Exxon Mobil (25%) and Shell (25%) with PetroChina aims to provide one million tonnes of LNG annually to China over the next 20 years. This project will utilise a 40 trillion cubic foot reserve in the Basin, representing a quarter of known reserves in Australia (Reuters, 2007). To facilitate production, a gas

processing plant has been proposed for Barrow Island. The LNG plant will initially comprise two trains capable of producing a total of 10 million tonnes per annum and approximately three shipments per week are expected to leave a dedicated LNG loading jetty. This deal is expected to create 3000 jobs during construction and 600 full time employees, as well as overall increased economic activity in the towns adjacent to the NWMR (DoIR 2007d) and gained Ministerial approval in October 2007. Another major project due for development in the same basin is Woodside's Pluto LNG Project. Located 190km northwest of Karratha, the project received environment approval by the Federal government in October 2007. The Pluto project is specifically aimed at meeting increased demand for LNG on Asian markets, and is estimated to generate around 3000 jobs during the construction phase, 200 permanent positions as well as a further 3000 indirect jobs generated through related industries (DoIR 2007d).

Other projects for development in the region are located in the Browse and Bonaparte basins. The Ichthys gas and condensate field in the Browse Basin is located 440km north of Broome and exploratory wells have already been drilled. Production is expected to commence in 2012, and the project is anticipated to create 200 full time jobs. Gas and condensate fields located at Scott Reef and Brecknock in the same basin are currently in the stages of exploration and appraisal, and production is anticipated to commence around 2014 (DoIR 2007d). To the north, the Bonaparte Basin has potential to provide LNG to domestic consumers. The Petrel and Tern fields are being currently assessed for the suitability and are located around 250km west of Darwin, on the border with Western Australia (DoIR 2007d).

The DOIR provides biannual updates of mineral exploration projects which are committed and under consideration, with the most recent data from August 2007 summarised in Tables 5.8 and 5.9. Table 5.8 details new projects committed as of August 2007, all of which are in the Carnarvon Basin. Nine new projects were under consideration as of August 2007, with five again located in the Carnarvon Basin (see Table 5.9). Five of these projects alone have the capacity to increase LNG production by 44 Mt annually and create almost 16,000 new jobs in total during the construction and

operational phases. If all these projects are approved, expenditure is expected to total over \$55 billion over the next five years. While there is a considerable amount of development planned for the petroleum industry in and adjacent to the NWMR, the availability of labour is anticipated to increasingly become an issue, as discussed in Section 5.4.1.

**Table 5.8 Committed oil and gas projects as of August 2007**

<i>Field / basin location</i>	<i>Company</i>	<i>Type</i>	<i>Production</i>	<i>Jobs</i>	<i>Expenditure</i>
North West Shelf Project Expansion	Woodside Energy Ltd	5 <sup>th</sup> LNG train Loading jetty	4.4 Mt/a to commence 2008	1500 (construction) 20 (operation)	\$2.45 billion
Angel, Carnarvon Basin (offshore)	Woodside Energy Ltd	Production platform 3 subsea wells Subsea pipeline	800 million f <sup>3</sup> /d of gas 50,000 bbl/d of condensate to commence 2008	NA	\$1.6 billion
Stybarrow, Carnarvon Basin (offshore)	BHP Billiton Petroleum Pty Ltd	9 oil wells	80,000 bbl/d of liquids to commence 2008	NA	\$860 million
Vincent, Carnarvon Basin (offshore)	Woodside Energy LTD	Oil field	100,000 bbl/d to commence 2008	NA	\$1 billion
Pyrenees, Carnarvon Basin (offshore)	BHP Billiton Petroleum Pty Ltd	FPSO vessel, subsea wells and flowlines	96,000 bbl/d to commence 2010	NA	\$2 billion
Van Gogh, Carnarvon Basin (Offshore)	Apache Energy LTD	Oil field	63,000 bbl/d to commence 2009	NA	\$600 million

(Source: DOIR, 2007d)

**Table 5.9 Oil and gas projects under consideration as of August 2007**

<i>Field / basin location</i>	<i>Company</i>	<i>Type</i>	<i>Production</i>	<i>Jobs</i>	<i>Expenditure</i>
Greater Gorgon gas fields, Carnarvon Basin (offshore)	Chevron, ExxonMobil, Shell	Up to 30 subsea wells LNG production facility on Barrow Island	10 Mt/a of LNG	3000 (construction) 600 (operation)	\$11 billion
Ichthys, Browse Basin (offshore)	Inpex	Offshore semi-submersible facility LNG production facility on Maret Islands	8 Mt/a of LNG 312mmbbl/d condensate to commence 2012	2000 (construction) 500 (operation)	\$8 billion
Pluto, Carnarvon Basin (Offshore)	Woodside Energy Ltd	LNG production facility on Burrup Peninsula	5-6Mtpa	3000 (construction) 200 (operation)	\$6 billion
Scott Reef /Brecknock, Browse Basin (offshore)	Woodside Energy Ltd	LNG production facility	15 Mt/a of LNG to commence 2012-14	2000 (construction)	\$12 - 14 billion
Tern/Petrel Bonaparte Basin (onshore/offshore)	Santos Ltd	Gas field Pipeline Onshore gas plant	n/a	n/a	\$1 billion
Onslow (onshore)	BHP Billiton Petroleum Pty Ltd and Exxon Mobil	Onshore LNG production facility linked to Scarborough gas field	6 Mt/a of LNG	2400 (construction) 125 (operation)	\$5 billion
Pilbara Gas to Liquids Fuels	Sasol Chevron Australia	GTL plant drawing gas from Wheatstone field	45,000 bpd diesel 20,000 bpd of naphtha	3000 (construction) 300 (operation)	\$10 billion
Macedon, Carnarvon Basin (offshore)	BHP Billiton Petroleum Pty Ltd	Gas field – recovery to date is dry	n/a	n/a	n/a
Scarborough, Carnarvon Basin (offshore)	Exxon Mobil BHP Billiton Petroleum Pty Ltd	Gas field	Feasibility & feasibility assessment	n/a	\$100 million

(Source: DOIR, 2007d).

## **6 COMMERCIAL FISHING**

### **6.1 State and Commonwealth policy objectives**

The responsibility for management of commercial fisheries in Western Australia is shared between State and Commonwealth authorities through the Western Australian Government Department of Fisheries and the Australian Fisheries Management Authority respectively. The Constitution provides that the Commonwealth is responsible for the management of fisheries from 3 nautical miles (nm) offshore to the edge of the 200 nm Australian fishing zone, with States responsible for fisheries in all other waters adjacent to that State. While the 3 nm limit is a historical dividing line between Commonwealth and State jurisdiction, the Offshore Constitutional Settlement (OCS) of 1995 between the Commonwealth and the State of Western Australia specifies whether fisheries management in waters adjacent to or within the North-west Marine Region come under State, Commonwealth, or joint control.

Under the OCS Western Australia generally has responsibility for managing the majority of fishing adjacent to Western Australian State waters except where certain arrangements are in place (Department of Fisheries, 1995). These include:

1. the Northern prawn fishery - controlled by the Commonwealth;
2. Tuna and tuna-like fisheries - controlled by the Commonwealth;
3. Deep water trawling in waters outside the 200 metre isobath - controlled by the Commonwealth;
4. Shark fishing east of Koolan Island - controlled jointly by the State and Commonwealth under State law, referred to as the Northern Shark Fishery;
5. Demersal longlining and demersal gillnetting south of 33°S – outside the North-west Marine Region, controlled jointly by the State and Commonwealth under State law.

Bony fish such as snapper, sharks and rays and invertebrates such as rock lobster, prawns (excluding the Northern Prawn Fishery) and shell fisheries are the sole responsibility of the State.

Commonwealth managed commercial fisheries within the North-west Marine Region comprise the Northern Prawn Fishery, the North West Slope Trawl Fishery, the Western Deepwater Trawl Fishery and the Western Tuna and Billfish Fishery. Further details about these fisheries, including catch and value, is provided in section 6.3.

At the Commonwealth level, the Fisheries Management Act 1991 is the main legislation that governs fisheries. The Australian Fisheries Management Authority (AFMA) was established under this Act and is responsible for monitoring of fisheries activities within the Australian Fishing Zone and undertakes statutory licensing as well as ongoing research and policy development (AFMA, 2005). The AFMA is also the primary body dealing with illegal fishing activity by both domestic and international vessels. Specific policy objectives which currently govern the activities of the AFMA include reference to implementing cost-effective fisheries management, exercising a precautionary management approach consistent with ecologically sustainable development, meeting international obligations relating to fish stocks and avoiding endangering the living resources of the Australian Fishing Zone. Legislation at both State and Commonwealth levels includes a range of input and output controls such as restrictions on vessels and fishing gear, licensing, seasonal or spatial closures, size limits or catch quotas.

In Western Australia, the Department of Fisheries is the authority primarily responsible for fisheries management within State waters. The Department of Fisheries undertakes to conserve, develop and share the fish and aquatic resources according to the principles of ecologically sustainable development. There is a recognition that pressures on the fisheries of Western Australia are increasing due to technological developments and population growth and that a strong degree of regulation and enforcement is necessary to achieve these goals. The main activities of the department are based around management, research and development, community education, as well as facilitating compliance activities on behalf of the Commonwealth and other State agencies (Department of Fisheries, 2005). Key acts of legislation which govern fishing activity at the State level include the Fish Resources Management Act 1994 and the Pearling Act 1990 (Department of Fisheries, 2005).

## **6.2 Activity at the State and National level**

Commercial fisheries products are one of Australia's major export commodities. The total value of Australian exports of fishery products amounted to \$1.55 billion in 2005-06, with rock lobster being the most valuable export, being valued at \$489 million, followed by pearls (\$288 million), abalone (\$246 million), tuna (\$177 million) and prawns (\$134 million) (ABARE, 2007). However, despite the large size of the Australian Fishing Zone, Australia ranks 50<sup>th</sup> in terms of total fisheries products landed, reflecting the largely nutrient poor waters and the focus of Australian fisheries on high value marine species.

The 2001 national census indicated that 4,501 people were employed in the fishing industry, with another 4,221 employed in aquaculture, 5,540 in wholesaling, 2,213 in seafood processing and a further 3,152 in undefined commercial fishing activities (ABARE, 2007). These data have been criticised as under-estimating the totals employed in transport and processing, whilst the 2006 census data are not yet available. A more recent survey conducted in 2005-06 by the ABARE estimated that 2,035 people were directly employed in Commonwealth wild catch fisheries, with another 11,364 employed in State wild catch fisheries, although no data for New South Wales and Victoria are included in the latter total. Based on a survey of industries, it was estimated that the seafood processing sector employed a total of 786 full time and 1,908 part time individuals in 2005 (ABARE, 2007), although varying definitions of part time employment across states means that these figures are indicative in nature.

Commercial fishing at both State and National levels is heavily impacted by environmental conditions and the status of wild fish stocks. Since the introduction of the Commonwealth Fisheries Management Act 1991, stock assessments on priority Commonwealth managed fisheries have been undertaken annually. Increasing numbers of fish species are being assessed each year and trends indicate an overall rise in species overfished or subject to overfishing since 1992 (Bureau of Rural Sciences, 2007). However, a significant number of fish stocks also remain unclassified, which has repercussions for the future stability of fish stocks as well as for assigning accurate and sustainable catch quotas for licensees. In addition, Commonwealth managed fisheries, State managed fisheries and those with a

proportion of production going to export markets are subject to independent assessment. Under the Environment Protection and Biodiversity Conservation Act 1999, these assessments are conducted to ensure ecological sustainability and provide independent review of fishing activity prior to approval of new management arrangements (Department of Environment and Water Resources, 2004).

Fish stocks under State management are assessed annually by the Western Australian Department of Fisheries and those under Commonwealth authority are evaluated by the Bureau of Rural Sciences within the Department of Agriculture, Fisheries and Forestry. These assessments are based on a combination of methods, including catch and effort data, and ongoing monitoring of spawning stock. The greatest certainty in stock predictions is evident in more established and highly regulated fisheries, for example the Northern Prawn Fishery, while for the majority of fisheries where a high degree of uncertainty exists, a precautionary approach is adopted when assessing fish stocks.

Recent trends relating to catch in Western Australian State waters are provided in Table 6.1. These show that from 2000-01 to 2005-06 the Western Australian total catch by weight declined by 5% and the value of production declined by 9%. There is evidence of short-term fluctuations, particularly with regard to the period 2004-05 to 2005-06 when the total state catch and value of production declined by 23% and 16% respectively. It is estimated that 2,389 people were employed in the catch sector of the State managed fisheries in 2005-06, with another 125 full time and 627 part time jobs in the seafood processing business in Western Australia (ABARE, 2007).

**Table 6.1 Volume (tonnes) of commercial fish catch in Western Australian state waters 2000-01 to 2005-06**

<b>Fishery</b>	<b>2000-01</b>	<b>2001-02</b>	<b>2002-03</b>	<b>2003-04</b>	<b>2004-05</b>	<b>2005-06</b>
<i>Crustaceans</i>	15,759	13,804	16,687	18,893	17,368	14,946
<i>Molluscs</i>	5,154	3,688	8,189	4,843	8,094	4,042
<i>Fish</i>	14,780	16,616	16,472	17,833	16,198	14,956
<i>Other</i>	92	72	118	87	91	66
<b>Total</b>	<b>35,785</b>	<b>34,180</b>	<b>41,466</b>	<b>41,656</b>	<b>41,751</b>	<b>34,010</b>

(Sources: ABARE 2007; 2004)

**Table 6.2 Value of production (\$'000) of commercial fish catch in Western Australian state waters 2000-01 to 2005-06**

<b>Fishery</b>	<b>2000-01</b>	<b>2001-02</b>	<b>2002-03</b>	<b>2003-04</b>	<b>2004-05</b>	<b>2005-06</b>
<i>Crustaceans</i>	356,450	361,771	336,119	316,747	319,081	338,937
<i>Molluscs</i>	198,898	212,677	226,229	163,945	173,303	159,122
<i>Fish</i>	37,064	40,893	43,734	48,567	50,191	43,351
<i>Other</i>	509	868	1,066	1,1012	739	1,019
<b>Total</b>	<b>592,921</b>	<b>616,209</b>	<b>607,148</b>	<b>530,271</b>	<b>543,314</b>	<b>542,429</b>

(Sources: ABARE 2007; 2004)

### **6.3 Regional activity**

#### *6.3.1 Fish catches*

Commercial fishing activity within the boundaries of the North-west Marine Region takes place under State and Commonwealth management, although some fisheries operate in both waters. Table 6.3 summarises the principal State and Commonwealth fisheries and recent catch trends where available.

With regard to State managed fisheries, Table 6.3 illustrates the varied contribution of each fishery to the North West economy, with the inshore prawn trawling being the most significant in financial terms. This fishery is focused around Shark Bay and Exmouth (which are both outside the North-west Marine Region), contributing 82% of the value of Western Australia's total prawn catch (Gascoyne Development Commission, 2006), the bulk of which is destined for export to Asian markets. It is evident from Table 6.3 that prawn catches from Shark Bay have declined whilst that from Exmouth has increased in recent years. Over the longer term, there is little evidence of a consistent decline in Shark Bay prawn catch, whilst the impact of Cyclone Vance in 1999 was particularly marked in subsequent years' catch from Exmouth Gulf, resulting in the trend in catches illustrated in Table 6.3.

**Table 6.3 Estimated catch and value of major commercial fisheries within and adjacent to the NWMR, 2000-2005**

Fishery	Area	Catch (t)		Value (\$m)	
		2000	2005	2000	2005
<i>State-managed fisheries</i>					
Shark Bay Prawn Fishery	Gascoyne	2,250	1,628	42.7	22.7
Exmouth Gulf Prawn Fishery	Gascoyne	565	1,068	9.6	12.6
Shark Bay Scallop Fishery	Gascoyne	1,345	1,923	7.1	6.5
Shark Bay Beach Seine & Mesh Net Fishery	Gascoyne	300	263	0.9	0.8
Wetline Fishery	Gascoyne	n/a	~100	n/a	n/a
Onslow Prawn Fishery	Pilbara	87	85	1.5	1
Nickol Bay Prawn Fishery	Pilbara	512	84	8	0.8
Broome Prawn Fishery	Pilbara	159	47	1.7	0.4
Mackerel Fishery	Pilbara	103	101	1.9 <sup>a</sup>	2.7 <sup>a</sup>
Gillnet & Barramundi Fishery	Kimberley	147	118	0.9	0.7
Kimberley Prawn Fishery	Kimberley	236	265	3.7	2.5
Beche-de-mer Fishery	Pilbara & Kimberley	n/a	78	n/a	0.6
<i>State-managed fisheries where management areas extend into the North-west Marine Region</i>					
Northern Demersal Scalefish Fishery		470	922	2.6	5.4
West Coast Deep Sea Crab		205 <sup>b</sup>	207	2.7 <sup>b</sup>	2.7
Pilbara Demersal Finfish Fishery		2,391	3,005	8.5	11.6
Shark Bay Snapper Fishery		488	582	2.7	3
West Coast Demersal Scalefish Fishery		768	1,220	3.7	7.8
Mackerel Fishery (Gascoyne)		68	18	1.9 <sup>a</sup>	2.7 <sup>a</sup>
Mackerel Fishery (Kimberley)		118	173	1.9 <sup>a</sup>	2.7 <sup>a</sup>
<i>Joint managed fisheries</i>					
Northern Shark Fishery		103	1,347	0.4	2.9
<i>Commonwealth-managed fisheries</i>					
Northern Prawn Fishery		9,752	5,124	164.7	65.0
North West Slope Trawl Fishery		118 <sup>b</sup>	61.6 <sup>c</sup>	1.1 <sup>b</sup>	1.2 <sup>c</sup>
Western Deepwater Trawl Fishery		243 <sup>b</sup>	109.5 <sup>c</sup>	1.8 <sup>b</sup>	1.0 <sup>c</sup>
Western Tuna and Billfish Fishery		n/a	926	n/a	3.2

(Sources: ABARE, 2007; AFMA, 2007; Department of Fisheries 2006, 2001)

<sup>a</sup> Refers to total catch value for mackerel from Gascoyne, Pilbara and Kimberley regions

<sup>b</sup> 2001-02 data

<sup>c</sup> 2003-04 data

In terms of tonnage, the State managed Pilbara Demersal Finfish Fisheries is seen to be most significant, targeting species such as blue spot emperor, threadfin bream and crimson snapper. The fishery encompasses the area seaward of the 50m isobath and landward of the 200m isobath north of latitude 21°35'S and between longitudes 114°9'E and 120°E, although current trawling is restricted to zones north of Point Samson and Port Hedland.

The Commonwealth managed fisheries encompass waters both within and adjacent to the North-west Marine Region and are dominated in terms of value and tonnage by the Northern Prawn Fishery. This fishery covers the area from low water mark to the 200 nautical mile boundary, extending from Cape Londonderry in Western Australia to Cape York in Queensland. The fishery is managed by the AFMA through a combination of input controls under the 1995 Northern Prawn Fishery Management Plan, with a total of 77 vessels operating in 2005. This represents a significant decline in participation from an average of 248 vessels in the 1980s and 144 vessels in the 1990s (AFMA, 2007). The main target species are banana prawns, tiger prawns and endeavour prawns, which accounted for 59%, 34% and 7% of the total catch in 2006 respectively. Banana prawns are harvested in the April-June period and the tiger prawn season lasts from August-November. The fishery is divided into 15 areas for data collection purposes. The westernmost Bonaparte area lies within the North-west Marine Region, extending from 127°E to 129°E and south of 10°S. Most of the fishing activity in the Bonaparte region takes place to depths of 85m in an area stretching approximately 300km offshore from Cape Londonderry in a north-easterly direction. The total catch in this region in 2006 amounted to 231 tonnes, representing a decline from a peak in 1997-98 of around 1,500 tonnes. Whilst overall catches have declined over this period, the fishery has been increasingly focused on banana prawns, which constituted almost 100% of the catch in 2006. This will partly reflect management actions designed to reduce overall effort in the tiger prawn fishery by 30% which have been implemented since 2005 in the form of buyout of fishing gear and vessel concessions under the 'Securing our Fishing Future' package administered by the Commonwealth Government and it is considered, in light of the reduced effort, that the fishery is not overfished (Bureau of Rural Sciences, 2007). There has been concern regarding the bycatch of turtles, but recent evidence indicates that measures to reduce these have been successful, although bycatch of sea snakes remains a management issue.

The Western Tuna and Billfish fishery extends northwards from 34°S to the Cape York Peninsula, also including Australian territorial seas around Christmas Island and the Cocos Islands. The fishery is utilised by commercial and recreational fishers as well as charter boats. The Commonwealth manages the commercial sector only via the AFMA through a system of limited entry permits, although individual transferable

quotas are expected to be introduced in 2007 as part of the 2005 Western Tuna and Billfish Management Plan. The principal target species include broadbill swordfish, bigeye tuna, yellowfin tuna and skipjack tuna, although sharks and other tuna are also taken. Detailed catch data is restricted as less than five commercial vessels operated in the fishery in 2005, although stocks of the main target species are classed as not overfished in the most recent assessment (Bureau of Rural Sciences, 2007). Annual variations in catch reflect varying effort, which itself arises from a combination of factors including fish prices, freight costs, stock abundance and environmental conditions. Within the North-west Marine Region, data from 2002 indicated that effort was concentrated off the coast from Exmouth with a total of 75 landings whilst a further 59 landings were reported in Carnarvon (AFMA, 2003a), although no data are available detailing catch tonnage or value. Catches of yellowfin tuna in the pelagic longline fishery were particularly high off Exmouth, peaking in the January to March period in 2002. Sharks were also noted as significant bycatch off Exmouth, being dominated by blue sharks which may be either released or retained for their fins. Whilst finning at sea has been banned in all Commonwealth tuna fisheries since 2000, a total of 20 sharks per trip may be landed with fins included.

The North West Slope Trawl Fishery is a crustacean trawl fishery extending from 114°E to around 125°E between the 200m isobath and the outer limit of Australian territorial waters, targeting species of scampi and prawn. In 2005, a total of 7 permits were held, the majority of these operators also fishing in the adjacent Northern Prawn Fishery. Therefore, although the trawl fishery is open all year round, effort is seasonal and opportunistic in relation to the closed season restrictions on activity in the Northern Prawn Fishery. Whilst catches have declined significantly since 2001, this is thought to be primarily as a result of declining effort as catch per unit effort has remained relatively stable, although the stock status of scampi is classified as uncertain (BRS, 2007). Trawling activity is focused around the 200m isobath which forms the eastern edge of the fishery, with most taking place in the middle and southern sections stretching for approximately 900km offshore from Onslow along the 200m isobath towards the north-west. Participation in this fishery is particularly restricted due to difficulties in competing with the mining sector for labour as well as seasonal variations in product prices. It is possible, however, that effort could increase in this fishery as a result of the buyout of concessions in the Northern Prawn Fishery.

The Western Deepwater Trawl Fishery covers Australian territorial waters to 200 nautical miles between longitudes 115° 08'E and 114°E, targeting a range of finfish including tropical snappers in the northern region. In 2005, there were 11 permits for the whole fishery, covering a wide range of gear and vessel types. Although open all year round, activity is again part time and opportunistic, with most fishing taking place along the 200m isobath in two areas, one stretching from Geraldton to Carnarvon and the other between Perth and Margaret River. The northern fishing area has tended to focus more on tropical slipper lobsters or 'bugs' in recent years but there is little evidence of a consistent trend. Whilst effort in 2005-06 has been particularly affected by high fuel prices, again there is potential for displaced fishing effort as buyouts from concessions in the Northern Prawn Fishery take place. Given the small number of operators and diversity of catch and effort across such a large area, there has been comparatively little data collected or stock research undertaken, and therefore the status of stocks in the fishery remains uncertain (Bureau of Rural Sciences, 2007).

The Northern Demersal Scalefish fishery in the North-west Marine Region is an example of a jointly managed fishery operating under offshore constitutional settlements between the State and Commonwealth governments. The Northern Demersal Scalefish fishery extends from the low water mark to the territorial sea limit off the Western Australian coast east of longitude 120°E, comprising the majority of the Kimberley regional coastline, although commercial activity is excluded to the 30m isobath in the vicinity of Broome from Cape Bossut to Cape Coulomb. A total of five vessels employing approximately 15 people were licensed in 2005. The fishery targets red emperor, goldband snapper and other emperor, snapper and cod species by line and trap fishing, with landings almost doubling over the period 2000-01 to 2005-06. This increase reflects in large part the higher goldband snapper catch which rose from 283 tonnes in 2004-05 to 429 tonnes in 2005-06, which is taken to reflect a combination of historic underutilized effort and greater efficiency by some vessels in the fleet (Department of Fisheries, 2006).

### *6.3.2 Employment*

Table 6.4 details the employment in the various commercial fisheries operating within and adjacent to the North-west Marine Region.

**Table 6.4 Employment in commercial fisheries within and adjacent to the NWMR, 2005**

Fishery	Direct employment 2005	Additional information
<i>State-managed fisheries</i>		
Shark Bay Prawn Fishery	120	Additional processing employment at Carnarvon
Exmouth Gulf Prawn Fishery	37	Additional processing employment in Exmouth
Shark Bay Scallop Fishery	160	Additional processing employment at Carnarvon
Shark Bay Beach Seine & Mesh Net Fishery	30	Additional processing employment at Denham
Onslow Prawn Fishery	12-15	10 processing jobs in Onslow
Nickol Bay Prawn Fishery	35	
Broome Prawn Fishery	20	
Pilbara Mackerel Fishery	42	
Kimberley Gillnet & Barramundi Fishery	14	Processing and distribution throughout Kimberley
Kimberley Prawn Fishery	80	
Beche-de-mer Fishery	36	Collection mostly in remote areas of the Pilbara and Kimberley
<i>State-managed fisheries where management areas extend into the North-west Marine Region</i>		
Northern Demersal Scalefish Fishery	15	
West Coast Deep Sea Crab	7	5 full time and 2 part time fishers
Pilbara Demersal Finfish Fishery	32	
Shark Bay Snapper Fishery	34	
West Coast Demersal Scalefish Fishery	53 single license vessels in 2006	186 other vessels hold licenses associated with other fisheries. Estimated 2 crew per vessel
Mackerel Fishery (Gascoyne)	42	
Mackerel Fishery (Kimberley)	42	
<i>Joint managed fisheries</i>		
Northern Shark Fishery	35	
<i>Commonwealth-managed fisheries</i>		
Northern Prawn Fishery	77 vessels in 2006	
North West Slope Trawl Fishery	7 vessels in 2006	Data for Commonwealth fisheries refers to entire area of each fishery
Western Deepwater Trawl Fishery	3 vessels in 2006	
Western Tuna and Billfish Fishery	Less than 5 vessels in 2006	

(Sources: AFMA, 2007; Department of Fisheries, 2006)

With regard to State managed fisheries, table 6.4 shows that a total of around 800 jobs were directly related to fishing activity within or in State waters adjacent to the North-west Marine Region in 2005. The most significant fisheries in terms of employment are clearly the Shark Bay scallop and prawn fisheries, employing over 200 people

directly in a relatively small area. It should be noted that these figures will over-estimate the total number of individuals directly employed in the North West, as there will be overlap in terms of skippers and crew working in more than one fishery. This is illustrated with regard to the Shark Bay scallop and prawn fisheries, with 27 of the 39 licensed boats in the scallop fishery also holding Shark Bay prawn fishing licenses in 2005 (Department of Fisheries, 2006). It must also be remembered that numerically small numbers of directly employed individuals in a fishery may account for a significant component of economic activity in smaller or remote communities. However, the majority of employment in these fisheries is on a part time basis or subject to seasonal fluctuation. The prawn trawling season in the Gascoyne extends from March to October each year, while further north in the Pilbara, environmental factors and the size of the fishery limit employment opportunities to the months of June to August (Department of Fisheries 2006). Scallop trawling occurs from March to April in the Gascoyne region, prior to migrating to areas further south, outside the boundaries of the NWMR (Department of Fisheries, 2006).

Data relating to employment in the Commonwealth managed fisheries is uneven in terms of coverage and potentially difficult to relate to those operating in and adjacent to the North-west Marine Region. It has been reported that up to seven individuals may work on a trawler in the Northern Prawn Fishery (AFMA, 2003b), implying that the current total may be in the order of 540 individuals. However, the season is relatively short, lasting for 6 weeks in the April-May period and 15 weeks from August to November in 2006. Furthermore, there is no data indicating the amount of employment in each of the sectors within the large area encompassed by the fishery, hence more detailed information relating to employment within the waters of the North-west Marine Region is difficult to ascertain. Of the three major processors in Western Australia associated with the Northern Prawn Fishery (AFMA, 2003b), none have premises in the settlements adjacent to the North-west Marine Region. The North West Slope and Western Deepwater Trawl Fisheries both involve very limited numbers of vessels and employment in each fishery was estimated to amount to 25-35 people on a part time basis. Furthermore, onboard processing and packaging limits the potential for indirect employment (AFMA, 2004). No data can be located for this Report detailing employment in the Western Tuna and Billfish fishery, other than noting that very few vessels were operating in this fishery in 2006.

There are also indirect employment opportunities associated with the seafood processing and wholesaling sector which are significant within the towns adjacent to the North-west Marine Region. Two fish processing companies are listed in the current Yellow Pages at Learmonth and Denham, whilst there are three fish wholesalers in Carnarvon and one each in Onslow, Broome and Point Samson.

## **6.4 Socio-economic dimensions**

### *6.4.1 Drivers of change*

The commercial fisheries of the North-west Marine Region are subject to a range of influences in terms of activity, most of which can be categorised at the national and regional level. There are certain international forces which can be identified as having an underlying influence on activity, particularly currency exchange rates with regard to export-oriented commercial fisheries and also drivers of consumer demand in key export markets such as GDP and trading relations between these countries and Australia. Prawn and scampi from the Northern Prawn Fishery and the adjacent North West Slope Trawl Fishery are exported to Japan, China and Spain, whilst tuna from the Western Tuna and Billfish Fishery is highly focused on the Japanese market. Fisheries within State waters are more geared towards domestic markets.

The fisheries of the North-west Marine Region are highly regulated through a series of mainly input controls and it is these which largely govern the variations in catch and effort within each fishery. Of particular relevance in this context is the introduction of the Commonwealth Harvest Strategy Policy which is intended to provide a common basis for quantifiable biological and economic objectives to be applied to each fishery. Strategies consistent with this Policy are required to be in place by the start of 2008. With regard to Commonwealth fisheries within the North-west Marine Region, this may not result in immediate changes to regulations, as some fisheries including the Northern Prawn Fishery and the Western Tuna and Billfish Fishery have been identified as requiring more complete stock assessment work to enable the Harvest Strategy Policy to be implemented. Harvest strategy frameworks are reported to be in development for the North West Slope and Western Deepwater Trawl Fisheries (BRS, 2007). The Northern Prawn Fishery and the Western Tuna and Billfish Fishery are the most regulated Commonwealth fisheries within the North-west Marine Region in terms of closures, catch limits and gear restrictions and these

can change on an annual basis with implications for fishing activity within the Region's waters. The current 2007 Northern Prawn Fishery regulations, for example, include a closure of the area bounded by 126°58'E and 13°S during the first season to prevent the taking of small prawns, this area encompassing most of the fishery's waters lying within the North-west Marine Region. A similar situation of strong regulation governs fishing activity within State waters. As these regulations are reviewed annually, it is evident that factors affecting stock levels including environmental conditions and fleet activity will determine the effort in each fishery. Environmental conditions can range from the large scale impacts of cyclones to the consequences of low rainfall, which decreases the schooling tendency of banana prawns, resulting in a decrease in catch and effort during low rainfall. However, it is apparent that the overseas and domestic markets remain strong for all products from Commonwealth fisheries and therefore there is little reason to suggest that underlying demand for these products will diminish.

#### *6.4.2 Socio-economic linkages*

##### *Employment*

A range of links exist between the activities of the commercial fishing sector and other industries in the North West. The industry has a number of flow-on effects to local communities and the surrounding hinterland, the most significant being direct and indirect employment generated in regional communities. For example, the gillnet and barramundi fishery in the Kimberley is an important supplier for the tourist market, particularly for the popular holiday town of Broome, distributing to local restaurants and supermarkets (Department of Fisheries, 2006). Other industries present in the North West, particularly the minerals sector, contribute to the development of infrastructure in coastal areas. Increasingly, in accordance with State regional development policy, employees in these industries are being encouraged to locate to regional centres as an alternate base for fly-in/fly-out employment (Storey, 2001). In addition, such high value industries often finance the development of local housing, transport and other infrastructure for their employees, which is also likely to service the commercial fishing sector.

The most recent research relating to indirect multiplier effects in terms of employment arising from commercial fishing dates back to 1992 (Economic Research Associates,

1992). This report used a multiplier of 1.87 to characterise the effect of employment in sectors related to commercial fishing. This would mean that an additional 700 full time equivalent jobs were created in sectors linked to commercial fishing using the employment data available for State fisheries detailed in Table 6.4, around half of which be expected to be in the retail and transport sectors.

The employment impacts of the Commonwealth managed fisheries are difficult to elucidate in detail, given the large areas involved, the seasonality of employment and relatively small numbers of vessels in most of the fisheries. Furthermore, it is apparent that the largest Commonwealth fishery in the NWMR, the Northern Prawn Fishery, has very limited downstream impacts within the economy of the North West given the lack of evidence of processing facilities associated with this fishery. It has been noted that the Western Tuna and Billfish fishery has linkages with port facilities and, presumably, processing activity in Exmouth and Carnarvon, whilst it would be logical for some of the crustacean catch in the North West Slope Trawl fishery to be landed and marketed via Onslow. Similarly, the Western Deepwater Trawl fishery between Geraldton and Carnarvon would be expected to have some linkages with processing, sales or distribution within Carnarvon, and the Northern Demersal Scalefish fishery would have linkages to Broome.

The existence of skills shortages across the majority of industries in rural and regional areas has been well documented, and the commercial fishing sector is not exempt. Skills required for commercial fisheries are industry specific and usually unable to be utilised in other sectors. A shortage of crew on commercial fishing vessels is a particular concern across the industry, limiting the potential number of fishing days per vessel. A strategy adopted by the Western Australian Fishing Industry Council (WAFIC) attempts to ease the impact on fishers by dealing with this priority issue. Initiatives of the strategy include participation in the State's 'Go West Now' campaign and streamlining the application process for temporary S457 visas applicants, encouraging interstate and international migration to fill shortages (WAFIC, 2007). Crew shortages can be linked to perceptions of the type of employment as well as unattractive wages and working conditions. The presence of high value extractive mineral industries has fuelled wage based competition for labour across all industries in the North West, and offering significantly higher wages for

less demanding employment, the fishing industry has suffered as a result. However, it should be remembered that due to the seasonal nature of the industry, the vast majority of staff are employed on a part time basis, with employees usually seeking additional supplementary sources of income in other industries, thereby alleviating some of the pressures associated with skill shortages in rural and regional areas.

Catch rates and fishing regulations as established by State and National authorities are also indirectly associated with employment levels in the industry. In light of the aforementioned trends, increased regulation and stricter catch limits are unlikely to result in greater employment within the commercial fishing sector. However, achieving and maintaining sustainable catch rates is a necessity for future stability of the industry, ensuring a stable resource base to secure future employment (Sumalia *et al.*, 2000). In this respect, maximum utilisation of fish resources to maintain current employment levels and economic growth has implications for the potential of the industry as a future employer. In addition, Australian fisheries target largely high value marine species, predominantly for sale on international markets. This has implications for the stability of returns for produce particularly as certain species such as prawns are highly vulnerable to fluctuations in world commodity prices, in turn affecting returns to local economies.

Evidence suggests commercial fisheries are experiencing stable or declining employment levels (Huddleston, 2006). Figures at the national level predict employment in the fishing sector will decline by 1.4% per annum to 2011-12 (Department of Employment and Workplace Relations, 2007). In the North West, employment in two of the largest State managed fisheries, prawn and scallop trawling, has declined by 20% from 2000, although an increase was seen in the beach seine and mesh net fishery, which is considered to represent a significant contributor to the local Denham economy, although no detailed data are available (Department of Fisheries, 2006). In light of these findings, future growth of this industry as a major employer in the region is unlikely however it is likely to remain significant as an employer in certain regional communities.

### *Linkages in key fisheries*

Given the differences in size, characteristics and trends within the State and Commonwealth fisheries operating in and adjacent to the North-west Marine Region, it would be appropriate to focus comment on those which are of most economic significance. The Commonwealth Northern Prawn Fishery is of particular interest in this regard following the implementation of the 'Securing Our Fishing Future' package in 2005. This structural adjustment package was designed to reduce the numbers of fishers competing for resources and involved \$150 million being targeted towards buyout of concessions. In the Northern Prawn Fishery, this resulted in a 43% reduction in vessel statutory fishing rights and a 34% reduction in gear statutory fishing rights by 2007. Whilst it is evident that a reduced catch across the whole fishery will eventuate, the distribution of this reduction is unclear as yet, hence the impacts within the waters of the North-west Marine Region are uncertain. However, it has been noted that this buyout could result in a transferral of effort into adjacent fisheries such as the Western Trawl fisheries, which could in turn increase activity within key ports adjacent to the Region such as Onslow and Carnarvon.

In contrast, there are certain State managed fisheries which have experienced considerable growth in recent years. The Pilbara Demersal Finfish fishery which extends into the NWMR has increased in value by 19% in real terms since 2000, being valued at \$11.6 million in 2005. Employing approximately 32 people in 2005, activity in this fishery covers a large spatial area, extending the total length of the Pilbara coastline and targeting a diverse range of high value fish species including, snapper and emperor species, threadfin bream, flagfish and Rankin cod. Catch rates in the trawl, trap and line fisheries in the area have fluctuated since 1985 and improvements in efficiency have lead to the unsustainable harvest of particular species (Department of Fisheries, 2006).

The Northern Shark Fisheries, representing the Western Australian North Coast Shark Fishery in the Pilbara and western Kimberley and the Joint Authority Northern Shark Fishery under State management in the eastern Kimberley, constitute another fishery exhibiting rapid growth, with an increase in catch value in real terms amounting to over 500% from 2000 to 2005. Much of this is attributed to the increased catch of sandbar sharks, which accounted for almost 50% of the catch in 2005. This reflects an

increased fishing effort in the Pilbara and western Kimberley where this species is prevalent, as well as increased catch efficiency. A range of management initiatives have since been introduced for the 2005-06 season including permanent closures, limiting seasonal access, reorienting the fishery towards the use of gillnets and other gear restrictions which are intended to reduce pressure on sandbar sharks and increase black-tip shark catch (Department of Fisheries, 2006).

Shark Bay in the Gascoyne is notable as the focus of four of the major State managed commercial fisheries comprising the prawn, scallop, snapper, and beach seine and mesh net fisheries. In 2005, the joint contribution of these fisheries to the economy was around \$33 million (Department of Fisheries 2006). This represents a decrease of approximately 44% in real terms from \$53 million in 2000, largely due to declines in prawn catch, which are economically the most significant species in the area. The snapper fishery at Shark Bay was the only fishery to experience an increase in value over the five year period to \$3 million, despite the State reduction of catch quotas over this time. All these fisheries are closely monitored for signs of stock depletion and no such evidence has come to light in the most recent data, indicating that the future of the fisheries and their associated industries seems assured on these grounds. However, external factors including cyclones are significant in terms of short term fluctuations in effort and therefore catch. Furthermore, variability can be introduced by operators choosing to redirect effort elsewhere, as in 2005 when the scallop fishery was focused on the Abrolhos Islands due to better catches being available

In the longer term, expansion of commercial fishing activity is considered unlikely given the current regulatory environment, labour shortages and high transport costs associated with commercial fishing in the North-west Marine Region. However, growth in the tourism and recreational fishing sectors in particular could potentially exclude commercial fishers from accessing certain marine areas, especially with the creation of new marine reserves. A similar situation could be seen with growth in offshore aquaculture, increasing competition among resource users for certain productive marine areas (Department of Fisheries 2004). Competition for coastal land is also a possibility with coastal infrastructure used for commercial fishing unlikely to complement the needs of aquaculture. Generally the activities of these two sectors are

compatible, especially in terms of processing and transport infrastructure, and there is potentially scope for integrated development into the future.

## **7 RECREATIONAL FISHING**

### **7.1 State and Commonwealth policy objectives**

Recreational fisheries in Australia are managed primarily by the respective State governments. In Western Australia the Department of Fisheries is responsible for the management and monitoring of recreational fishing activity within both Commonwealth and State managed waters, up to 200 nautical miles off the coast. The main governing legislation for recreational fisheries in the State is the Fish Resources Management Act 1994, which governs recreational catch of all bony fish and shark, all aquatic invertebrate, as well as marine algae and sea grasses (Department of Fisheries 2006). Management of recreational fisheries is achieved through restrictions on size, bag and gear limits, as well as seasonal closures in certain fisheries (Department of Fisheries 2006). Licences are also required for the recreational catch of certain species including rock lobster, abalone, and marron as well as for freshwater angling and netting (Department of Fisheries 2006). Community participation in recreational fisheries management is promoted through the Recreational Fishing Advisory Committee (RFAC) and 12 Regional Recreational Fishing Advisory Committees (RRFAC) created under the Fish Resources Management Act 1990. The RFAC consists of 15 members representing the government, recreational fishers, commercial fishers and the chartered fishing sector amongst others. The RFAC and its regional committees have the role of advising the Minister for Fisheries on matters relating to the management of recreational fishing. Recfishwest is the State branch of RecFish Australia, representing the peak angling body at the national level which actively participates in public consultation procedures and is a supporting member of the Federal Fisheries Research and Development Corporation at the national level.

In addition to management, the State Department of Fisheries is responsible for ongoing research and development, community education and compliance activities. In accordance with the objectives of community outreach and education, the Department of Fisheries has an extensive list of publications related to recreational fishing in the state. One of the most comprehensive documents is the annual State of the Fisheries report which provides, among others, an overview of recreational fishing activity, management arrangements and stock levels for fisheries in each of the state's

regions. The regions relevant for the North West include the West Coast region which extends from Augusta to the Zuytdorp Cliffs north of Kalbarri, the Gascoyne region which extends from the Zuytdorp Cliffs to the mouth of the Ashburton River near Onslow and the Pilbara/Kimberley region which extends from the Ashburton River to the Northern Territory border. Ongoing research and development findings are also published through management and occasional papers released frequently by the department. Recreational creel surveys are conducted regularly along different areas of the states coastline as a part of ongoing monitoring of fish stocks and angler participation rates, with results being published as they become available. The role of the Commonwealth in managing recreational fisheries is largely supervisory and at the legislative level, supporting local, and State and Territory governments in their management activities. Federal funding is also available to community groups for the development of local projects focused on encouraging sustainable recreational fishing, developing local fishing infrastructure, ongoing education and awareness and providing support to local sea rescue groups (DAFF, 2007).

Another facet of recreational fishing in Australia is the activity of commercially operated fishing charters. Currently there is no national system in place for the management of the industry. In Western Australia, regulation of the fishing charter industry is divided across three State legislative bodies, each of which is responsible for managing a different aspect of the industry. Bag, size and possession limits apply for all fish caught in charter vessels, under the guides of the Fish Resources Management Act 1994, and at the conclusion of each trip reports must be submitted to the Department of Fisheries. Vessel licensing must conform to one of three categories including fishing tours, restricted fishing and eco-tours. Currently in Western Australia there is a moratorium on the issue of new charter licenses, subject to adjustment of current industry regulations (Department of Fisheries 2006).

## **7.2 Activity at the State and National level**

Fishing is one of the most popular and accessible recreational activities in Australia. In 2000, around 3.36 million people across the country participated in recreational angling at least once over the year (Henry and Lyle, 2003) and the ABS estimated that in 2003 around 5 million people were involved in this activity (ABS, 2003). Whilst contemporary data on participation rates in recreational fisheries are unavailable at the

national level, it is anticipated that, based upon these data, the total number of participants has increased. Catch rates in recreational fisheries are difficult to quantify due to difficulties in obtaining accurate data and the increasing popularity of catch and release fishing. In 2003, catch rates in Australia were estimated at around 30,000 tonnes, and effort per tonne of fish retained is expected to increase in the future as a result of growing participation rates (Kearney *et al.*, 2003). Whiting, flathead, herring and bream were the top four species of finfish caught by recreational anglers in 2000, while prawns, yabbies, crayfish and blue swimmer crab were the most popular crustaceans (Henry and Lyle, 2003).

### **7.3 Regional activity**

#### *7.3.1 Participation*

The most detailed survey of participation in recreational fishing remains the National Indigenous and Recreational Fishing Survey (NRIFS) commissioned by the Department of Agriculture, Fisheries and Forestry using data collected in 1999-2000 (Henry and Lyle, 2003). Participation rates were calculated with reference to the population aged 5 and over in the three statistical divisions adjacent to the NWMR. These are cited as being 39% for the Central division (equivalent to the Gascoyne region referred to in this Report), 47.5% in the Pilbara and 52.7% in the Kimberley.

Table 7.1 applies these participation rates to the 2001 and 2006 census data for each of the coastal statistical local areas (SLAs) in settlements adjacent to the North-west Marine Region. This uses the place of usual residence population data to give an indication of the resident population in these settlements likely to participate in recreational fishing for these two dates. Over the 2001-06 period, these projections indicate that the total number of recreational fishers increased by 1.7% between 2001 and 2006. In a wider context, there are an estimated 643,000 total recreational fishers currently in Western Australia (Recfishwest, 2007), indicating that the settlements adjacent to the North-west Marine Region accounted for around 5% of the projected State total in 2006. Based on 2006 resident population data, the SLAs of Roebourne and Port Hedland in the Pilbara and Broome in the Kimberley contained the highest total number of estimated recreational fishers, accounting for over half of the total estimated number in the North-west Marine Region, underlining the concentration of recreational fishing activity in specific locations. However, this overall pattern

includes divergent trends, with a decline in the estimated number of resident recreational fishers of around 4% and 9% in the Kimberley and Gascoyne respectively being balanced by an increase in numbers in the Pilbara of around 9%. The increase in total recreational fishers over the 2001-06 period in the Pilbara reflects the growing resident population in the Roebourne statistical local area, which includes the towns of Karratha and Wickham as well as the port of Dampier.

**Table 7.1 Projected total recreational fishers based on resident local population in statistical local areas adjacent to the NWMR 2001-06**

	Population aged 5 and over		Estimated recreational fishers	
	2001	2006	2001	2006
<i>Gascoyne</i>				
Shark Bay	845	808	330	315
Exmouth	2,072	1,926	808	751
Carnarvon	5,862	5,244	2,286	2,045
Total	8,779	7,978	3,424	3,111
<i>Pilbara</i>				
Ashburton	5,121	5,405	2,432	2,567
Roebourne	13,135	14,974	6,239	7,113
Port Hedland	10,919	10,946	5,187	5,199
East Pilbara	5,087	5,959	2,416	2,831
Total	34,262	37,284	16,274	17,710
<i>Kimberley</i>				
Broome	11,509	11,941	6,065	6,293
Derby West Kimberley	6,991	5,846	3,684	3,081
Wyndham East Kimberley	6,413	6,040	3,380	3,183
Total	24,913	23,827	13,129	12,557
<b>TOTAL</b>	<b>67,954</b>	<b>69,089</b>	<b>32,827</b>	<b>33,378</b>

(Sources: ABS, 2006; 2001; Henry & Lyle, 2003)

However, these calculations are based on place of usual residence population data from the 2001 and 2006 census, which do not include the visitor population in the North West and which will evidently be significant in terms of participation in a popular tourism-related activity. Therefore, table 7.2 repeats these calculations using the location on census night population data from 2001 and 2006 in order to give a more complete picture of the likely total resident and visitor population engaged in recreational fishing. As would be expected, using the resident and visitor population data results in a significant increase of around 40% in the estimated total number of recreational fishers from around 33,000 in 2001 to 47,000 in 2006. The most rapid

growth from 2001 to 2006 is evident again in the Pilbara, with an increase in the order of 22% contributing towards the overall rise in estimated recreational fishers in the Region of around 10% between 2001 and 2006. Furthermore, the SLAs of Broome and Roebourne contained the highest total number of estimated recreational fishers using this estimate of total population in 2006.

**Table 7.2 Projected total recreational fishers based on location on census night in statistical local areas adjacent to the NWMR 2001-06**

	Population aged 5 and over		Estimated recreational fishers	
	2001	2006	2001	2006
<i>Gascoyne</i>				
Shark Bay	2,060	1,963	803	766
Exmouth	4,062	4,048	1,584	1,579
Carnarvon	8,547	8,122	3,333	3,168
Total	14,669	14,133	5,721	5,512
<i>Pilbara</i>				
Ashburton	6,307	7,496	2,996	3,561
Roebourne	14,694	17,892	6,980	8,499
Port Hedland	12,128	12,348	5,761	5,865
East Pilbara	6,072	10,068	2,884	4,782
Total	39,201	47,804	18,620	22,707
<i>Kimberley</i>				
Broome	17,226	18,554	9,078	9,778
Derby West Kimberley	8,347	7,668	4,399	4,041
Wyndham East Kimberley	9,454	9,379	4,982	4,943
Total	35,027	35,601	18,459	18,762
<b>TOTAL</b>	<b>88,897</b>	<b>97,538</b>	<b>42,801</b>	<b>46,980</b>

(Sources: ABS, 2006; 2001; Henry & Lyle, 2003)

Overall, this demonstrates the significance of visitors towards recreational fishing activity within the North West, contributing towards a considerable increase in population and therefore estimated recreational fishing activity, particularly in the Pilbara region and more specifically the town of Broome in the Kimberley. The SLA of Roebourne includes the towns of Karratha, Wickham and Roebourne itself which, based upon these data, are more likely to reflect recreational fishing activity from the resident population rather than visitors as in the case of Broome.

There are few recent surveys which allow further analysis of the relative contribution to overall recreational fishing activity from residents and visitors. Data from the

Gascoyne region collected in 1998-99 indicated that over three quarters of all recreational fishers surveyed were from outside the Gascoyne (Sumner *et al.*, 2002). Furthermore, total numbers of participants does not equate to fishing effort or catch rates, which will reflect individual investment in time and fishing gear. The timing of Census Night on 8 August 2006 fell within the peak quarter for domestic visitors to all three tourism regions, although international visitors mainly arrived in the October-December quarter in 2006. However, as noted elsewhere in this Report, international visitors account for less than 10% of total visitors to the North-west, although they do contribute over a quarter of total visitor expenditure. Therefore, it is considered that, assuming participation rates as measured in 2000-01 remain valid, the projection of around 33,000 resident recreational fishers rising to 50,000 at any time as a result of visitors offers a reasonable estimate of recreational fishing activity within the Region.

### 7.3.2 *Location of activity*

With regard to the location of recreational fishing activity within the Region, data are again limited, although the NRIFS survey revealed the concentration of fishing effort in the region off the coast of Karratha, Exmouth and Carnarvon (FRDC, 2005). In particular, coastal waters off Point Samson had the greatest recorded catch in the region between 160,000-180,000 fish during the 2000 season (FRDC, 2005).

Recreational creel surveys are regularly undertaken by the Department of Fisheries in various areas across the state with the most recent surveys conducted in the Gascoyne in 1998-1999 and in 1999-2000 for the Pilbara. It is difficult to identify long term trends from these data as recreational fishing surveys are undertaken at irregular and lengthy time intervals. As a result, a significant gap is evident in data related to the extent of recreational fishing in the North West as a whole.

The Pilbara survey of boat and shore-based recreational fishing between Broome and Onslow indicated that the total recreational catch was estimated to be around 383 tonnes, although this survey excluded charter boat operators (Williamson *et al.* 2006). Environmental conditions, particularly daily tidal variations in the region, limited the amount of beach fishing undertaken, with boat-based fishing being the more popular option. Fishing activity peaked in the winter months and was concentrated around regional centres such as Karratha, Kalbarri, and Broome and in areas where the

coastline was more accessible from boat ramps. However, recreational angling was also undertaken in inland water bodies, including creeks, mangroves and river systems throughout the region. The most popular target species as indicated by catch rate include spangled emperor, Spanish and other mackerel species, golden trevally, blue swimmer crab, blackspot tuskfish and threadfin salmon (Department of Fisheries, 2006). The Gascoyne survey covered the area between Shark Bay and Exmouth Gulf, with a total catch of around 350 tonnes being recorded, although this survey also excluded charter boat operators. Most fishing activity was concentrated around Shark Bay which accounted for around 37% of the total fishing effort. Other important areas of activity were centred upon Coral Bay in the southern section of Ningaloo Marine Park and the northern area of the park around to Exmouth Gulf. The main target species included emperor, pink snapper and mackerel and effort was again highest during the autumn and winter months.

A popular location for recreational fishing in the North-west Marine Region is the Shark Bay Peninsula. Being part of a world heritage area, increasing numbers of tourists visit the area each year, numbering in excess of a quarter of a million in 2004 (Gascoyne Development Commission, 2006). Approximately 80% of tourists to the area were intrastate in origin, the majority visiting during the April to September period (Department of Fisheries 2006). Fishing in Shark Bay is divided into three management zones, the Eastern Gulf, Denham Sound and Freycinet Gulf, each with different total allowable catch (TAC) limits for both recreational and commercial sectors. In the Ningaloo Marine Park, recreational fishing activity must also conform to Department of Environment and Conservation (DEC) regulations, with new zoning regulations implemented in 2005 prohibiting all fishing activity in certain sanctuary areas. Currently 65% of the marine park is accessible to recreational anglers (Department of Fisheries, 2006).

Commercially operated fishing charters are also active in the NWMR and contribute to overall catch rates in the region. A total of 103 fishing tour operators were licensed in 2005 in the Pilbara and Kimberley regions, with a further 19 licences for restricted fishing or eco-tour activities. From this total of 122 licences, 47% were active during the 2005 season. An estimated total of 156 tonnes of finfish catch was reported for Kimberley and Pilbara fishing charters in 2005, with catch rates remaining relatively

stable from 2002 to 2005 (Department of Fisheries 2006). During the same season in the Gascoyne, 78 vessels were licensed as fishing tour operators with a further 16 in restricted fishing or eco-tour categories. Only 40% of licensees were active during the 2005/06 season, with an estimated 74.5 tonnes of fish caught. Catch rates remained stable, decreasingly slightly from 2002 levels. Despite stable catch rates, fishing-only tours dropped by around 30% in the Gascoyne, while an increase of approximately 17% was seen in the Kimberley and Pilbara regions. The growth of the charter industry in the Kimberley and Pilbara has come about largely due to the reputation of the area as a pristine and remote environment (Department of Fisheries, 2000). The role of the fishing charter industry in tourism is discussed in greater detail in the marine tourism chapter of this report.

## **7.4 Socio-economic dimensions**

### *7.4.1 Drivers of change*

The main driver of change affecting the future of recreational fishing activity is population growth, with disposable income also influencing participation in this activity. With continued development of the minerals resource sector in this region, population growth is assured into the future. Socio-economic trends reveal income levels throughout the region increased from 1996 to 2006, with growth up to 19% in real terms being seen in certain regional centres (Clifton *et al.*, 2007). This has been particularly evident in the Pilbara due to the presence of the inland minerals sector and offshore oil and gas operations around Dampier, having on average 20% higher incomes than the remainder of the state.

Data from the DPI indicate that the total number of recreational vessel licenses in postcodes adjacent to the NWMR increased by 17% from 2004 to 2006, with over 86% of registered vessels being less than 6.5 meters in length (DPI, personal communication, July 2007). Based on findings from the National Recreational and Indigenous Fishing Survey, 55% of recreationally licensed boats in Australia were used for fishing during the 1999-2000 season (Henry and Lyle, 2003). If this percentage is used as a bench mark value and assuming participation rates have remained the same, around 4,480 vessels are likely to have been actively involved in fishing in and adjacent to the NWMR in 2006. The increasing popularity of boat-based fishing is likely to continue into the future, with recent anecdotal evidence

suggesting a decrease in the number of shore-based anglers (ABC News, 2007), although specific data on this aspect of recreational fishing are unavailable.

Changes in fishing methods and growing environmental awareness have also had an impact on catch rates and effort in recreational fisheries. In particular, the increasing popularity of sports and game fishing has increased effort per tonne of fish retained. Specific data on this type of catch and release fishing are unavailable, as there is little monitoring of this type of fishing activity. However, RecFish Australia has a code of practice in place for game fishing, and local fishing clubs usually monitor the activities of their members. Game fishing vessels usually range in size from 12 to 35 meters in length, and data from 2004 to 2006 indicate an 8% increase in the number of vessels over 8.5 metres registered in postcodes adjacent to the North-west Marine Region (DPI, personal communication, July 2007). Western Australia in particular has a national and international reputation for the quality of its sports and game fishing, particularly in the NWMR where annual sailfish tournaments are held offshore from Dampier and Broome (Department of Fisheries, 2000). Growing environmental ethics and awareness of the need for sustainable fisheries are also likely to contribute to the increase in sports fishing, as anglers are progressively more satisfied with fishing as a sport rather than catching their daily bag limits (Western Angler Magazine, personal communication). In addition, cheaper and more accessible technology such as GPS and fish finder systems has meant boat fishing is more efficient and targeted. These trends are likely to continue into the future, particularly as fishing pressure is already significant in the Region, with effort per tonne of fish retained expected to increase further up to 2050 (Kearney, 2003).

However, there are longer term influences on recreational fishing within the North-west Marine Region which could reduce the extent of this activity. The remoteness of the region, together with rising fuel prices, could deter visitors and in particular family groups from visiting the North West, leading to an increased reliance on the professional and sports angling sector (Western Angling Magazine, personal communication). There are also ongoing discussions between the recreational and commercial fishing sector regarding catch allocations which could limit the extent of this activity into the future. However, these are tentative statements and there is little

evidence as yet of either impacting upon the popularity of recreational fishing within or adjacent to the North-west Marine Region.

#### *7.4.2 Indigenous fishing activity*

Fishing is also an important element in the lives of coastal Indigenous Australians. Forming an integral part of tradition, fishing has significant economic, cultural and dietary importance to local Indigenous groups, also contributing to social and cultural cohesion. Traditionally fish stocks were managed by local Indigenous groups through seasonal catches and limits on the number of each species taken. Elements of Indigenous fishery management can often be used as examples to mainstream resource users of how to better manage fish stocks, indicating a degree of untapped potential for fisheries management. While mainstream regulations apply to all Indigenous fishers, indigenous organisations frequently regard them inappropriate for traditional fishing and hunting activities. Consultation by government management bodies is currently underway with Indigenous groups to seek greater compatibility of management arrangements and future sustainability of fish resources. Survey data on Indigenous fish catch are generally unreliable and in no way exhaustive of all activity in the NWMR. Little distinction is made in State fisheries surveys between Indigenous and non-Indigenous fish catch. A national Indigenous fishing survey undertaken in 2000-2001 across Northern Australia, including north Western Australia, indicated molluscs and finfish were the two most numerous species retained by Indigenous groups in the area. Total catch was estimated at around 3 million animals, compared to 56 million caught across the country over the same period (Henry and Lyle, 2003), giving some comparison as to the relative significance of fishing activities amongst Indigenous populations.

#### *7.4.3 Socio-economic linkages*

The main reasons cited for participating in recreational fishing relate to the opportunity to relax, undertake a sporting pastime and to spend time with family in an outdoor setting (Henry and Lyle, 2003). These underline the social and recreational significance of fishing to the community which is typically amplified in regional areas where fishing very much comprises a part of the lifestyle, as indicated by proportionally greater participation rates in non-metropolitan areas (Henry and Lyle,

2003). As a result, the multiplier and flow on effects of recreational fishing particularly in regional communities are significant.

The NRIFS estimated the annual individual expenditure on items or services that could be attributed to fishing activity in 1999-2000 as being \$706 in Western Australia, compared to the national average of \$552. This equated to a total direct expenditure in the order of \$338 million at the State level. Table 7.3 indicates the resulting distribution of this expenditure amongst Western Australian recreational fishers, highlighting the linkages between recreational fishing expenditure and boat and trailer supply and maintenance services which account for over half of all expenditure.

**Table 7.3 Attributable fishing expenditure by Western Australian recreational fishers by item category 1999-2000**

Item category	Attributable expenditure	
	\$M	%
Boat / trailer	200.6	59.3
Travel	55.6	16.4
Fishing gear	31.0	9.2
Camping gear	26.7	7.9
Accommodation	8.4	2.5
Bait	7.0	2.1
Dive gear	3.2	0.9
Fees / licenses	3.2	0.9
Clothing	1.6	0.5
Other	1.2	0.4
<b>TOTAL</b>	<b>338.5</b>	<b>100</b>

(Source: Henry & Lyle, 2003)

The projected total number of recreational fishers calculated in Section 7.3.1 can be utilised to provide a more up to date evaluation of expenditure associated with recreational fishing activity. For this purpose, it is preferable to use the total number of recreational fishers based on resident population as the projected total using resident and visitor population is a snapshot and is not reflective of the annual total of recreational fishers. Furthermore, the estimated individual spend of \$706 in 1999-2000 will have increased subject to inflation and, particularly, fuel prices. It should therefore be recognised that the estimated expenditure calculated below is very much at the low end of the scale.

Assuming a total resident recreational fishing population of 33,378 within the towns adjacent to the North-west Marine Region in 2006, an individual spend of \$706 would equate to an overall annual direct spend of \$23.5 million. According to the allocation of direct expenditure for Western Australian recreational fishers detailed in Table 7.3, this is likely to result in resident recreational fishers in the North West spending around \$13.9 million annually on boats and trailers. As these are likely to be occasional outlays, it should not be assumed that they are regular annual inputs into the local economy. The total likely spend on fuel (\$3.8 million), fishing and camping gear (\$2.1 million and \$1.8 million respectively) along with the other categories listed in Table 7.3 are more likely to be significant at the local level.

Estimates of indirect expenditure carried out in 1989-90 and 1995-96 both indicated that indirect expenditure by recreational fishers amounted to 90% of the total direct expenditure. This would generate a total indirect expenditure of \$21.2 million in the North West in 2006, yielding an aggregate expenditure of \$44.7 million. Assuming average annual earnings of around \$56,000 in Western Australia in 2006 (ABS, 2007), this total expenditure would support the equivalent of around 800 full time jobs within the North West. Again, it should be stressed that, for the reasons given above, these will be under-estimates of the true total.

Given this pattern of expenditure, it is difficult to be precise with regards to the distribution of these impacts within the North West in terms of expenditure and employment. An analysis of entries under the 'fishing tackle' category in the Yellow Pages reveals that, of the 13 businesses within the North West, four each are in the largest tourist centres of Exmouth and Broome, three are in the Carnarvon / Shark Bay area and one each is present in Kalbarri and Karratha, underlining the dependence of this sector upon visiting recreational fishers.

However, the extent of recreational fishing within the North West will largely be a reflection of the principal function of the major settlements. The population of towns such as Wickham and Dampier is a function of the iron ore industry, whilst Karratha has a wider range of administrative services and Point Samson, with a population of 315 in 2001, is the local centre for local boat operators and seafood restaurants (Shire of Roebourne, 2007), hence is far more likely to exhibit closer socio-economic

linkages with recreational fishing than would be expected given its population size. It is therefore reasonable to conclude that the towns with larger resident and visitor populations in the North West are statistically more likely to have closer linkages with recreational fishing but those smaller coastal settlements with historical or other associations with fishing are also likely to have particularly significant ties with this sector.

### 8.1 State and Commonwealth policy objectives

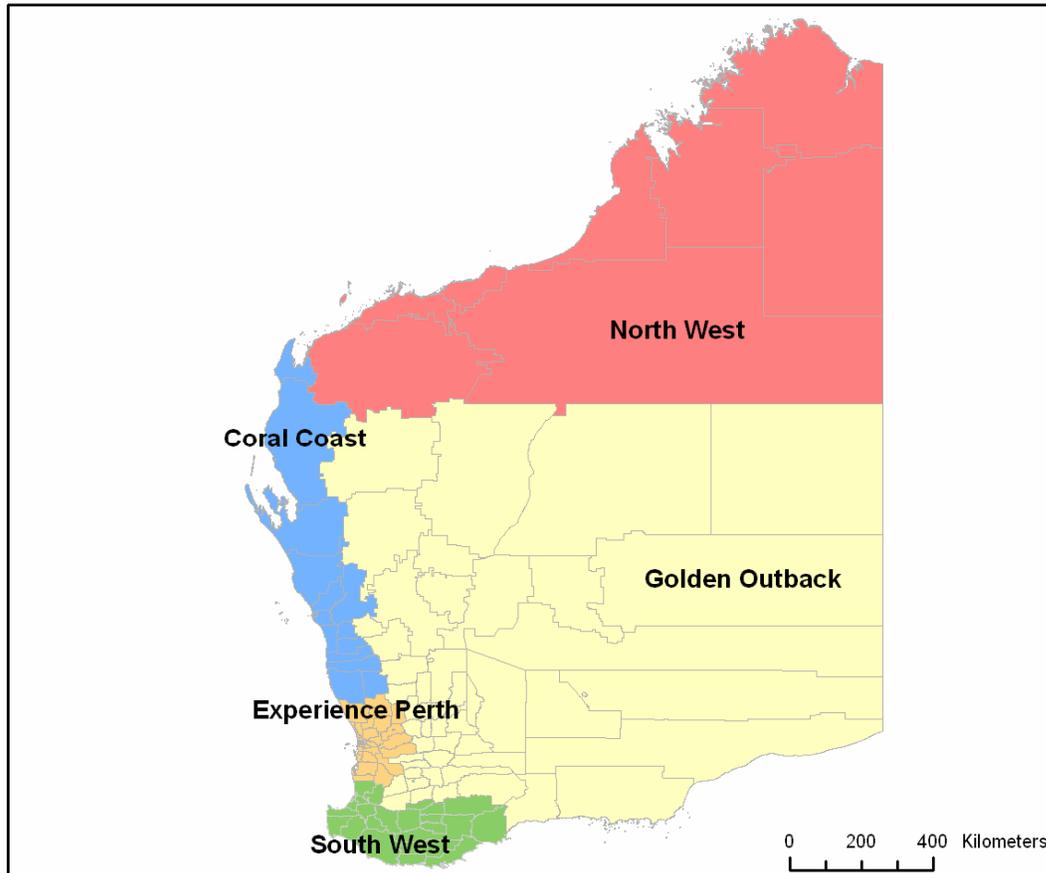
At the Commonwealth level, tourism policy is directed by the measures outlined in the Tourism White Paper of 2004. This document resulted in the amalgamation of the Australian Tourism Commission, See Australia, the Bureau of Tourism Research and the Tourism Forecasting Council into Tourism Australia in July 2004. This statutory body has the objectives of stimulating demand for Australian tourism through identifying Australian tourism experiences, branding and marketing Australia overseas and working with State and Territory government departments and the private sector to facilitate these. It has also established the goal of increasing overall tourism revenue from \$33.7 billion in 2003-04 to \$38.9 billion in 2007-08 (Tourism Australia, 2007). Funding is provided under the White Paper for this and other measures totalling \$235 million, with \$120 million being earmarked for international marketing.

Tourism Western Australia is the statutory authority at the State level which co-ordinates its activities with Tourism Australia. It is responsible for promotion, research and development into the strategic growth and management of tourism in the State and is positioned within the portfolio of the Minister for Tourism. The policy objectives of Tourism Western Australia are to increase visitation, enhance visitor experiences, grow regional tourism, attract investment into the sector and highlight the contribution of tourism towards the economy and social well-being of the State. These underpin the vision of Western Australia as the 'world's natural choice' of destination (Tourism Western Australia, 2006a).

The organisation of tourism promotion and marketing within the State changed dramatically in 2004 following the perceived need to prioritise the marketing of distinct packages within the State and to reduce the bureaucracy associated with the existing eleven tourism regions. These regions were realigned with the effect of creating five regions, each with a Regional Tourism Organisation (RTO) representing the tourism industry in that region. Each RTO is under contractual obligations with the State government to promote their region and with specific responsibility to

market the region within Western Australia. The area of responsibility of each RTO is illustrated in Figure 8.1.

**Figure 8.1 Regional Tourism Organisations within Western Australia**



(Source: Tourism Western Australia, 2006a)

## **8.2 Activity at the State and National level**

At the national level, inbound visitor arrivals totalled 5.5 million in 2006, representing an annual increase of 0.6% but well below the previous annual increase of 5.5%. Domestic visitor nights totalled 285.7 million nationally in 2006, which constituted an annual increase in the order of 3.6% in contrast to the preceding year's decline of 7.1%. Inbound and domestic visitors generated total revenues of approximately \$22 billion and \$62 billion in 2006, representing annual increases in real terms of 8.1% and 2.3% respectively (Tourism Forecast Committee, 2007). This spend can be expressed as tourism's share of national GDP, reflecting the total value of goods and services consumed by visitors after deducting the cost of goods and services used in

their production. In 2005-06, tourism accounted for 3.9% of national GDP, which represents a continued decline from a peak of 4.7% in 2000-01. However, factors such as the effects of the Olympic Games and the introduction of GST contributed largely to this historic peak, whilst the GDP contribution of increased tourism activity is partly offset by the continued growth in the domestic economy (ABS, 2007a).

Another indicator of the economic contribution made by tourism is the Gross Value Added, which is a measure of the gross output of goods and services provided (excluding net taxes) less the value of intermediate inputs required to produce these. GVA calculations enable the identification of key beneficiary industries associated with tourism. In 2005-06, the GVA of tourism amounted to \$31.3 billion, with air and water transport accounting for 14% of this, accommodation 13.6%, other retail trade 11.5% and takeaway food outlets 9.8%, highlighting the sectors most closely associated in financial terms with tourism (ABS, 2007). Data relating to visitors to Western Australia for the year 2006 is summarised in Table 8.1.

**Table 8.1 Visitor summary for Western Australia, 2006**

<i>Visitor origin</i>	<i>Number of visitors</i>	<i>Visitor nights</i>	<i>Expenditure (\$ million)</i>
Intrastate	5,414,000	19,750,000	2,008
Interstate	1,349,000	10,101,000	1,310
International	624,000	16,039,000	1,317
<b>TOTAL</b>	<b>7,388,000</b>	<b>45,710,300</b>	<b>4,635</b>

(Source: Tourism Western Australia, 2007a)

Table 8.1 indicates that, whilst intrastate visitors comprised the largest segment of visitors to Western Australia, accounting for 73% of total visitor numbers, their expenditure only accounted for 43% of the total visitor expenditure. International visitors, comprising 8% of the total, contributed around 28% of total expenditure, equivalent to that of interstate visitors. In 2006, the number of international visitors to the State declined by 1.8%, while a dramatic rise was seen in interstate visitor numbers (41%), and 8% for intrastate visitors. Over the longer term, however, international visitor numbers increased during the period 2000 to 2006 by a total of 2.8%, interstate visitors increased by 37% and intrastate visitor numbers rose marginally, by 1%. Data from 2001-02 suggested that around 8% of the workforce in Western Australia were directly or indirectly employed in the tourism industry, which

contributed a total of \$2.7 billion or 3.5% of the Gross State Product in that year (Access Economics, 2003).

### 8.3 Regional activity

#### 8.3.1 Visitor numbers

The majority of the coastline adjacent to the North-west Marine Region is incorporated into the 'North West' RTO tourism region, which covers the Local Government Areas (LGAs) in the Pilbara and Kimberley planning regions. The Gascoyne LGAs of Exmouth, Carnarvon and Shark Bay lie within the 'Coral Coast' RTO tourism region which extends south to the Perth metropolitan boundary (Figure 8.1). Table 8.2 provides an annual summary of the distribution of all visitors to Western Australia by tourism region from 2000 to 2006.

**Table 8.2 Distribution of all visitors to Western Australia by tourism region 2000-06**

<i>Tourism Region</i>	<i>Annual total visitor numbers</i>						
	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>
Experience Perth	3,691,000	3,972,300	3,866,100	3,503,600	3,722,800	3,437,400	3,716,500
South West	2,076,200	1,976,300	2,081,500	2,137,400	2,125,900	2,008,100	2,064,200
Golden Outback	791,900	819,700	886,000	848,500	813,000	731,200	768,300
Coral Coast	629,900	698,000	693,100	754,200	687,900	616,900	646,400
North West	515,200	604,400	557,100	521,500	574,100	575,800	690,900
<b>TOTAL</b>	<b>7,704,200</b>	<b>8,070,700</b>	<b>8,083,800</b>	<b>7,765,200</b>	<b>7,923,700</b>	<b>7,369,400</b>	<b>7,886,300</b>

(Sources: Tourism Western Australia 2007a, 2007b, 2007c)

These figures indicate that the Coral Coast and North West are consistently the least visited tourism regions of Western Australia, attracting between 7% and 9% of all visitors annually since 2000. The Coral Coast has experienced a notable decline in visitors of around 14% since 2003, whilst conversely the North West has seen an increase in visitors since 2003, most notably in 2006 when visitor numbers increased by 20%.

Table 8.3 below details the total number of overnight visitors to locations adjacent to the North-west Marine Region. These data use a four year running average to increase the sample size and reliability of the data, although this means that recent trends cannot be discerned. However, this does indicate the primacy of Broome as the main

tourist destination within the Region, accounting for a fifth of all overnight visitors, approximately one in five of whom are international tourists.

**Table 8.3 Average number of annual overnight visitors to locations adjacent to the NWMR 2003-2006**

	Domestic		International		Total	
	Number	%	Number	%	Number	%
<i>Gascoyne</i>						
Carnarvon	112,500	11.4	30,300	13.6	142,800	11.8
Exmouth	68,500	7.0	26,700	12.0	95,200	7.9
Shark Bay	78,000	7.9	38,400	17.2	116,400	9.6
<i>Pilbara</i>						
Ashburton	66,750	6.8	16,300	7.3	83,050	6.9
Roebourne	125,000	12.7	10,100	4.5	135,100	11.2
Port Hedland	79,750	8.1	14,200	6.4	93,950	7.8
East Pilbara	64,500	6.6	5,600	2.5	70,100	5.8
<i>Kimberley</i>						
Broome	197,250	20.0	37,100	16.6	234,250	19.4
Derby-West Kimberley	59,750	6.1	13,200	5.9	72,950	6.0
Wyndham-East Kimberley	77,500	7.9	19,700	8.8	97,200	8.0
Halls Creek	54,750	5.6	11,800	5.3	66,550	5.5
<b>TOTAL</b>	<b>984,250</b>	<b>100</b>	<b>223,400</b>	<b>100</b>	<b>1,207,550</b>	<b>100</b>

(Source: Tourism Western Australia 2007f, 2007g)

Carnarvon represented almost 12% of total visitor nights over this period, a larger proportion of whom were international in origin. The Gascoyne destinations as a whole accounted for around 40% of total visitors but attracted almost 75% of total international visitors, indicating that the total spend associated with these visitors could well be much greater than that in the Pilbara and Kimberley. There will also be a significant component of workers in transit to offshore oil and gas installations or to inland mines accounting for the numbers of domestic visitors to Roebourne, along with Ashburton, East Pilbara and Port Hedland in particular. This is also reflected in the apparent increase in total visitors to the North West tourism region since 2003, much of which will evidently reflect the increase in non-resident working population associated with the Pilbara minerals sector.

### 8.3.2 Tourism activity

Tourism activity in the North-west Marine Region includes a variety of marine-based activities including charter boats, diving, fishing and sailing. The numbers of participants in these activities is not readily available, but an indication of their distribution in the North West can be determined through current entries in the Yellow Pages in combination with peak organisation and State records where available. Table 8.4 summarises tourism services using categories as defined in the Yellow Pages and includes marine boat launching ramp locations given to the nearest settlement.

**Table 8.4 Location of tourism-related services along the coastline adjacent to the North-west Marine Region**

Location	Boat charter services	Yacht clubs	Marine boat launching ramps
Kalbarri	1	-	2
Monkey Mia	1	-	1
Denham	2	-	3
Shark Bay	1	-	-
Coral Bay	1	-	-
Carnarvon	-	1	2
Exmouth	8	1	3
Onslow	2	-	-
Karratha	5	-	3
Dampier	1	1	4
Port Hedland	2	1	1
Broome	13	1	3
Derby	2	-	2
Wyndham	-	-	1
Kununurra	2	-	-

(Sources: DPI, 2007a; Yachting Western Australia, 2007; Yellow Pages)

This demonstrates the widespread availability of facilities to support recreational boating activity in towns adjacent to the Region. The provision of boat launching ramps services a range of demands including the recreational fishing sector but is included in this discussion as there are obvious linkages with tourism demand. Whilst there is a wide distribution of boat launching facilities, they are restricted in number, although are likely to be increased or upgraded into the future, with the DPI recently announcing ramp upgrades worth \$175,000 at St John's Creek in Karratha and \$75,000 to accommodate trailer parking at Lake Argyle under the Recreational Boating Facilities Scheme (DPI, 2007b). Table 8.4 also highlights the demand for boat charter services, particularly in the main towns of Broome and Exmouth. Chartered boat activity out of Broome comprises mostly extended cruises of up to 14

days for groups numbering up to around 20 people, involving a combination of activities including scenic visits, diving and game fishing. Scenic tours and diving are generally undertaken from June to November, and comprise a diverse range of destinations along the coastline between Broome and Wyndham, with common locations including the Buccaneer Archipelago, Montgomery Reef, the Bonaparte Archipelago, Mitchell Falls and King George Falls. Some operators also offer extended tours of the northern atolls and Rowley Shoals. Chartered fishing activities are available in the wet season from November to March, although these are offered by a relatively small number of Broome operators. Those organisations based in Exmouth are predominantly focused upon diving, snorkelling, whale watching and scenic tours of the Ningaloo Reef and operate all year round. A relatively minor segment of the tourism industry in the North-west Marine Region involves cruise ships visiting as part of a wider itinerary which are focused exclusively on visits to the port of Broome. A total of 14 visits were recorded in the financial year 2005-06, representing the peak annual total of visits since 2000-01 (AAPMA, 2007).

### *8.3.3 Tourism expenditure*

Estimates of tourism expenditure in the three planning regions are made on a rolling biannual average, the latest available data covering the period 2003-04. Combined domestic and international tourist expenditure was highest in the Kimberley, totalling \$227.3 million, with the Pilbara total reaching \$225.9 million and the Gascoyne markedly lower at \$172.2 million. Domestic tourist expenditure dominated in all three regions, accounting for 86-88% of the total in each region (Gascoyne Development Commission, 2006; Kimberley Development Commission, 2006; Pilbara Development Commission, 2006).

However, more detailed data are required to fully evaluate the economic contribution made by tourism. The most recently available figures relate to tourism in 2001-02, when the total direct tourism gross value added for Western Australia was \$2.2 billion (Access Economics, 2003). This research used a satellite accounting method to explore the impact of tourism contribution to the economy in various ways. One method which allows identification of industry sector dependence on tourism is the tourism product ratio, which is defined as the proportion of expenditure made by tourists on a particular industry's output. This identified that in the case of Western

Australia, those industries most closely dependent on tourism included air and water transport, with a tourism product ratio of 77%, accommodation, cafes and restaurants (34%), beverages and tobacco products (20%) and retail trade and takeaway food (13%).

In addition, tourism makes indirect contributions to the economy through the indirect consumption of other products used in the production of goods and services consumed by the sector. The total indirect value added by tourism was estimated to be \$1.4 billion in 2001-02, meaning that the total direct and indirect value added by tourism at the State level amounted to \$3.6 billion. The distribution of these indirect benefits to the supply side industries will evidently be more dispersed than direct benefits, but the highest proportions were associated with business and property services (25%) and services to transport (10%). Table 8.5 summarises the calculated direct and indirect economic impacts of tourism for the tourism regions in Western Australia for 2001-02. All five regions are included to aid comparison and analysis.

**Table 8.5 Direct and indirect economic impacts for tourism regions in Western Australia, 2001-02**

Tourism Region	Direct value added		Indirect value added	
	<i>Value (\$ million)</i>	<i>% of total</i>	<i>Value (\$ million)</i>	<i>% of total</i>
Experience Perth	1,392	62.9	851	61.1
South West	351	15.6	225	16.2
North West	196	8.7	122	8.8
Coral Coast	187	8.3	115	8.3
Golden Outback	122	5.4	80	5.7
<b>TOTAL</b>	<b>2,249</b>	<b>100</b>	<b>1,393</b>	<b>100</b>

(Source: Access Economics, 2003)

These data further demonstrate the ranking of tourism regions seen with respect to visitor numbers, with the two tourism regions adjacent to the North-west Marine Region area receiving less than 10% of the total State direct and indirect economic benefits associated with tourism. It is possible that the above data over-estimates indirect benefits in the more remote North West and Coral Coast tourism regions to some extent, as these involve sourcing of goods which are more likely to require transport from other regions within the State.

Bearing in mind that total visitor numbers to Western Australia in 2006 were 2.3% down on those in 2001, it is likely that the above estimates are applicable to the current situation. At the tourism region level, visitor numbers in 2006 compared to those in 2001 had declined by 7% with respect to the Coral Coast and increased by 14% with regard to the North West, so it is likely that there has been some increasing divergence, with the North West currently accruing a greater proportion of direct and indirect economic benefits than the Coral Coast.

### 8.3.4 Employment

Table 8.6 details the numbers employed in 2004 in the tourism industry for each Local Government Area in the Gascoyne, Pilbara and Kimberley planning regions. The data indicates that the total number of people employed in tourism varies from 567 in the Gascoyne to 1,059 in the Pilbara and 1,311 in the Kimberley planning regions. These figures conceal the local variability within each region, as the LGAs of Broome, Roebourne, Port Hedland and Wyndham-East Kimberley account for 65% of all tourism jobs in towns adjacent to the North-west Marine Region. However, other LGAs such as Shark Bay in particular and Exmouth to a lesser extent are more dependent on tourism, which employs a large proportion of the workforce in these locations whilst contributing relatively little to the overall tourism total.

**Table 8.6 Employment in tourism in areas adjacent to the North-west Marine Region, 2004**

<i>Planning Region</i>	<i>Local Government Area</i>	<i>Employment in tourism</i>		
		<i>Number</i>	<i>% of total number</i>	<i>% of workforce in SLA</i>
Gascoyne	Shark Bay	151	5.2	33.3
	Upper Gascoyne	4	0.1	2.5
	Carnarvon	241	8.4	7.5
	Exmouth	171	5.9	14.3
Pilbara	Ashburton	153	5.3	4.8
	Roebourne	461	16.0	5.6
	Port Hedland	323	11.2	5.1
	East Pilbara	122	4.2	3.8
Kimberley	Broome	771	26.7	11.6
	Derby-West Kimberley	139	4.8	4.2
	Wyndham-East Kimberley	317	11.0	9.3
	Halls Creek	30	1.0	2.2

(Sources: Tourism Western Australia 2007f, 2007g)

The satellite accounting analysis used by Access Economics (2003) estimated that the ratio of direct to indirect employment in tourism was 0.3, i.e. every three direct jobs in tourism generated one additional indirect job. Whilst different methods are used to define employment in the industry, this ratio would imply that the total direct and indirect tourism employment in the areas adjacent to the North-west Marine Region amounts to around 4,000.

Another perspective on employment in the tourism sector can be provided through the quarterly Survey of Tourist Accommodation (ABS, 2007b). The most consistent data relating to employment covers the period 2005-07 which is summarised in Tables 8.7-8.8 below.

**Table 8.7 Numbers employed in tourist accommodation sector for the Coral Coast Tourism Region 2005-07**

<b>Date</b>	<b>Hotels, motels and serviced apartments</b>	<b>Holiday flats, units and houses</b>	<b>Visitor hostels</b>
March 2005	564	30	40
March 2006	631	n/a	43
March 2007	666	19	43

(Source: ABS, 2007b)

**Table 8.8 Numbers employed in tourist accommodation sector for the North West Tourism Region 2005-07**

<b>Date</b>	<b>Hotels, motels and serviced apartments</b>	<b>Holiday flats, units and houses</b>	<b>Visitor hostels</b>
March 2005	1227	n/a	68
March 2006	1229	n/a	72
March 2007	1282	n/a	62

(Source: ABS, 2007b)

These data clearly underline the greater numbers employed in tourism accommodation overall in the North West tourism region. Hotels, motels and serviced apartments are the most significant category in terms of employment in both regions, but employment is increasing in this category at a faster rate of 18% in the Coral Coast than the 4% increase observed in the North West tourism region over the period 2005-07. The lack of data with respect to holiday flats, units and houses could reflect

the small number of businesses and need to protect confidentiality and therefore should not be taken to indicate the absence of employment in this category.

### 8.3.5 Infrastructure

Table 8.9 summarises the status of tourism accommodation projects under construction in the towns adjacent to the North-west Marine Region in 2006.

**Table 8.9 Tourism accommodation projects under construction in areas adjacent to the North-west Marine Region 2006**

<i>Planning Region</i>	<i>Local Government Area</i>	<i>Number of projects</i>	<i>Total value (\$ million)</i>	<i>Lettable units</i>
Gascoyne	Shark Bay	1	0.5	9
	Exmouth	3	45.3	265
Pilbara	Ashburton	1	2.5	89
	Port Hedland	2	24	494
Kimberley	Broome	4	42	169
	Wyndham-East Kimberley	2	6.5	113

(Source: Tourism Western Australia, 2006b)

This highlights the varying extent and focus of investment in tourist accommodation in the North West in 2006. It is clear that Broome and Exmouth are the locations of most investment, which in Broome ranges from eco-cabins to self-contained apartments and hotels, while the Exmouth developments comprise four star villas and chalets. Elsewhere, Port Hedland is characterised by lower financial investment in a greater number of lettable units, all of which are comprised of motel rooms financed largely by the mineral resources sector. Investment in Ashburton and Shark Bay is in the form of camping facilities, while hotel and backpacker accommodation is being constructed in Wyndham-East Kimberley.

## 8.4 Socio-economic dimensions

### 8.4.1 Drivers of change

Whilst it is evident that domestic visitors dominate in terms of numbers and economic impact in Western Australia, there are broader scale macroeconomic and political influences which could affect the levels of domestic visitation. It is considered that the events of September 2001 encouraged Australians to take domestic holidays rather than overseas visits, which is reflected in the number of domestic visitors to Western

Australia being 8% higher in 2002 than in 2000. However, as is generally the case with sudden shocks to the tourist market, the effects were short-lived, and domestic visitors to Western Australia declined by 6% to pre-September 2001 levels during 2003. It is worthy of note that the continuing rate of increase in domestic GDP would be expected to result in a greater overall number of holidays as people's disposable income increases. However, other factors such as property prices and interest rates will temper individual expenditure on holidays, whilst it is likely that the availability of cheap flights and the purchasing power of the Australian dollar overseas are tempting more people to take foreign rather than domestic holidays.

With respect to the North West, it is evident that the principal factor restricting growth is the remote location, which incurs greater transport costs and precludes short day visits for the vast majority of domestic visitors. The provision or upgrading of transport infrastructure is perceived as the fundamental first step in facilitating private sector investment in a location. Tourism Western Australia identified priority areas of infrastructure investment in a submission to the State Infrastructure Strategy (2006). This indicated that air transport to regional airports is currently subsidised by the State and would require considerable growth in passenger numbers before privatisation could be considered. The case for additional airports or services in the towns adjacent to the North-west Marine Region is probably diminished by this issue of public investment. With regard to road transport, a loop road across the Cape Range National Park intended to enhance access to Milyering Visitor Centre and other sites within the park has high priority for recommended State investment over the next 5-10 years.

It is envisaged that these and other infrastructure projects could be considered for funding through the proposed State-wide Tourism Infrastructure Development Fund which, along with the Tourism Destination Development Fund, is to be included for submission in the 2007-08 budget round (Tourism Western Australia, 2006). The Infrastructure Fund would be specifically targeted to remote locations throughout the State including the Dampier Peninsula and Ningaloo Coast as well as Indigenous communities in the North West, with a suggested total of \$100 million being available to distribute to a total of 10-12 sites in line with State and regional development priorities. The Destination Development Fund would total around \$10 million to support projects falling outside of the Infrastructure Fund such as visitor centres,

heritage walks and signage to improve the tourism potential of destinations. The impact of these possible new funding sources is difficult to predict at this stage but it clearly represents an opportunity to facilitate visitor access to the North West which would have significant impacts on the future direction of tourism activity.

The main driver of tourism in the North West is the image of an unspoilt and pristine wilderness and associated tourism marketing activities capitalise upon this. At the State level, nature-based tourism was the subject of a tourism strategy document produced in 2004 which gave guidance to regional tourism organisations, stressing the need among others to capitalise upon the State's natural advantages, enhance interpretive materials to nature-based tourists, work towards accreditation of nature-based tourism and promote the realisation of economic benefits associated with this sector (Tourism Western Australia, 2004).

However, it is at the regional tourism level where these broader policies translate into actions. Each tourism region produced a ten year Development Strategy in 2004, which was updated in 2007 to cover the period 2007-2017. These updated Strategies will be discussed in this Report. It is anticipated that a full review of each Strategy will be undertaken in 2008. The measures outlined to facilitate tourism in each Strategy are not compiled in line with the Tourism Infrastructure Development Fund submission outlined above. Rather, they are the result of a lengthy participatory process designed to elicit views from visitors and the industry to determine the priorities for tourism within each region.

The updated Coral Coast Development Strategy (Tourism Western Australia 2007d) underlined the importance of marine-based activities to the region and evaluated the market-readiness of various tourist destinations within the North West. As such, this allows an insight into the likely future development of marine-based tourism. Given the predominance of coastal settlements and attractions in this region, it is reasonable to assume that the vast majority of visitors focus their activities upon the marine environment, although data are not available to quantify this. The vast majority of sites were classed as in need of investment to bring them to a market-ready stage. The common underlying causes were identified as expensive public transport, lack of high quality accommodation and few non-aquatic based tourism activities, leading to a

prioritisation of activities in certain locations. The provision of sustainable tourism accommodation and camping facilities are highlighted as priorities in Coral Bay and Ningaloo, whilst additional investment in amenities and services is stressed in Coral Bay. Kalbarri is likely to receive increased investment in promoting children's activities, reflecting the popularity of this destination with Western Australian family visitors. There is little evidence of planned activities in the Exmouth area, reflecting the degree of satisfaction recorded by visitors, but Shark Bay is the focus of most planned activities, aimed at improving transport links, providing high standard accommodation, increasing the level of amenities and number of interpretive centres and focusing on enhancing the participation of Indigenous communities with regard to guided walks and trails.

The North West tourism region differs in that there is a greater emphasis on outback and adventure activities, which include coastal areas but also stress inland activities such as hiking, fishing, four wheel driving and encounters with Indigenous communities (Tourism Western Australia 2007e). Broome and its environs offer highly specific marine-based attractions more associated with relaxation and comfort than with the more active pursuits highlighted in the Coral Coast region. There were a greater number of sites or activities deemed 'market-ready' in the North West tourism region. These included Broome, where development is likely to be focused on increasing the quantity rather than quality of accommodation, with the prospect of a possible international air link to Singapore serving to diversify the market should that eventuate. Various outdoor pursuits such as the Gibb River Road and Kimberley coast cruising were seen as in need of restricting visitor numbers in order to maintain their appeal rather than attempting to expand or improve facilities. With regard to sites where activities or improvements are proposed, there was a frequent focus on the need for safari style camping or backpacker accommodation. These included coastal locations such as the Burrup Peninsula, the Dampier Peninsula and the historic town of Cossack as well as national parks such as Karijini and Purnululu. Other coastal locations such as the Dampier Archipelago, the Montebellos Marine Park and the Mackerel Islands were proposed as areas where the marine ecotour or charter boat sector could expand, whilst a marina is in the planning stage in Nickol Bay on the Burrup Peninsula. Emphasis was also placed on involving and integrating Indigenous

communities with several small scale accommodation and interpretive activities in the Burrup Peninsula, Roebourne and the Dampier Peninsula.

#### *8.4.2 Socio-economic linkages*

It is evident from the above that there are a range of policies, priorities and possible funding sources which could diversify and enhance the tourism sector in and adjacent to the North-west Marine Region over the next 10 years, the need for which is reflected in the current static visitor numbers and economic benefits accruing for the North West as a whole from this activity. However, the extent of current socio-economic impacts and linkages merit examination as the tourism sector in the North West overall is highly specific both in terms of location and activity.

This is more the case in the Coral Coast tourism region, which can be summarised as attracting a stable annual total of visitors with a high proportion of international tourists, enabling a limited range of employment and economic benefits which are mainly concentrated in Shark Bay and Exmouth. Visitors are likely to be either focused on active marine pursuits in the Shark Bay-Ningaloo area or staying in the coastal town of Exmouth which generally involve older demographic groups. It is likely that the economic linkages and benefits associated with tourism in the Ningaloo area are relatively restricted, given the emphasis on specialised marine activities and the preference for caravans, camping and relatively low-grade accommodation by visitors in this area. This would serve to limit participation in employment mainly to individuals with particular diving or boating skills and expertise, who are likely to come from outside the area for these reasons. The plans for investment reflect this picture, with the emphasis on sustainable tourism development generally precluding large scale hotels or similar facilities which would generate more employment but which would be out of keeping with the landscape and tourist activities. The exception to this is the proposed expansion of higher standard accommodation in Shark Bay, which would be located on Landbank land in Denham which acts as the main entry point into Shark Bay. Given this overall description, it appears that the benefits of tourism in the Coral Coast region are highly concentrated and limited outside the two centres of Shark Bay and Exmouth to providing basic accommodation and marine tourism related services.

The situation is slightly different with respect to the North West tourism region, which is characterised by two contrasting forms of activity and location. The first can be described as archetypal sun, sea and sand tourism concentrated almost exclusively in the Broome area. In this case, tourism is at a relatively advanced stage of development, benefiting from a range of high quality accommodation. Given the relatively isolated situation of the town, it seems reasonable to suggest that the vast majority of visitors utilise goods and services provided locally and thereby increase the overall range of indirect economic benefits from tourism, but that these are highly concentrated within the town itself. However, it is likely that a large proportion of the goods and services, particularly related to catering, need to be of a high standard and diversity which may not be available locally, thereby decreasing the overall indirect economic benefits accruing to the immediate region. As visitors are attracted primarily by the beaches and quality of accommodation and services, it seems reasonable to assume that potential investors would require significant capital to gain entry into the industries supported by tourism, which again could mitigate against the participation of lower socio-economic groups in these activities.

The other principal form of tourism operating in the North West tourism region can be described as outback adventure tourism, predominantly in the Wyndham-East Kimberley area as reflected in the number of individuals employed in tourism and the extent of investment in tourist accommodation detailed above. Significantly, however, this form of tourism involves greater independence of travel, enabling the economic benefits of tourism to reach a wider range of more remote areas and potentially involving Indigenous communities in providing goods and services. Therefore the actual direct and indirect economic benefits of this form of tourism could be greater than that indicated above for the North West tourism region as a whole, whilst there are also likely to be less quantifiable but distinct social benefits to remote and Indigenous communities in association with this. Outback and adventure tourism of this type is limited in two senses, however. The first, which is recognised in the development strategy, relates to the need to maintain a sense of wilderness and escapism through deliberately not investing in facilities and services. The second is the fact that such tourism is restricted to particular socio-economic groups, described in the development strategy document as ‘empty nesters’ aged over 55 and ‘outdoor adventure enthusiasts’ aged 25 and over (Tourism Western Australia 2007e). It is also

likely that the participants in these activities are predominantly male, although this is not stated. Therefore it can be concluded that this form of tourism offers significant potential socio-economic linkages and benefits to a wider cross-section of local residents, including the Indigenous community, which would not otherwise be present. However, this is a small niche market and one which requires careful management to avoid losing its essence. Future development of this sector is therefore likely to focus on expansion into new areas, such as the Mitchell River National Park, which as a newly gazetted park, offers potential for branding and marketing to a specific niche sector.

It should also be noted that other settlements in the North West tourism region owe their existence largely to investment by the mineral resources sector, including locations such as Port Hedland and Tom Price. Tourist accommodation in these towns is often very limited and expensive owing to the standing reservation of hotel and motel rooms by the mineral resources sector and the associated general increase in accommodation rental prices, which acts as an obvious constraint to tourism development.

## **9 PEARLING AND AQUACULTURE**

### **9.1 State and Commonwealth policy objectives**

In Australia, State and Federal authorities are responsible for the management of pearling and aquaculture activities. Aquaculture can be defined as the ‘farming of aquatic animals and plants under controlled conditions, both in marine and freshwater environments’ (Department of Fisheries, 2005). Management of this industry is somewhat complicated as, in addition to fisheries legislation, aquaculture is subject to regulations concerning environmental protection, coastal or environmental management, land administration, land use planning, native wild life, and water management (Productivity Commission, 2004). Four federal parliamentary acts, including the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and the Fisheries Management Act 1991 regulate pearling and aquaculture activity across the country (Maunsell, 2004). Existing and pending Native Title claims must also be taken into consideration when it comes to the use of public lands and waters for aquaculture activities. The current Commonwealth Aquaculture Industry Action Agenda, implemented in 2000, provides the foundation for aquaculture development into the future. The major objectives of the strategy include developing a national aquaculture policy statement, ensuring environmentally sustainable development, improving education, training and workplace opportunities, promoting aquaculture produce in Australia and overseas, as well as encouraging access to the industry among Indigenous Australians (National Aquaculture Council, 2005). Responsibility for enforcing these policy objectives lies jointly with the Commonwealth and individual State governments.

At the State level, both statutory and non statutory measures are used for regulation of the industry, although inconsistency across State borders has impeded the development of the industry in certain areas (Productivity Commission, 2004). In Western Australia, the State Department of Fisheries is advised by the Pearl Producers Association (PPA) and the Aquaculture Council of Western Australian (ACWA), which are the peak bodies representing the pearling and aquaculture sectors respectively. The Department of Fisheries Aquaculture and Pearling division is responsible for management, research and development, as well as compliance and community education, all under the provisions of the Fish Resources Management

Act 1994 and the Pearling Act 1990. Specific objectives of State legislation include sustainable growth into the future with the goal of increasing GVP by \$100m to 2013, ensuring ecologically sustainable development, building infrastructure to promote future development and attracting investors to the industry to implement projects of critical importance (Zelko Lendich and Associates, 2003). Regulation at the local level is also significant as many farms are privately owned and responsible for the profitability of their own businesses.

## **9.2 Activity at the State and National level**

Pearling and aquaculture industries are increasingly significant contributors to Australian commercial fisheries exports. In 2006, 35% of all fisheries exports were from aquaculture sources, with the cultivation of barramundi and abalone growing most significantly in terms of value and volume of produced over the preceding five year period. In 1998, the aquaculture industry contributed \$506 million to the Australian economy, while by 2006 this had increased to \$748 million, amounting to an increase of around 19% in real terms (ABARE, 2007; 2000). In addition to the increase in overall value, Australia has experienced considerable diversification in relation to the species cultivated for aquaculture. At present, the major species farmed include tuna, pearl oysters, salmon, edible oysters and prawns (ABARE, 2007). The proximity to Asian markets provides an advantage for future development, as currently the majority of Australian seafood is exported to Hong Kong, Japan, and China (ABARE, 2007). With continued population growth and GDP in overseas markets placing greater demands on wild catch fisheries, future growth potential of this industry is significant.

In Western Australia, pearling and aquaculture products contributed over \$128 million to the national economy in 2006, representing 17% of the total value of Australian aquaculture (ABARE, 2007). The most profitable species farmed were pearls and pearl oysters in the north west of the State, although smaller operators in the south are increasingly contributing to the value of the industry with a diversifying produce base. The value and volume of aquaculture production from 2000 to 2006 are shown in Table 9.1 and Table 9.2 respectively, and over this period both experienced fluctuation and overall decline up to 2006. Whilst the quantities of pearls produced are not specified for commercial reasons, it is evident that the value of pearl

cultivation far exceeds the combined value of all other aquaculture activities in Western Australia, pearling being the second highest grossing fishery in the state behind the rock lobster fishery. The decline in the total value of pearl production after 2001-02 related primarily to economic conditions in the main export markets of Asia and an over-supply of low to medium quality pearls on the world market, but the total value of production has remained stable since that time. Data on employment in the industry is difficult to quantify, however from the 2001 census it is estimated that around 1500 people were employed in the pearling sector and 600 people were employed in aquaculture throughout the State (ABARE 2007; Fletcher *et al*, 2006).

**Table 9.1 Value of aquaculture produce in Western Australia, 2000-01 to 2005-06**

Sector	Value of production (\$ '000)					
	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Pearl oysters	150,000	175,000	124,000	122,000	122,000	122,000
Mussels	2,267	2,817	1,607	2,063	1,515	1,897
Yabbies	2,510	1,281	1,040	1,010	1,120	985
Marron	1,183	1,099	1,082	1,091	1,485	1,336
Other native & aquarium fish	801	1,015	1,861	2,612	1,888	871
Other not specified*	234	654	713	753	467	820
<b>TOTAL</b>	<b>156,995</b>	<b>181,866</b>	<b>130,303</b>	<b>129,529</b>	<b>128,475</b>	<b>127,909</b>

(Source: ABARE 2007; 2002)

\*Not specified elsewhere due to confidentiality restrictions

**Table 9.2 Volume of aquaculture produce in Western Australia, 2000-01 to 2005-06**

Sector	Volume of production (tonnes)					
	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Pearl oysters	n/a	n/a	n/a	n/a	n/a	n/a
Mussels	964	989	653	763	531	671
Yabbies	201	102	75	71	73	66
Marron	52	47	46	50	55	54
Other native & aquarium fish	95	94	246	359	316	57
Other not specified*	0	0	0	0	0	0
<b>TOTAL</b>	<b>1,312</b>	<b>1,231</b>	<b>1,020</b>	<b>1,243</b>	<b>975</b>	<b>848</b>

(Sources: ABARE 2007; 2002)

\*Not specified elsewhere due to confidentiality restrictions

### 9.3 Regional activity

In Western Australia, the pearling and aquaculture sector is almost exclusively dominated in terms of value by pearl farming, which was estimated at \$122 million in 2005-06, representing over 95% of the pearling and aquaculture sector by value. Table 9.3 details the value of pearling and aquaculture in and adjacent to the Northwest Marine Region, indicating that all of the pearl production in Western Australia originates from this area and that 75% of the value of production takes place in and adjacent to the Kimberley coastline. More precise estimates on the value of pearling are difficult to obtain for a number of reasons, including costs associated with marketing of produce prior to sale on international markets and the time lag seen between harvest and sale of produce (Fletcher *et al.* 2006).

**Table 9.3 Value of pearl and aquaculture production in the NWMR 2002-2005**

Sector	Value of production (\$ '000)		
	2002-03	2003-04	2004-05
Gascoyne			
Pearls	12,400	12,200	12,200
Goldfish and aquarium fish	168	183	138
Kimberley			
Pearls	93,000	91,500	91,500
Fish	1,066	1,496	1,019
Goldfish and ornamental fish	56	61	46
Pilbara			
Pearls	18,600	18,300	18,300
Goldfish, koi carp, ornamental fish	112	122	92
<b>Total pearls</b>	<b>124,000</b>	<b>122,000</b>	<b>122,000</b>
<b>Total fish</b>	<b>1,402</b>	<b>1,862</b>	<b>1,295</b>

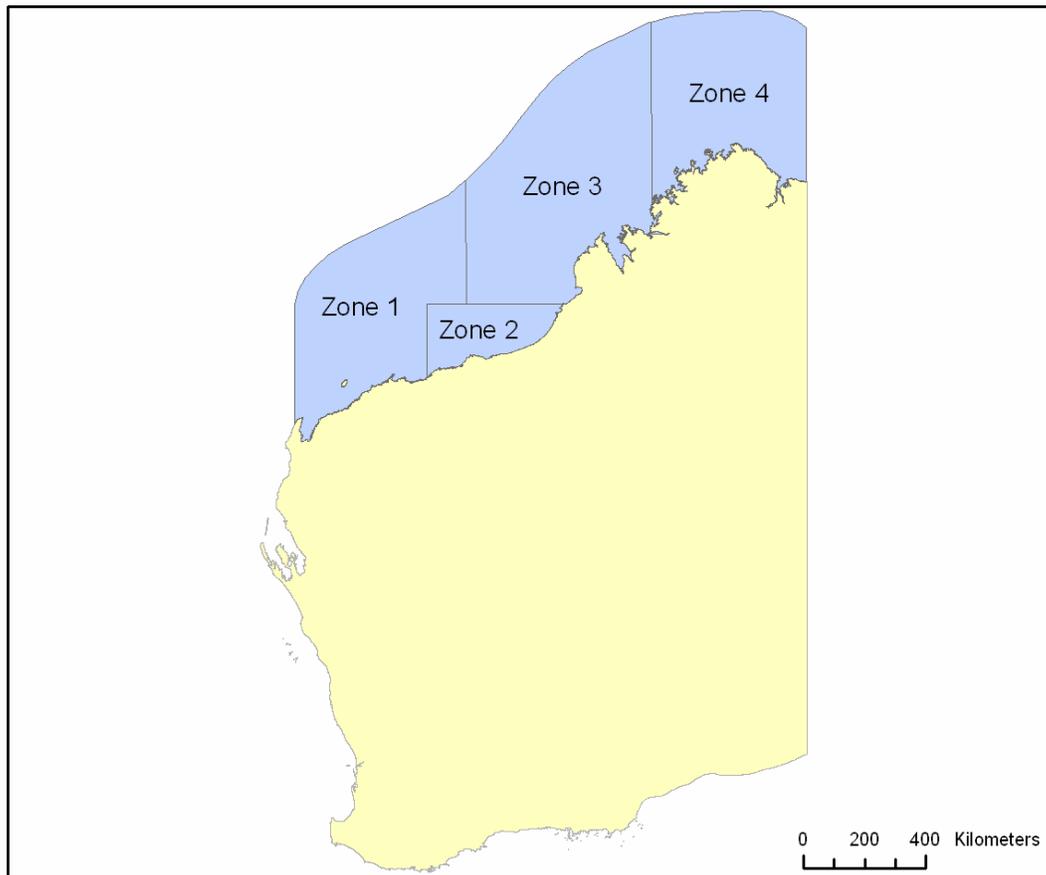
(Sources: Gascoyne Development Commission, 2006; Pilbara Development Commission, 2006; Kimberley Development Commission, 2006)

#### 9.3.1 Pearling

Confidentiality restrictions limit the extent of data in the public domain with respect to the pearling sector to some extent, the most recently available detailed information relating to 2000-01 (Department of Environment and Water Resources, 2003). The

fishery involves a wild harvest and hatchery component which are subject to differing management arrangements.

**Figure 9.1 Zonation of the Western Australian pearl oyster fishery**



(Source: Department of Fisheries, 2005)

The pearl oyster fishery harvests *Pinctada maxima* through manual collection by divers in shallow coastal waters along the North West Shelf in the four zones stretching from Exmouth Gulf to the Northern Territory border as indicated in Figure 9.1, with most activity taking place in Commonwealth waters. The wild oysters are seeded on boats over the fishing grounds, allowed to recover on the sea bed for a period of months and then transported to farms where the pearls are grown out. The fishery is regulated by a quota system, with the TAC in Zone 1 being 115,000 shells and the TAC for Zones 2 and 3 combined being 502,500 shells in 2000 (Department of Environment and Water Resources, 2003). Fishing does not take place in Zone 4, although this is not precluded under current management arrangements. The harvest

in 2000 was 58% of the TAC in Zone 1 and 100% of the TAC in Zones 2 and 3. However, effort is highly skewed, with an estimated 88% of the total catch in the fishery equivalent to 500,000 shells being taken in the Eighty Mile Beach area in Zone 2 in 2000 (Department of Environment and Water Resources, 2003). Additional restrictions are in place regarding minimum and maximum size (120mm and 160mm respectively), fishing methods and logbook requirements. In 2000, a total of 16 licenses were issued, five applicable to Zone 1, nine for Zones 2 and 3 together and two for Zone 3 alone (Department of Environment and Water Resources, 2003). A total of 9 vessels were operating in 2000, although this varies annually between 6 to 10 vessels, with most fishing taking place between March and July of each year when the water visibility is optimal for the divers. An assessment of the wild harvest fishery conducted in 2003 indicated that the management arrangements for the fishery were sustainable, with no indicators of declining catch rates or individual size class and no significant byproduct species being taken.

The hatchery component of the pearl sector commenced operations in 1992 and has superseded the collection and rearing of spat (the developmental stage during which shellfish larvae settle onto reefs). Quotas have been in operation since 1996, with an annual seeding limit of 350,000 hatchery reared shells in 2000 (Department of Environment and Water Resources, 2003). The collection of individuals for seeding and hatchery cultivation involves a wider variety of species including those found outside the North-west Marine Region as far south as Albany. Management arrangements are in place to regulate this activity, with one-off harvest limits being applied to each licensee. A total of 96 licenses had been issued up to the year 2000 relating to five other oyster species found within Western Australia.

Pearling activity within and adjacent to the North-west Marine Region is concentrated around the town of Broome and Eighty Mile Beach, which has historically been the most important centre for pearling. Most of the Pilbara sites are located in the Dampier Archipelago and the Montebellos/Lowendal area as well as Point Samson and Port Hedland (Kimberley Development Commission, 2006; Pilbara Development Commission, 2006).

### 9.3.2 *Aquaculture*

Aquaculture activity in the North West involves the rearing of fish species including ornamental and aquarium varieties, often in inland sites. In terms of value of production, aquaculture in the Kimberley again dominates the output from the North West (table 9.3). However, not all of this involves marine activities, with inland aquaculture activities taking place involving the commercial harvest of barramundi and redclaw crayfish within the waters of Lake Argyle (Department of Fisheries, 2006). Commercial finfish farming has developed in the Exmouth area since 2006, whilst a pilot program was recently established cultivating algae for the extraction of beta-carotene near Carnarvon. Three licences have also been endorsed by the Department of Fisheries for sea-cage finfish production in the Shark Bay area, however as of 2004 production had not yet commenced (Department of Fisheries, 2004a).

## **9.4 Socio-economic dimensions**

### 9.4.1 *Drivers of change*

The demand for aquaculture produce on international markets is one of the main factors driving changes in the Western Australian pearling and aquaculture industries in recent years. Largely high value marine species are harvested in the NWMR with pearls in particular having specific niche markets at the international level. The value of the pearling industry in Western Australia has stabilised and declined slightly in recent years. Heavily reliant on export markets, production peaked in 1999-2000 but experienced a decline to 2006, mainly due to the Asian economic downturn and an oversupply of pearls on global markets (Kimberley Development Commission, 2006). Over 50% of pearls from Western Australia are directly exported to Japan, with a further 10% exported indirectly (Department of Fisheries, 2005). Already a well established industry, pearling is unlikely to expand operations significantly into the future, as activity is limited by quotas and size restrictions on the harvest of wild oysters as well as environmental conditions determining the suitability of farming operations (Fletcher *et al.*, 2006). However, markets in North and South America are predicted to become increasingly significant in the future, hence the diversification of export destinations is a future possibility which could return production to 2000 levels (Department of Fisheries, 2005).

With regard to the cultivation of other aquaculture species, diversification of the species base is likely in the future. While overshadowed in terms of value by the pearling industry, the majority of species farmed for aquaculture are relatively new to the Region hence future growth and development is highly likely. With ongoing research, improvements in efficiency of harvest are expected as the industry becomes more established. Commercial trials are currently being undertaken in the Region for the expansion of barramundi, black tiger prawns and aquarium fish cultivation (Kimberley Development Commission, 2006). Market demand will act as one of the major constraining factors in industry development, especially if only servicing the domestic market. Nonetheless, the predicted value of aquaculture for the State is expected to increase, as illustrated in table 9.4 showing one estimate of the value of production in 2015.

**Table 9.4 Predicted future value of aquaculture in Western Australia, 2015**

Sector	Current Value 2000/01 (\$m)	Industry Estimated Value 2015 (\$m)	Consultant Estimated Value 2015 (\$m)
Marine Fish (Tuna, Mah-Mahi etc)	0.7	20	25
Prawns	-	75	25
Abalone	-	30	10
Oysters	-	5	1
Mussels	2.3	5	4
Freshwater crays (marron)	1.2	10	5
Yabbies	2.5	5	4
Barramundi	na	10	4
Aquarium Fish	0.25	5	2
Pearls (excl. <i>Pinctada maxima</i> )	0.05	25	10
Inland saline	-	-	5
Scallops	-	10	5
<b>TOTAL</b>	<b>7.0</b>	<b>200</b>	<b>100</b>

(Source: Zelko Lendich and Associates, 2003)

However, the State total aquaculture production declined in real terms by 28% from 2001 to 2006, predominantly as a result of the appreciating Australian currency. In light of this, estimates based on 2001 values may need to be revised but future growth in the activity of this industry is highly likely. Particular potential has been identified for the development of inland aquaculture in the region (Kolkovski and Machin 2004). The future potential of the industry implies positive repercussions for local

employment, particularly for small Indigenous communities in more remote areas of the Region.

As described in section 9.1, the complex policy environment surrounding aquaculture is often criticised for impeding future development of the industry. Regulation under numerous policy areas often prolongs the time taken for license and lease approvals (Productivity Commission, 2004). Depending on the location and type of proposed activity, approvals must be sought from a number of different governing organisations, with legislation potentially containing conflicting development objectives (Productivity Commission, 2004). In Western Australia five different approvals are required in order to process licence applications (Department of Fisheries, 2004c). Future industry development is also constrained by legislation related to infrastructure and lengthy time periods for approvals to be processed. Improving infrastructure was one of the priorities identified by the State government in order to facilitate future development of the industry, in particular for the north-west, provision of essential media such as power, as well as hatchery facilities for the pearling industry (Zelko Lendich and Associates 2003).

One of the other significant factors impacting development of pearling and aquaculture is the often overlooked social dimension, particularly with regards to community perceptions and aesthetics. Gaining social approval and acceptance of aquaculture will likely be vital component of industry growth in the future. In light of increased competition for marine resources, pollution and discharge from aquaculture facilities is a topical issue (Department of Fisheries, 2004b). The combination of growing environmental awareness and generally limited industry knowledge among community members can result in negative perceptions, impacting on the long term viability of the industry (Mazur *et al.*, 2005). In general, the proximity of culture sites or related infrastructure to residential areas will influence the degree of negativity in community perceptions, however these are often outweighed by benefits from direct and indirect employment generated (Mazur *et al.*, 2005). In Australia, pearling and aquaculture are generally undertaken in fairly remote locations in the State but with increased development in the region, particularly in the tourist sector, amenity issues will be a growing consideration in future development.

#### 9.4.2 Socio-economic linkages

Pearling and aquaculture activities complement a number of other marine industries in the Region. Being based largely in regional areas of the State, the contribution to local economies is significant, particularly in terms of employment generated. ABS census data states around 600 people were directly employed in aquaculture in Western Australia in 2001 (ABARE, 2007), however, the accuracy of this data is questionable due to the aggregation of industry categories, particularly pearling, in the census data. Nonetheless, more recent employment data aggregated by industry suggest this figure is likely to have increased since. In the pearling sector, around 1500 people were estimated to be employed throughout the State in 2005, taking into account the operation of pearl farms as well as employment in the wild catch fishery (Fletcher *et al.*, 2006), the vast majority of whom will be employed in locations within and adjacent to the North-west Marine Region. These data are subject to seasonal and market fluctuations in demand, with the majority of pearling crew active from March to July each year. Increasing efficiency in fishing methods and quality of hatchery shells has also reduced reliance on wild caught stocks, resulting in a decrease in the number of vessels from sixteen in 1997 to five in 2005 active in the wild catch pearling sector (Fletcher *et al.*, 2006). These changes have impacted on employment in the fishery, with a shift towards fewer staff numbers but increased skill levels in the labour force. In light of this, facilities such as the Broome Aquaculture Park have been important for industry development. Despite seasonality, ongoing support to pearl farms and aquaculture facilities is also necessary on a full time basis. Figures on Indigenous employment in aquaculture are unavailable, however, the 2001 census data on employment in the Agriculture, Forestry and Fishing sector indicated a small representation in the remote communities of Kalumburu and Beagle Bay (Clifton *et al.*, 2007).

Aquaculture is expected to have significant future potential for development, with associated positive outcomes for employment. Although employing only 0.7% of the total workforce in the Agriculture, Forestry and Fisheries sector at the national level, projected growth in this sector is expected to be 1.5% to 2011-2012, the second highest growth rate of all sectors in the industry (DEW, 2007). Contrary to demographic trends of an aging population in the NWMR (Clifton *et al.*, 2007), the median age of employees in the sector is 35, among the youngest seen in the industry

(DEW, 2007). This has possible implications with regard to permanency of employment and residency of workers and families in the area. Data with regard to the indirect employment generated through the presence of pearling and aquaculture industries in Western Australia are unavailable. However, from a study undertaken in South Australia, for every job directly generated through aquaculture activity an estimated 2.2 jobs were created during the 1998/99 season (Zelko Lendich and Associates, 2003). If this figure is used as a benchmark for Western Australia, the 2001 census data indicates that around 1320 jobs would be estimated to have been generated through aquaculture-related industries. A further 3300 jobs would have been generated in the pearling sector using 2006 employment data for this industry.

Promotion of pearling and aquaculture among the Indigenous population of the Region was identified as one of the main development priorities for the industry. The State Department of Fisheries currently supports a number of Indigenous aquaculture projects including the farming of barramundi, cherubim and edible rock oysters in the Pilbara and Kimberley regions (Department of Fisheries, 2006). The Kimberley Aquaculture Aboriginal Corporation (KAAC) is a non profit organisation assisting and supporting the development of aquaculture among Indigenous Australians. The KAAC was involved in establishing the Indigenous owned Manbana multi-species hatchery at the Broome aquaculture park, and is currently undertaking grow-out trials of black tiger prawns in conjunction with local Indigenous communities (Haylor, 2003). Another successful aquaculture project is the Bardi Ardyaloon hatchery located at One Arm Point, which has successfully been harvesting trochus shells for a number of years and is also involved in the trialling of other species for potential development (Kimberley Development Commission, 2006). In addition, Indigenous knowledge can provide useful insights in addition to what science has to offer, hence open communication between industry stakeholders and local communities is considered important for future development (Kaiser and Stead, 2002).

Apart from the effects of direct employment generated by aquaculture and pearling, the industry contributes indirectly in a number of ways. Data specific to the indirect contribution of pearling and aquaculture in the NWMR are unavailable, however National and State data give a certain indication of the importance of these industries. Marine fishing, aquaculture and seafood processing in conjunction contributed an

indirect value of \$2.8 billion to the national economy in 2002-03 (Allen Consulting, 2003). It is estimated that the indirect benefit of pearling to the Western Australian economy was around \$600 million in 2005, taking into account cost of fishing gear, fuel and wages (Department of Fisheries, 2005). Figures on the indirect value contributed by other aquaculture species to Western Australia are unavailable, due largely to the small scale of operations compared to the pearling industry.

A number of industries benefit from the presence of aquaculture in the NWMR, including local education and training, tourism, transport, and other local services. Constructed with funding from the State government, the development of the Broome Aquaculture Park provides one example of the benefits to the education sector. In conjunction with Kimberley TAFE, the centre provides facilities for industry specific education and training, as well as housing a number of commercial hatcheries (Department of Fisheries, 2006). The park aims to assist development of aquaculture in the area, and facilities are also utilised by local Indigenous people to further aquaculture activities in their communities. This can also link with local cultural tourism, particularly as fishing and aquaculture have significant historic and cultural importance for Indigenous people (Haylor, 2003). Local aquaculture produce is also supplied to the wider tourist market, with benefits for retail income and support of local restaurants, cafes and other tourist industries. The processing and transport of aquaculture produce further contributes to employment in the local economy, particularly as farming locations are often remote and significant distances from regional centres and port facilities. Aquaculture industries are usually complementary with commercial fisheries infrastructure, particularly in terms of processing and transport. Distribution of feed as well as other support industries creates further multipliers of the industry. The multiplier effects of aquaculture especially in regional areas are significant in maintaining social and economic sustainability into the future.

Pearling in particular plays an important role in tourism in the Region. Broome for example has utilised the industry as a focal point for tourism branding and marketing for a number of years. Historically the pearling industry has formed an integral and dramatic part of the town and currently the region is marketed as the 'Pearl Coast'. The pearling industry is accessible to tourists via a number means including through museums, pearl farm tours and cruises, as well as an extensive selection of pearl

galleries and retail outlets. A number of key locations in the town such as community halls or food outlets have also incorporated this branding into their businesses.

## **10 EMERGING INDUSTRIES**

This chapter will outline the principal areas of expansion and innovation with respect to sectors of industrial activity within and adjacent to the North-west Marine Region, where possible describing the likely socio-economic impacts.

### **10.1 Agriculture**

This discussion will include pastoral and arable agriculture and related sectors such as horticulture and viticulture. With regard to arable agriculture, the main likely area of expansion involves the Ord River Irrigation Scheme (ORIS) in the north-east Kimberley. The Scheme results from the irrigation water available from Lake Argyle and Lake Kununurra which are impounded waters from the Ord River Dam and the Kununurra Diversion Dam on the Ord River constructed in the 1960s and 1970s. These waters irrigate approximately 14,000 ha of cultivated land under Stage 1 of the Scheme, the main crop being sugar which accounts for a third of the irrigated area. Other crops include chickpeas, sorghum seeds, various tropical fruits and irrigated pasture for beef cattle. The cane harvest in 2004-05 amounted to 415,000 tonnes, yielding a sugar crop valued at \$16.1 million, all of which was exported to Indonesia (DoIR, 2007). This represented 30% of the total value of agriculture from the ORIS of \$53.6 million, with melons being worth \$12.2 million and pumpkins \$9 million. Initially, Stage 2 of the ORIS envisaged the irrigated area being expanded by an additional 16,000 ha through diversion of water from Lake Kununurra, with associated drainage infrastructure and service roads being constructed. The recent M2 proposal involves an additional expansion of the cultivable area of up to 30,000 ha towards the north-east of Kununurra, around half of which lies within the Western Australian state boundary. It is anticipated that the M2 proposal would cost around \$500 million and generate 650 construction jobs (DoIR, 2006).

Whilst the tropical fruits and pasture activities will continue to service the domestic market, it is very likely that the extension of the irrigated area under Stage 2 of the ORIS would involve considerable expansion of the sugar cane crop, given the significance of ethanol as a cheaper biofuel alternative to unleaded petrol. This would

involve both domestic and export markets, with domestic sales likely to be favoured due to current Government incentives such as the biofuel production grant scheme till 2012 and the phased introduction of excise on biofuels till 2015, as well as the strength of the dollar mitigating against export markets. However, Japan and South Korea are likely to be areas of strong demand for ethanol, although Australian exports would face stiff competition from cheaper Brazilian sources (Economics Consulting Services, 2007). Whilst it is too early to comment on the extent of diversification associated with the Stage 2 development, this would increase the amount of agricultural activity and throughput in the port of Wyndham, whilst the economies of scale associated with this development could lead towards a greater degree of crop processing in the area prior to shipment, thereby furthering the diversification of the employment base.

Elsewhere in the North West, there are prospects for agricultural diversification in the Gascoyne, which currently produces a range of fruit and vegetables along the Gascoyne River near Carnarvon. Horticultural produce totalled \$32 million in 2003-04, with consistent increases in production following the effects of Hurricane Steve in March 2000. Whilst there is a current focus on growing bananas and vegetables for the Perth and intrastate markets, it is considered that viticulture could increase considerably in the Carnarvon area in the future. The annual gross value of table grapes from the Gascoyne rose by 25% to \$8.7 million in 2005 and export markets are expanding as air freight permits rapid transport of fresh produce, with key markets including Singapore and other south-east Asian countries (Gascoyne Development Commission, 2006).

## **10.2 Mineral processing**

The North West is the focus for a unique concentration of mineral extraction activity, principally involving iron ore, but to date this sector has concentrated upon raw commodities rather than downstream processing and value adding. Whilst the continued growth of the extractive industries is likely to continue, there is a recognised need to build upon the export-led success of this sector in order to diversify the regional economy. One particular avenue has been to upgrade the value

of iron ore through iron and steel production in the Pilbara, which led to BHP Billiton constructing the Boodarie hot briquetted iron plant south of Port Hedland which commenced operations in 1999, exporting briquettes to the Asia Pacific region. However, technical difficulties, cost overruns and an industrial accident led to the closure of the plant in 2005, when it employed 490 individuals (BHP Billiton, 2005). There has also been a long-running proposal to construct an \$8 billion integrated iron ore and steel plant at Fortescue south of Karratha which experienced early difficulties relating to skilled labour availability and the electricity demands of such a plant not being able to be met in the Pilbara. Negotiations over this are still ongoing, despite the plant gaining environmental approval in 2004, as the companies involved have undergone internal changes and the focus of the proposal has shifted towards expansion of iron ore exports through a new port at Cape Preston (Environmental Protection Authority, 2006). It is therefore evident that locational issues have affected the ability of the iron ore sector to expand into downstream value added processing activities in the North West, particularly as the large corporations involved in this sector are able to source their labour, infrastructure and energy requirements more effectively elsewhere.

Argyle Diamonds located in the Kimberley is currently the world's largest supplier of diamonds, employing around 800 staff at the mine south of Kununurra. This is set to expand with the recent approval of a \$1 billion project to further the mine's production, extending its life expectancy to around 2018 (DFAT, 2007).

### **10.3 Energy, oil and gas**

The remote location of the North West has enabled private industry to take a role in supplying energy to regional towns that are not connected to the electricity grid under the Regional Power Procurement Process (Western Australian Office of Energy, 2007). This has resulted in various projects being established throughout the area. In the Gascoyne, the use of gas and wind power is increasingly replacing diesel as the preferred means of generating electricity. The Coral Bay Power Project involves a combined diesel and wind power project at a cost of \$14 million at Coral Bay and an additional wind turbine project at Denham being completed in 2007. Carnarvon and

Exmouth are also undergoing replacement of diesel fuelled stations with gas powered facilities. In the Kimberley, the West Kimberley Power Project comprises four liquefied natural gas fuelled power stations at Broome, Derby, Halls Creek and Fitzroy Crossing which are due to come online in late 2007 using LNG from a new plant at Karratha, whilst one diesel powered station at Looma is also being established (Horizon Power, 2007). In the Pilbara, there is an estimated total of 35MW capacity under construction, the majority of which is again fuelled by natural gas from offshore sources. All of these projects involve additional labour requirements in the short term but will require a relatively small labour force to operate and maintain the stations once constructed.

With regard to the oil and gas sector, the ongoing expansion of production and exploration will provide a range of opportunities to related services. These include maintenance, supply, fabrication and construction companies located both onshore and offshore as well as those organisations specialising in offshore technology. Whilst the presence of this sector is limited within the North West at present, it is reasonable to assume, particularly in the light of the projected increase in gas production, that opportunities for investment within the North West will broaden the sector's base of activities.

#### **10.4 Manufacturing**

The diversification of the manufacturing base in the North West, whilst being constrained by location as well as labour availability, offers considerable scope for future activity. The proximity of relatively cheap natural gas to the Burrup Peninsula, combined with the availability of port facilities at Dampier, led to the construction of the \$500 million ammonia and urea plant operated by Burrup Fertilisers which was completed in 2003 and employs around 100 people (Chemicals Technology, 2007). It is estimated that this plant alone will increase local and regional business activity by around \$30 million annually (DFAT, 2007). Other opportunities capitalising upon the mineral assets of the North West include synthetic hydrocarbons and chlor-alkali production using salt and gas resources. The Gascoyne also has potential to add value

to the fishing sector through smoking, pickling or bottling of fish products (DLGRD, 2007a).

## **10.5 Tourism**

The tourism sector in the North West has many potential areas for diversification and expansion, building upon the natural and cultural assets of the area. In terms of tourism operators, there are a number of areas for potential investment ranging from established lots and strata within the resort of Broome, developing new accommodation facilities at increasingly accessible locations such as Lake Argyle and investing in residential lots associated with the 400 berth capacity marina at Exmouth. There are also significant opportunities for greater development of cultural tourism activities centred upon the Indigenous community and their historical and cultural associations throughout the North West. The possible extension of new protected areas offer new opportunities to market nature-based tourism activity packages, which could be combined with innovative ventures based on crocodile farm establishments and safari-style operations.

## **10.6 Aquaculture**

The aquaculture sector, as a new and developing area of activity, is undergoing a considerable degree of investment as exemplified by the Broome Tropical Aquaculture Park which offers research and development opportunities in this sector. New possible areas of activity include seaweed cultivation for the production of beta carotene. This activity is already widespread in south-east Asia but suffers from lack of expertise, large scale investment and value added production activities, which would presumably be less significant in an Australian context. There are also potential avenues to diversify fish aquaculture into the farming of new species including ornamental and aquarium fish as well as farming of commercial and recreational target species such as prawns, shrimp and barramundi (DLGRD, 2007b).

## **10.7 Indigenous-owned businesses**

This chapter has outlined potential areas of economic diversification in the North West, highlighting the opportunities for future activity. It is also essential to note the existing and potential contribution by Indigenous-owned businesses, in that they offer new directions for employment and growth in remote communities as well as existing centres of high unemployment amongst the Indigenous community. The BAMA ISX website lists over 40 such enterprises in the North West. In the Pilbara, these comprise mainly arts-based individual businesses centred on Roebourne, whilst the Dampier Peninsula includes a number of cultural tourism businesses operated by Indigenous-owned organisations. In the wider Kimberley region, Indigenous-owned businesses listed include aquaculture, commercial fisheries, marine tourism and construction amongst others. The potential of these to contribute towards the economic and social development of Indigenous communities is exemplified by Ngarda Civil and Mining, which was established in 2001 and currently employs a workforce of 170 people, 140 of whom are Indigenous, in contracting services to the mining and construction industries in Port Hedland and Pannawonica (BAMA ISX, 2007). It is estimated that this company's annual contribution towards the Port Hedland economy in wages and purchasing exceeds \$10 million, whilst also offering training and experience to enable employees to find work with larger mining companies in the Region (DEW, no date). The growth of Indigenous-owned businesses in the North West, whilst currently diverse in scope and the majority employing small numbers of individuals, could offer a partial solution to the perennial skills shortages affecting the mining and minerals sector in particular, facilitating the flow of socio-economic benefits to Indigenous communities in the coastal areas of the North West.

## **11 FUTURE DIRECTIONS AND ISSUES FOR INDUSTRIES OF THE NORTH-WEST MARINE REGION**

### **11.1 Oil and gas**

Chapter 5 of this Report has outlined the extent of oil and, particularly, gas exploration and production within and adjacent to the North-west Marine Region, underlining the increasingly significant role of liquefied natural gas (LNG) production within this sector. LNG is primarily destined for export markets but also will play an important role in domestic electricity generation for communities throughout the North West. The long-term prospects for the oil and gas sector as a whole are reflected in the timescales under which current and proposed production activities are scheduled, these generally being in the order of decades. Whilst the sector does operate under difficult conditions with regards to labour and transport costs amongst others, these have been offset to some extent by the current high prices for oil and gas on the world market, facilitating the increase in exploration and production activity.

There are few grounds to expect that this activity will lessen over the foreseeable future and, should new recoverable reserves be identified, it is reasonable to project that this activity will increase into the future. Currently, the majority of activity takes place in Commonwealth waters off the Pilbara coast with onshore gas pipelines via towns including Dampier and Onslow connecting the offshore fields to Perth and Bunbury. Oil is generally exported from the offshore terminals of Thevenard Island, Airlie Island, Barrow Island and Varanus Island, with some imports through the port of Broome. Hence the major economic and environmental impacts of this sector within the North West are associated with onshore facilities such as LNG production at Barrow Island and the Burrup Peninsula near Dampier.

The scale and rate of offshore gas exploration and recovery in the Browse and Carnarvon basins was also underlined in Chapter 5, highlighted by the recent approvals for the Greater Gorgon and Pluto LNG projects, which together represent around \$20 billion of capital investment and involve the creation of thousands of jobs within the North West and the State as a whole, as well as providing opportunities for the recovery of further gas from 'stranded' fields in the region. Bearing in mind the expected lifespan of these two projects which are in the order of 40-60 years, it is

evident that there will be significant socio-economic impacts on the adjacent Pilbara and Kimberley communities well into the future. It is envisaged that these projects will provide additional employment prospects for Indigenous Australians alongside other sectors of the local communities, although the full extent of the employment impacts are yet to become apparent. The unexplored onshore areas of the Canning Basin would also have significant economic consequences for the Region should recoverable reserves be identified in this basin. Similarly, any production activity in the southern Carnarvon Basin would impact the Gascoyne in particular which has thus far experienced little involvement with the oil and gas sector. Conversely, it might be expected that any further discoveries in the Bonaparte Basin would be more likely to be associated with development in the port of Darwin, given its facilities and size, rather than the more restricted and isolated port of Wyndham.

## **11.2 Ports and shipping**

The main driver behind the future development of the major ports of the North West will be future trends in demand for and production of iron ore and the capacity of these ports to meet the needs of this sector. Plans exist for significant expansion at ports including Port Hedland, with investment by Fortescue Metals Group and BHP Billiton into new berths and there are longer term aspirations for a new outer harbour port which would lead to a doubling of capacity in the next decade (DEW, personal communication). However, a recent review concluded that, whilst potential for additional capacity at the three major iron ore exporting ports of Port Hedland, Dampier and Port Walcott existed, there were a range of constraints affecting the ability to enhance capacity at these ports (DPI, 2007). These included issues associated with the physical capacity of existing rail infrastructure and the environmental implications of increased rail use in Port Hedland, the limitations imposed by planning restrictions and areas of cultural heritage around the port of Dampier and the likely impact of any considerable expansion at Port Walcott on the nearby tourist and residential areas of Point Samson. It was therefore concluded that, in order to meet the projected increase in demand for iron ore from Chinese and Japanese markets, a new port with a capacity of around 300 million tonnes annual throughput would be needed within a timeframe of 6-12 years and the optimum site for this was identified as being Ronsard Island, located 120km east of Karratha. If this development proceeds, it would involve construction of berths, harbour facilities,

dredging of approach channels as well as extending rail linkages and the provision of workforce accommodation on site. This development would principally cater for iron ore exports but would have capacity for other users and would be managed by a Port Authority. The Ronsard Island location does not include currently designated protected areas, although species of rare flora in mangrove and coastal grasslands have been identified, whilst there are also potentially areas of importance for turtle nesting, dugongs and migratory bird species and the island is in close proximity to whale migration routes, all of which would require inclusion in any subsequent environmental impact analysis.

Such a development has clear implications for both alleviating the intense pressure for expansion at the existing ports of the Region whilst also opening up new areas for related industries and downstream processing activities. However, as has been noted elsewhere in this Report, the success of implementing downstream processing industries in proximity to ports has been limited thus far. The Burrup Industrial Estate is serviced by the Dampier Port Authority, with the major industrial activity being focused on landfall facilities for LNG piped from the North West Shelf and Pluto offshore gas fields. There is evident potential for industrial development using the abundant cheap gas as feedstock but thus far only the one site manufacturing ammonia operated by Burrup Fertilisers has been developed. Contributory factors towards this include the cost of earthworks and the rugged topography of the peninsula as well as areas of significant Indigenous cultural heritage constraining development opportunities. The holding of land for development in the adjacent industrial areas such as the Maitland Estate and West Intercourse Island could be reversed in light of the level of demand for iron ore storage, hence the longer term prospects for industrial development on these sites appear restricted (DPI, 2007). From an economic standpoint, it is relatively unlikely that, if the Ronsard Island port proposal were to proceed, there would be any notable difference in terms of the attraction of the site for downstream processing or related industrial activity, given its remote location and the associated labour, infrastructure and power requirements which have been noted as detrimental to downstream industrial development at the other major ports in the Region.

With regard to the other ports in the North West, the most positive prospects for economic diversification would appear to be associated with the port of Broome, given its current uses by a wide range of growth sectors including the tourism industry, particularly the cruise ship tourism sector, and the offshore oil and gas sector. Whilst Broome accounted for only 16 port calls by cruise ships in 2006-07, this generated a total direct expenditure of \$600,000 which is estimated to create an additional indirect spend of around \$500,000 (Cruise Down Under, 2007). There are positive prospects for growth in this sector as a result of the increase in Australia's large luxury cruise fleet, whilst the opening of the new \$4.5 million cruise ship terminal at Darwin in 2007-08 could enhance the attraction of the wider North-west Marine Region for this sector, although it is uncertain as to whether Broome is sufficiently central to the itinerary of the larger companies based on the east coast. However, Broome is also well situated to expand its throughput of gas from offshore facilities, particularly as demand for gas from the electricity generation schemes operating throughout the Region increases into the future. The port of Wyndham is another instance of possible growth through agricultural diversification in association with the planned expansion of the Ord River Irrigation Scheme around Kununurra. Should the proposed M2 irrigation scheme proceed, this would open up an area of around 30,000ha for cultivation which would inevitably generate significant flow-on effects through increased port trade. This possible benefit should be assessed alongside the reduced need for seasonal labour in sugar cultivation in comparison with the fruit growing sector, the demand for fruit pickers throughout the season generating a range of short term income-generating opportunities as well as attracting visitors to the region for this purpose. However, the M2 scheme has yet to be implemented and the final outcome in terms of agricultural productivity and port activity is uncertain at present.

### **11.3 Commercial fishing**

The overview of the commercial fishing sector in the North-west Marine Region highlights several key factors which will influence its future development. With regard to Commonwealth-managed fisheries, the introduction of the Securing Our Fishing Future package in 2005 with its component structural adjustment elements and Harvest Strategy policy have redefined the basis on which these fisheries are managed and regulated. The structural adjustment packages, with the attendant

reduction in gear and licences in the Northern Prawn Fishery, will inevitably decrease the labour participation rates in this sector. However, given the low numbers involved and the limited wider economic impact of this fishery within the Region, it is unlikely that this will introduce notable socio-economic changes within the communities of the North West. The Harvest Strategy policy is, furthermore, grounded in ensuring the long term sustainability of fish stocks and has a strong precautionary element, hence alterations in stock management associated with this policy are more likely to involve catch reductions in one form or another, particularly in cases where stock levels are uncertain as is often the case with the larger Commonwealth-managed fishery zones included within the North-west Marine Region. This overall package has been introduced at a time when employment within commercial fishing is declining at the national level, reflecting the problems of wage competition and the age profile of the sector, whilst there is increasing recognition of the need to introduce effective and stringent regulations to ensure the industry continues to be viable (DEW, 2007; FRDC, 2003). Therefore, there are little grounds to suggest that the Commonwealth-managed fisheries will experience diversification or growth in the foreseeable future within the North-west Marine Region.

In comparison, the State-managed fisheries within and adjacent to the North-west Marine Region represent a far more significant economic input into the communities of the North West. This is accentuated by the remote location of some of these settlements whilst the cultural and social aspects of fishing will also be vital to these communities. Within the North West, the Shark Bay area including the settlements of Denham, Monkey Mia, Shark Bay and Carnarvon supports the prawn, scallop, blue swimmer crab and beach seine and mesh net fisheries. Of these, the prawn and scallop trawl fisheries are the most significant in terms of employment, supporting an estimated 120 and 160 jobs respectively, whilst catches were valued at \$22.7 million and \$6.5 million respectively in 2005. Both fisheries have been negatively impacted by the increased value of the Australian dollar, but the prawn fishery has been affected to a greater extent by increased fuel prices and competition from aquaculture, resulting in the ratio of catch value to fuel costs decreasing from over \$10 in 1999 to just over \$3 in 2005 (Department of Fisheries, 2007a). Whilst recent assessments have shown both fisheries to be operating appropriately from a stock management viewpoint, current management activities are directed towards resolving conflicts

within the prawn and scallop fisheries over access to trawling grounds within Shark Bay, with options including buyback as well as closures or gear controls. Given the economic constraints affecting the prawn fishery in particular, buyback could well serve to reduce effort in this sector rather than the scallop fishery. Again, the socio-economic consequences of this are difficult to pinpoint, given the dependence of processing industries on the other fisheries in Shark Bay and the existence of joint prawn and scallop fishery license holders, but any reduction in effort in the high value prawn fishery would undoubtedly have local repercussions.

The Exmouth Gulf prawn fishery is the other major fishery in State-managed waters adjacent to the North-west Marine Region in terms of income, with catches totaling \$12.6 million in 2005 although employment was restricted to a total of 37 individuals. This fishery operates under differing circumstances to those found in Shark Bay, with little need for further management activity given that trawling only occurs over about 35% of the area of the Gulf and stock levels are considered to be in excess of those required to maintain catch rates (Department of Fisheries, 2006). At present, fifteen of the sixteen licenses are held by one operator, therefore it appears relatively unlikely that more operators could enter the fishery on a competitive basis even if additional licenses were made available. The Kimberley prawn fishery is the third largest fishery in terms of employment in the North West and could be subject to more stringent future management in light of identified deficiencies in relation to catch and effort information, stock assessment and bycatch data (Department of Environment and Heritage, 2004).

#### **11.4 Recreational fishing**

Analysis of the recreational fishing sector in Chapter 7 of this Report highlighted the extent of uncertainty with regards to the number and location of resident recreational fishers in the North West, as well as the significance of visitors with regard to the total recreational fishing effort and its spatial distribution. The projected total spend based on a conservative estimate of resident recreational fishers alone in 2006 indicated that this sector could support the equivalent of around 800 full time jobs, with the likely actual total including visiting recreational fishers being much higher. In terms of future development and activity within this sector, it is reasonable to assume that participation is going to be largely influenced by the rate of population growth and

personal income in each locality, which will both be related to employment in the mining sector. Tourism centres will also be associated with additional seasonal increases in recreational fishing activity. In these terms, the expansion of Broome as the prime tourist destination will result in the continued growth in recreational fishing activity not just in the immediate vicinity but in the wider North West, given the availability of extended recreational fishing tours throughout the Kimberley and to offshore islands.

Other locations where recreational fishing is likely to be significant and increase into the future include Point Samson, with its reputation for high quality recreational fishing, and areas popular with tourists towards the south in and around Shark Bay and the Ningaloo Marine Park. Restrictions are in place in certain cases, particularly with regard to pink snapper in Shark Bay, which are intended to distribute the catch between the recreational and commercial fisheries involving daily catch limits and seasonal closures during spawning aggregation periods.

The future of recreational fishing along the west coast is the subject of a recent publication from the Department of Fisheries, reflecting concern over the stocks of key demersal target species such as pink snapper and sweetlip emperor in the Kalbarri zone which lies between 28°S and 27°30'S (Department of Fisheries, 2007b). This report shows an increase in overall recreational fishing activity within approximately 50km radius of Kalbarri between 1995-96 and 2005-06, which would reflect the increasing popularity of this area as a tourist destination. This region, along with other areas of the North-west Marine Region, will be subject to increasingly frequent visits of longer duration from recreational boats from outside the region, given the increase in boat ownership and size of vessel described in Chapter 7 and the increase in personal leisure time, particularly amongst the retired sector of the community, throughout Western Australia. Whilst recreational boat ownership should not be automatically equated with participation in recreational fishing, there will be a correspondence between the two and this is likely to be increasingly evident throughout the North-west Marine Region.

## **11.5 Marine tourism**

Whilst there is evident potential for growth in marine tourism throughout the North West, bearing in mind the quality and diversity of coastal resources, this has been restricted by the remote location of the North West as a whole, the availability, reliability and quality of transport infrastructure and the limited provision of services necessary to the tourism sector. The analysis of marine tourism within the North West in Chapter 8 has underlined the varying segments of the tourist market which are being targeted by tourism authorities. It is therefore not possible to project future trends in tourism across the entire North West but some comments regarding the activities at existing hotspots can be made.

The prevalence of diving, snorkeling and similar marine-based tourism activities in the Kalbarri / Shark Bay / Ningaloo region capitalizes upon the distinct ecological characteristics of this stretch of the coast and, given the relatively low overall visitor numbers, management should be able to ensure that these qualities are not adversely affected by visitor activity. This sector of the tourist market is likely to continue to increase in numbers, both domestically and internationally, generating a significant economic input to communities in this area which could offset losses sustained through any reduction in commercial fishing activity. Similarly, the strength of Broome as the prime tourist attraction for marine-based tourism involving beach activities and chartered fishing would appear to be the basis for continued growth, as reflected in data relating to building and tourism accommodation investment in the locality. The economic linkages are likely to remain more constrained in this area, regardless of the rate of future growth, given the emphasis on package holidays and prepaid activities characterizing the Broome tourist market. However, the chartered boat industry is one sector which will continue to benefit from the upmarket image of this resort, with all inclusive fishing tours, cruises and other activities being available to destinations within and adjacent to the North-west Marine Region. The coastal areas of the Kimberley are likely to continue to generate relatively little economic benefits through marine tourism, partly due to access difficulties and partly due to the nature of outback tourism which is more dominant in this part of the North West. However, it is important to note that the economic returns generated through tourism are more likely to exert stronger multiplier effects in these more remote areas and

reach a greater proportion of Indigenous residents, although precise data on this are lacking.

### **11.6 Pearling and aquaculture**

This Report has highlighted the variety of aquaculture activities practiced within the North West and particularly the economic dominance of the pearling sector centred upon Broome. With the advent of the Broome Aquaculture Park, the focus of the pearling industry in this area is likely to increase, building upon the reputation of the region as a centre of knowledge and innovation for the pearling sector and reflecting the benefits to potential operators to establish sites in the vicinity. However, as with aquaculture, physical constraints as well as potential conflicts with other coastal resources users may serve to further delimit the number of potential sites for this activity over and above the limitations imposed by labour shortages and transport and energy requirements. This is reflected in the static, although still significant, annual value of the pearling sector's output over the 2002-2005 period. The process of diversification in the aquaculture sector offers possibilities for expansion, but again there will be the same constraints upon the industry. It is possible, however, that Indigenous communities could enter into this sector in greater numbers, provided that transport and power requirements were assured, given the dispersal of these communities throughout the coastal North West and the additional potential marketing opportunities associated with Indigenous produce. However, this would require careful support and sponsorship from government as well as Indigenous groups in order that it was perceived as a viable source of income, a problem which has beset various aquaculture operations as a result of disease or market price fluctuations.

### **11.7 Developing industries**

This Report has identified a range of other industrial sectors in the coastal environment where growth has been experienced or could be envisaged in the future. In economic terms, the most significant of these appears to be the potential for agricultural diversification and expansion in association with the Ord River Irrigation Scheme, which opens up a range of opportunities for direct and indirect employment and sales of produce within and outside of the North-west Marine Region. The potential for the growth in Indigenous-owned businesses also offers significant scope

for increasing the flow of economic and other benefits to this section of the North West's community.

### **11.8 Development hotspots and trends over the next two decades**

The task of projecting trends in economic activity involves a large number of assumptions to be made regarding macro-scale economic influences which, whilst a detailed analysis is outside the scope of this Report, include oil prices, currency exchange rates, international and domestic trade policies, geopolitical issues as well as unexpected influences on the global economy exemplified by the collapse of the subprime mortgage lending market in the United States. Therefore, the following broad comments are made on the highly simplified basis of continued stability and growth in the Australian domestic economy, identifying areas of likely future expansion and the nature of this economic activity in each case.

Shark Bay has been identified as one of the principal development hotspots in the southern area of the North West, with a small but growing tourism sector centred upon marine activities within the Bay being associated with greater recreational fishing effort, both of which are likely to come into conflict with other commercial uses of the Bay including fishing and aquaculture. Given the environmental significance of the Bay area in terms of marine biodiversity and the presence of Hamelin Pool, the only marine nature reserve in the State, the need to maintain a strong precautionary approach to managing commercial activities in the Bay is evident. The data presented in this Report indicates that, whilst the commercial fisheries within the Bay area are generally well managed, there exists the capacity to quickly capture all available fish stocks given the technology used and restricted fishing grounds, which again underlines the need for proactive and effective fisheries management which is also sensitive to the fisheries' importance to the local economy.

The coastline between Exmouth and Port Hedland encompasses over 500km but is a focal point of interest to this Report given the diversity of coastal resource uses present. This includes two of the top five exporting ports in the country, servicing an iron ore industry which is of international significance, along with the proposed site for an additional port which would at current rates be the largest exporter in the country. Furthermore, the offshore oil and gas sector supports employment and

infrastructure throughout this area, with further continuation of activity seemingly guaranteed. The adjacent waters are host to State and Commonwealth fisheries which generate employment and support other services in the area, whilst tourism mainly involving charter boat activity to offshore locations including the Montebello Islands is of importance. All of these activities are likely to continue into the foreseeable future, with iron ore exports dominating the economy, although other minerals such as salt exports will also continue to generate employment. However, it is perhaps an advantage in terms of marine planning that these export-led economic activities have so far failed to stimulate downstream industrial processing, resulting in an absence of environmental deterioration so often associated with the presence of large scale industrial activity in coastal locations. Similarly, whilst the population of towns such as Port Hedland, Karratha, Wickham and Onslow can be safely projected to grow into the future, the limited economic linkages generated by these dominant industries are unlikely to result in a rapid expansion of population and associated environmental problems. Nevertheless, the growth of coastal industrial activity will require ongoing careful management, particularly in the area of ship and shore-based pollution risk minimization, bearing in mind the coastal environmental qualities and characteristics in this area.

The town of Broome and its environs represent the other major development hotspot, centred principally upon the expansion of the town's tourism functions and the potential impacts of this upon the coastal environment. Whilst shore-based coastal leisure tourism activities themselves are not particularly damaging to the coastal environment, the consequences of increased visitor numbers in relation to issues including sewage treatment and disposal, urban runoff, the presence of plastics and other non-biodegradable litter alongside other forms of pollution are of significance to the coastal environment and endangered or protected species in the region. Similarly, recreational fishing in this area as a result of tourism will continue to increase into the future and could require greater management intervention, particularly as the impacts of this activity are potentially widespread throughout the remote coastal Kimberley.

The other principal coastal settlements in the North West, whilst likely to undergo some form of growth and diversification, are less likely to constitute priorities for marine planning. Indeed, the expansion of activities such as agriculture around

Carnarvon and Wyndham and pearling and aquaculture development in various coastal locations are likely to represent net benefits in socio-economic terms whilst presenting relatively minor threats to the coastal environment. Further oil and gas development offshore throughout the Region is likely to continue, and will require ongoing management to reduce the risk of pollution incidents as far as possible. The growth of tourism in relatively minor centres such as Kalbarri and Coral Bay in the south is again on such a scale that existing tourism management policies are capable of directing this growth to ensure sustainable use of the coastal environment.

## 12 CONCLUSION

This Report has outlined the drivers of growth, the current status of development and the socio-economic linkages associated with sectors of economic activity within and adjacent to the North-west Marine Region in Western Australia which encompasses Commonwealth waters between Kalbarri and the Northern Territory border. This area of Western Australia is renowned for the scale of its extractive industries, principally iron ore and the offshore oil and gas sector, which have driven the recent unparalleled expansion in the State's economic activity and which underpin many aspects of the North West's economy. The drivers of growth behind these major areas of activity reflect the demand led by China accompanied by other Asian countries for raw mineral exports, which shows little sign of abating in the foreseeable future. However, it is essential to note that the global economy is subject to unforeseen shocks and disturbances, which can often have equally unpredictable consequences, as evidenced in the late 1990s in east Asia and more recently following events in the US housing market, to cite just two examples. Future projections and comments such as those made in this Report cannot encompass all possible scenarios of change in the national economy, let alone the macro-economic drivers at the global scale. Bearing this in mind, there are certain broad conclusions which can be drawn with respect to the evidence presented in this Report.

Making the necessary assumption of economic stability into the medium to long term, the next one to two decades should witness the continued growth of iron ore exports through the ports of the North West, reflecting the extent of planned investment into production and port facilities. Similarly, the offshore oil and gas sector appears stable in terms of production capacity, with significant potential for growth evident particularly in regard to gas and liquefied natural gas. However, the socio-economic linkages generated by these advanced extractive industries have been limited by the remote location of the North West, leading to the well known problems of skills shortages as well as issues related to transport and energy infrastructure which would be essential for the establishment of viable downstream processing industries. The local and regional economic benefits associated with these industries are therefore relatively limited, despite employing high concentrations of residents at specific locations, a situation which is unlikely to alter in the foreseeable future.

The other areas of economic activity outlined in this Report, whilst generating relatively little in overall financial terms, involve far more detailed linkages with other economic sectors within the North West. Tourism and recreational fishing are to some extent interlinked, particularly with regard to charter boat fishing, and have been demonstrated to represent significant areas of growth in the towns and smaller settlements. Given the relatively pristine nature of the North West, which in part reflects the absence of downstream industrial activity noted above, there are reasonable grounds for optimism that these two sectors, along with pearling, will continue to generate locally significant direct and indirect economic benefits into the future. However, the environmental impacts of concentrated tourism activity will require ongoing management and possibly intervention to redirect activities where there is evidence of environmental or resource degradation.

In terms of GVP and GVA, Commonwealth commercial fisheries in the North-west have been shown to be comparatively minor to State fisheries operating in and adjacent to the Region. State fisheries are of principal significance to the quality of the North West's environment and economy. These fisheries have a history of close management intervention through various means to ensure effort is maintained at sustainable levels, which will be essential to meet the future challenges of reconciling commercial fishing interests with those of the growing tourism and recreational fishing sectors as well as the nascent aquaculture industry. Certain locations such as Shark Bay and Broome as well as Exmouth Gulf have been noted to be particularly likely areas where these interests are potentially conflicting in the near future.

This Report has also included analysis of new and developing industries within the Region. In some cases, such as the Ord River Irrigation Scheme, these offer potential for economic diversification with little perceived adverse coastal impact, whilst elsewhere, such as with proposals for salt production, there are potential conflicts principally with recreational activities which will require sensitive management.

It is hoped that this overview of the socio-economic impacts of the economic activities within and adjacent to the North-west Marine Region enables a programme of action to be developed which ensures that its coastal resources can be used in an ecologically sustainable manner for the benefits of all stakeholders.

## 13 REFERENCES

### Chapter 2

Battye, J. (1978). *Western Australia: A History from its Discovery to the Inauguration of the Commonwealth (Second Edition)*. The University of Western Australia Press, Nedlands.

Jarvis, N. (1979). *Western Australia: An Atlas of Human Endeavour*. Government Printer, Perth

Library Information Service of Western Australia (2007). *Western Perspectives on a Nation*. Available online at <http://www.liswa.wa.gov.au/wepon/index.html>

Mitchell, S. (1994). *Culture, Contact and Indigenous Economies on the Cobourg Peninsula, Northwestern Arnhem Land*. Unpublished PhD Thesis, Northern Territory University, Darwin

Paterson, A. (2006). Towards a historical archeology of Western Australia's Northwest. *Australasian Historical Archeology*, 24, 99-111

Stacey, N. (2007). *Boats to Burn: Bajo Fishing Activity in the Australian Fishing Zone*. Australian National University E-Press, Canberra.

### Chapter 3

Clifton, J., Tonts, M. and Boruff, B. (2007). *A Socio-economic overview of the coastal communities adjacent to the North-west Marine Region*. Department of Environment and Water Resources, Hobart

Department of Employment and Workplace Relations (2007), *Small Area Labour Markets*. Department of Employment and Workplace Relations, Canberra

Department of Treasury and Finance (2006). *Gross State Product, 2005-06*. Department of Treasury and Finance, Perth

Department of Treasury and Finance (2007). Budget Papers, 2007. Department of Treasury and Finance, Perth

The Economist (2007). Country Briefings: Australia. Available online at <http://www.economist.com/countries/Australia>

International Monetary Fund (2007). World Economic Outlook. International Monetary Fund, Washington

OECD (2007). Country Statistical Profiles: Australia 2007. Available online at <http://stats.oecd.org>

State Training Board (2007). Beyond the Resources Boom. Government of Western Australia, Perth.

#### **Chapter 4**

ABC News (2007a). Pilbara salt mine plan worries pearl industry. Available online at <http://www.abc.net.au>

ABC News (2007b). Cost of living too high in Port Hedland. Available online at <http://www.abc.net.au>

ABS (2001). Census data 2001. Available online at <http://www.abs.gov.au>

AAPMA (2007). Trade Statistics. Available online at <http://www.aapma.org.au>

BTRE (2007a). Latest international sea freight statistics. Available online at <http://www.btre.gov.au/>

BTRE (2007b). Australian Sea Freight 2004-05: Information Paper No. 58. Available online at <http://www.btre.gov.au>

Bureau of Transport Economics (2000). Regional Impact of Ports. Available online at <http://www.btre.gov.au>

Dampier Port Authority (2007). Dampier Port Development Plan. Available online at <http://www.dpa.wa.gov.au>

DPI (2007). Port Handbook Western Australia 2006. Available online at <http://www.dpi.wa.gov.au>

DPI (2004), Port Hedland Enquiry by Design. Available online at <http://www.dpi.wa.gov.au>

Gripaios, P., Gripaios, R. (1995). The impact of a port on its local economy: the case of Plymouth. *Maritime Policy & Management*, 22, 13-23

Port Hedland Port Authority (2003). Port Planning Study. Available online at <http://www.phpa.wa.gov.au>

Storey, K. (2001). Fly-in/fly-out and fly-over: mining and regional development in Western Australia. *Australian Geographer* 32, 133-148

## **Chapter 5**

ABARE (2007). Australian Mineral Statistics, March quarter 2007. Available online at <http://www.abareconomics.com>

ABS (2004). Regional Profiles. Available online at <http://www.abs.gov.au>

APPEA (2007). Strategic leaders report. Available online at <http://www.appea.com.au>

ATC (2007). Oil and gas overview. Available online at <https://www.austrade.gov.au/>

DITR (2006). Resources and Energy. Available online at <http://www.industry.gov.au>

DoIR (2007a). Western Australia oil and gas review 2006. Available online at <http://www.doir.wa.gov.au>

DoIR (2007b). Western Australia mineral and petroleum statistics digest 2006. Available online at <http://www.doir.wa.gov.au>

DoIR (2007c). Petroleum Explorer's Guide to Western Australia. Available online at <http://www.doir.wa.gov.au>

DoIR (2007d). Projects commissioned, committed and under consideration November 2006. Available online at <http://www.doir.wa.gov.au>

DoIR (2006). Global economic outlook: the big picture. Available online at <http://www.doir.wa.gov.au>

DoIR (2005). Building future prosperity: going global, western Australian trade and investment strategy. Available online at <http://www.doir.wa.gov.au>

Gascoyne Development Commission (2006). Gascoyne Economic Perspective. Available online at <http://www.gdc.wa.gov.au>.

Kimberley Development Commission. 2006. Kimberley Economic Perspective. Available online at <http://www.kdc.wa.gov.au>

MCE (2007). Council's Home Page. Available online at <http://www.mce.gov.au>

Macfarlane, I. (2006). New government-industry strategy to secure energy future. Media Release. Available online at <http://www.appea.com.au/>

Pilbara Development Commission (2006). Pilbara Economic Perspective. Available online at <http://www.pdc.wa.gov.au>.

Reuters (2007). Shell signs deal to sell Gorgon LNG to PetroChina. Available online at <http://www.reuters.com>

## Chapter 6

ABARE (2007). Australian Fisheries Statistics 2006. Available online at <http://www.abareconomics.com>

ABARE (2004). Australian Fisheries Statistics 2003. Available online at <http://www.abareconomics.com>

AFMA (2007). Fisheries A to Z Index. Available online at [https://www.afma.gov.au/fisheries/fisheries\\_index.htm](https://www.afma.gov.au/fisheries/fisheries_index.htm)

AFMA (2005). What we do. Available online at <http://www.afma.gov.au/about/>

AFMA (2004). Draft Environmental Assessment Report - Western Trawl Fisheries. Available online at [https://www.afma.gov.au/environment/assessment/docs\\_draft/westtrawl.pdf](https://www.afma.gov.au/environment/assessment/docs_draft/westtrawl.pdf)

AFMA (2003a). Southern and Western Tuna Billfish Fishery – Data Summary 2002 Available online at [www.afma.gov.au/information/publications/fishery/data\\_summ/docs/swtbf\\_2002.pdf](http://www.afma.gov.au/information/publications/fishery/data_summ/docs/swtbf_2002.pdf)

AFMA (2003b). Northern Prawn Fishery – Strategic Assessment Report. Available online at [https://www.afma.gov.au/environment/assessment/docs\\_draft/npf.pdf](https://www.afma.gov.au/environment/assessment/docs_draft/npf.pdf)

BRS (2007). Fishery Status Reports 2006. Available online at <http://affashop.gov.au/>

Department of Employment and Workplace Relations (2007). Industry Employment Outlook Agriculture Forestry and Fisheries. Available online at <http://www.skillsinfo.gov.au/skills/Industries/AgricultureForestryFishing>

Department of Fisheries (2006), State of the Fisheries Report 2005-2006. Available online at <http://www.fish.wa.gov.au/docs/sof/index.php>

- Department of Fisheries (2004), Draft Aquaculture Plan for Shark Bay Fisheries Management Paper 171. Available online at <http://www.fish.wa.gov.au>
- Department of Fisheries (2001). State of the Fisheries Report 2000-2001. Available online at <http://www.fish.wa.gov.au/docs/sof/index.php>
- Department of Fisheries (1995). Offshore Constitutional Settlement 1995. Available online at <http://www.fish.wa.gov.au/>
- Gascoyne Development Commission (2006). Gascoyne Economic Perspective. Available online at <http://www.gdc.wa.gov.au/>
- Huddleston, V. (2006). A Scenario Analysis of the Social Impact of The Western Rock Lobster Industry Management Options on Fleet Hosting Communities. Institute for Regional Development, University of Western Australia, Perth
- Kimberley Development Commission (2006), Kimberley Economic Perspective Available online at <http://www.kdc.wa.gov.au/>
- Pilbara Development Commission (2006), Pilbara Economic Perspective Available online at <http://www.pdc.wa.gov.au/>
- Western Australian Fishing Industry Council (2007). Editorial. Available online at <http://www.wafic.com.au/images/wafic-15--faeke.pdf>
- Storey, K. (2001). Fly-in/fly-out and fly-over: mining and regional development in Western Australia *Australian Geographer* 32, 133–148
- Sumalia, U., Guenette, S., Alder, J. and Chuenpagdee, R. (2000). Addressing ecosystem effects of fishing using marine protected areas, *Journal of Marine Science*, 57, 752–760

Department of Environment and Water Resources (2004), Fisheries and the Environment. Available online at <http://www.environment.gov.au/coasts/fisheries/index.html>

## **Chapter 7**

ABS (2007). Employee Earnings, Benefits and Trade Union Membership, Australia 2006. Available online at <http://www.abs.gov.au>

ABS (2006). 2006 Census data. Available online at <http://www.abs.gov.au>

ABS (2003), Recreational Fishing Year Book 2003. Available online at <http://www.abs.gov.au>

ABS (2001). 2001 Census data. Available online at <http://www.abs.gov.au>

Baharthah, T. (2006). Department of Fisheries Community Survey 2005. Available online at <http://www.fish.wa.gov.au>

Clifton, J., Tonts, M. and Boruff, B. (2007). A Socio-economic overview of the coastal communities adjacent to the North-west Marine Region. Department of Environment and Water Resources, Hobart

DAFF (2007). Recreational Fishing Community Grants Program. Available online at <http://www.daff.gov.au>

Department of Fisheries (2006). State of the Fisheries Report 2005-2006. Available online at <http://www.fish.wa.gov.au>

Department of Fisheries (2000). Management Directions for Western Australia's Recreational Fisheries. Available online at <http://www.fish.wa.gov.au>

FRDC (2005). Recreational Fishing Catch – North Western Region. Available online at <http://adl.brs.gov.au>

Gascoyne Development Commission (2006). Gascoyne Economic Perspective.

Available online at <http://www.gdc.wa.gov.au>

Henry, G. and Lyle, J. (2003). The National Recreational and Indigenous Fishing

Survey. Available online at <http://www.daff.gov.au>

Kearney, B., Foran, B., Poldy, F. and Lowe, D. (2003). Modelling Australian

Fisheries to 2050: Policy and Management Implications. Available online at

<http://www.cse.csiro.au/research/futures/fishfutures/>

Shire of Roebourne (2007). About us. Available online at

<http://www.roebourne.wa.gov.au>

Williamson, P., Sumner, N. and Malseed, B. (2006). A 12 month survey of

recreational fishing in the Pilbara region of Western Australia during 1999-

2000, Department of Fisheries, Perth. Available online at

<http://www.fish.wa.gov.au>

## **Chapter 8**

ABS (2007a). Tourism Satellite Account 2007. Available online at

<http://www.abs.gov.au>

ABS (2007b). Survey of Tourism Accommodation 2005-2007. Available online at

<http://www.abs.gov.au>

Access Economics (2003). The Economic Contribution of Tourism to the State of

Western Australia: a tourism satellite account-based analysis. Available online

at <http://www.tourism.wa.gov.au>

Association of Australian Ports and Maritime Authorities (2007). Cruise vessel visits.

Available online at <http://www.aapma.org.au>

Department for Planning and Infrastructure (2007a). Boat launching ramps. Available

online at <http://www.adpi.wa.gov.au>

Department for Planning and Infrastructure (2007b). More State funding for boating facilities. Available online at <http://www.dpi.wa.gov.au/15398.asp>

Gascoyne Development Commission (2006). Gascoyne Economic Perspective. Available online at <http://www.gdc.wa.gov.au/>

Kimberley Development Commission (2006). Kimberley Economic Perspective. Available online at <http://www.kdc.wa.gov.au/>

Pilbara Development Commission (2006). Pilbara Economic Perspective. Available online at <http://www.pdc.wa.gov.au/>

Tourism Australia (2007). Background. Available online at <http://tourism.australia.com>

Tourism Forecast Committee (2007). Forecast 2007 Issue 1. Available online at <http://www.tra.australia.com>

Tourism Western Australia (2007a). International Visitor Review Western Australia 2007. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007b). Interstate Visitor Review Western Australia 2007. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007c). Intrastate Visitor Review Western Australia 2007. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007d). Australia's Coral Coast Development Strategy Update 2007-2017. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007e). Australia's North West Development Strategy Update 2007-2017. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007f). Tourism Region Fact Sheet: Australia's North West 2006. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2007g). Tourism Region Fact Sheet: Australia's Coral Coast 2006. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2006a). Annual Report 2005-06. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2006b). Tourism Accommodation Development Register June 2006. Available online at <http://www.tourism.wa.gov.au>

Tourism Western Australia (2004). A Nature Based Tourism Strategy for Western Australia. Available online at <http://www.tourism.wa.gov.au>

Yachting Western Australia (2007). Club Search. Available online at <http://www.wa.yachting.org.au>

## **Chapter 9**

ABARE (2007). Australian Fisheries Statistics 2006. Available online at <http://www.abareconomics.com>

ABARE (2002). Australian Fisheries Statistics 2001. Available online at <http://www.abareconomics.com>

Aquaculture Council of Western Australia (2007). About the Aquaculture Council of Western Australia. Available online at [http://www.aquaculturecouncilwa.com/about\\_acwa](http://www.aquaculturecouncilwa.com/about_acwa)

Allen Consulting (2003). The Economic Contribution of Australia's Marine Industries 1995-6 to 2000-2003. Allen Consulting Group, Canberra, Available online at <http://www.allenconsult.com.au>

Clifton, J., Tonts, M. and Boruff, B. (2007). A Socio-economic overview of the coastal communities adjacent to the North-west Marine Region. Department of Environment and Water Resources, Hobart

Department of Environment and Water Resources (2003). Assessment of the Western Australia Pearl Oyster Fishery. Available online at <http://www.environment.gov.au>

Department of Employment and Workplace Relations (2007). Industry Employment Outlook Agriculture Forestry and Fisheries. Available online at <http://www.skillsinfo.gov.au/skills/Industries/AgricultureForestryFishing>

Department of Fisheries, (2006). State of the Fisheries Report 2005-2006. Available online at <http://www.fish.wa.gov.au>

Department of Fisheries (2005). Pearling and Aquaculture. Available online at <http://www.fish.wa.gov.au/sec/aqua/index.php>

Department of Fisheries (2004a). Draft Aquaculture plan for Shark Bay Fisheries Management Paper 171. Available online at <http://www.fish.wa.gov.au>

Department of Fisheries (2004b). Draft Aquaculture Plan for Exmouth Gulf Fisheries Management Paper 172. Available online at <http://www.fish.wa.gov.au>

Department of Fisheries (2004c). Applying for an Aquaculture License on Private Land in Western Australia. Available online at <http://www.fish.wa.gov.au/docs/aq/aq022/index.php?0307>

Fletcher, W., Friedman, K., Weir, V., McCrea, J., Clark, R (2006). Pearl Oyster Fishery ESD Report Series No.5. Available online at <http://www.fish.wa.gov.au>

Gascoyne Development Commission (2006). Gascoyne Economic Perspective. Available online at <http://www.gdc.wa.gov.au/>

Haylor, G. (2003). Investigating opportunities to support indigenous aquaculture in Australia: Visit to Kimberley, Western Australia. Kimberley Aquaculture Aboriginal Corporation and Department of Agriculture Forestry and Fisheries

Australia. Available online at

<http://govdocs.aquaculture.org/cgi/content/abstract/2006/101/1010420>

Kaiser, M. and Stead, S. (2002). Uncertainties and values in European aquaculture: communication, management and policy issues in times of changing public perceptions. *Aquaculture International* 10, 469-490.

Kimberley Development Commission (2006). Kimberley Economic Perspective. Available online at <http://www.kdc.wa.gov.au/>

Kolkovski, S and Machin, D. (2004). Identification and evaluation of sites for the development of large-scale, land-based marine aquaculture in Western Australia: Fisheries Occasional Publication 13. Available online at <http://www.fish.wa.gov.au>

Maunsell Australia (2004). Assessment and Reporting of the Ecologically Sustainable Development of Australia Aquaculture - an Industry Perspective. Available online at [http://www.australian-aquacultureportal.com/action\\_agenda/pdf/esdreport.pdf](http://www.australian-aquacultureportal.com/action_agenda/pdf/esdreport.pdf)

Mazur, N., Aslin, H. and Byron, I. (2005). Community Perceptions of Aquaculture: Final Report. Available online at <http://affashop.gov.au>

National Aquaculture Council (2005). Australian Aquaculture Industry Action Plan. Available online at <http://www.australian-aquacultureportal.com/>

Pilbara Development Commission (2006). Pilbara Economic Perspective. Available online at <http://www.pdc.wa.gov.au/>

Productivity Commission (2004). Assessing Environmental Regulatory Arrangements for Aquaculture. Available online at: <http://www.pc.gov.au/research/crp/aquaculture/index.html>

Zelko Lendich and Associates (2003). Proposed Strategy for the Development of the Western Australian Aquaculture Industry: Final Report. Available online at <http://govdocs.aquake.org/cgi/content/abstract/2004/802/8020300>

## **Chapter 10**

BHP Billiton (2005). Boodarie Iron. Available online at <http://www.bhpbilliton.com/>

Chemicals Technology (2007). Industry projects. Available online at <http://www.chemicals-technology.com/projects/>

DEW (no date). Stories of successful enterprises and entrepreneurs: Ngarda Civil and Mining. Available online at <http://www.workplace.gov.au>

DFAT (2007). Trade matters: Kimberley and Pilbara, Western Australia. Available online at <http://www.dfat.gov.au>

DLGRD (2007a). Opportunities in manufacturing. Available online at <http://www.dlgrd.wa.gov.au>

DLGRD (2007b). Opportunities in aquaculture. Available online at <http://www.dlgrd.wa.gov.au>

DOIR (2006). Committed and commissioned projects November 2006. Available online at [www.doir.wa.gov.au/](http://www.doir.wa.gov.au/)

DOIR (2007). Ord Irrigation Scheme Stage 2. Available online at <http://www.doir.wa.gov.au/>

Economics Consulting Services (2007). Sugar and ethanol production: Ord River Stage 2. Available online at <http://www.agric.wa.gov.au/>

Environmental Protection Authority (2006). Materials stockpiling and handling facilities, Cape Preston. Available online at [http://svc033.wic009tp.server-web.com/docs/2318\\_B1229.pdf](http://svc033.wic009tp.server-web.com/docs/2318_B1229.pdf)

Horizon Power (2007). Major projects. Available online at  
[http://www.horizonpower.com.au/about\\_us/major\\_projects/index.html](http://www.horizonpower.com.au/about_us/major_projects/index.html)

Western Australian Office of Energy (2007). Regional Power Procurement Process.  
Available online at  
[http://www.energy.wa.gov.au/2/3195/64/regional\\_power\\_.pm](http://www.energy.wa.gov.au/2/3195/64/regional_power_.pm)

## **Chapter 11**

Cruise Down Under (2007). Economic impact of the cruise shipping industry in  
Australia, 2006-07. Available online at <http://www.cruisedownunder.com>

Department of Environment and Heritage (2004). Assessment of the Kimberley prawn  
managed fishery. Available online at <http://www.environment.gov.au>

Department of Fisheries (2007a). Shark Bay prawn and scallop fisheries: draft review  
report. Available online at <http://www.fish.wa.gov.au>

Department of Fisheries (2007b). Managing the recreational catch of demersal  
scalefish on the west coast: future management scenarios for community  
consideration. Available online at <http://www.fish.wa.gov.au>

Department of Environment and Water Resources (2007). Industry Employment  
Outlook: agriculture, forestry and fishing March 2007. Available online at  
<http://www.dewr.gov.au>

Department of Planning and Infrastructure (2007). Port and related infrastructure  
requirements to meet the expected increases in iron ore exports from the  
Pilbara. Available online at <http://www.dpi.wa.gov.au>

Fisheries Research and Development Corporation (2003). Modelling Australia's  
fisheries to 2050: policy and management implications. Available online at  
<http://www.frdc.com.au>