



Browse LNG Precinct



Browse Liquefied Natural Gas Precinct Strategic Assessment Report

(Draft for Public Review)
December 2010

Appendix D-4

ECONOMIC ANALYSIS:
Fishing Industry Impact Study –
Kimberley LNG Project

ANNEX

Economic Analysis: Fishing Industry Impact Study – Kimberley LNG Project

A report prepared for
Western Australian Department of Fisheries

Prepared by



December 2009

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Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ATO	Australian Taxation Office
DECON	Demographic Economic
DEWR	Department of Employment and Workplace Relations
fte	full-time equivalent
GRP	gross regional product
I-O	input-output
LNG	liquefied natural gas
m	millions
S	Shire
t	tonnes
WA	Western Australia

Executive Summary

This study, prepared as a part of a broader study for WA fisheries, is concerned with the regional economy of the West Kimberley region and involves an assessment of the impact on the region of a range of fishing industry scenarios associated with development of an LNG processing facility. Specific tasks involved in the study were to prepare the following:

- a standard input-output model for the West Kimberley regional economy for 2007/08 and extend it as a DECON model; and
- estimates of the regional economic and population impact for a range of fishing industry scenarios arising from the Kimberley LNG Project

Estimates of economic and population impact were based on a series of assumptions regarding the level of output, expenditure and employment in each fishing industry sector. Estimates of economic impact provide a statement of regional economic activity arising from the fishing industry scenarios and do not indicate whether the costs of changes in the level of activity outweigh the benefits.

Total impacts (direct and indirect) include the initial impacts generated by the fishery and indirect (or flow-on) impacts into other sectors of the regional economy.

Impact Scenarios from the LNG Facility Development

Six scenarios were developed to highlight the potential economic and population impacts of the LNG facility development. These hypothetical scenarios were based on consultation with industry representatives and input from the Department of Fisheries WA.

The scenarios used as a basis for the calculation of economic and population impacts are summarised in Table ES1.

Table ES1 Fishing industry impact scenarios from LNG facility development

Scenario No.	Industry Sector	Description
One	Broome Prawn Fishery	Catch declines by 25 per cent from current levels.
Two	Kimberley Gillnet and Barramundi Fishery	Catch of Threadfin Salmon declines by 20 per cent from current levels and number of boats operating in the area falls from three to two.
Three	Northern Demersal Scalefish Fishery	Level of activity associated with the fishery in the West Kimberley region declines by 10 per cent.
Four	Mackerel Fishery	Catch of Mackerel declines by 20 per cent from current levels and number of boats operating in the area falls from four to three.
Five	Charter Boat Fishery	Increase in number of charters by 10 per cent during construction phase.
Six	Charter Boat Fishery	Decrease in number of charters by 10 per cent.

Estimates of economic impact were prepared to highlight the effect of each scenario on the regional economy. Estimates are provided in terms of four indicators:

- value of output;
- GRP;
- employment; and
- household income.

The impact of the scenarios on the population level in the region was also calculated.

Estimates of economic impact under each scenario are summarised in Table ES2.

Table ES1 Economic and population impact of LNG facility development fishing industry scenarios^a

	Scenario One	Scenario Two	Scenario Three	Scenario Four	Scenario Five	Scenario Six
Output (\$m)						
Total direct effects	-0.18	-0.09	-0.53	-0.53	0.44	-0.57
Employment (fte)						
Total direct effects	-0.4	-1.2	-4.0	-4.0	1.5	-3.8
Total flow-on effects	-0.3	-0.3	-0.7	-1.1	1.3	-2.1
Total	-0.8	-1.5	-4.7	-5.1	2.9	-5.9
Household Income (\$m)						
Total direct effects	-0.01	-0.03	-0.19	-0.05	0.19	-0.25
Total flow-on effects	-0.02	-0.02	-0.04	-0.06	0.07	-0.11
Total	-0.03	-0.05	-0.23	-0.11	0.26	-0.37
GRP (\$m)						
Total direct effects	-0.05	-0.04	-0.35	-0.29	0.30	-0.27
Total flow-on effects	-0.03	-0.03	-0.09	-0.11	0.14	-0.22
Total	-0.08	-0.08	-0.43	-0.40	0.44	-0.50
Population (no)						
Total direct effects	-1	-2	-6	-6	2	-6
Total flow-on effects	0	0	-1	-2	2	-3
Total	-1	-2	-7	-7	4	-9

^a Scenarios 1 to 6 are defined in Table ES1 and explained in further detail in Sections

Source: Sections 5 to 9.

1. Introduction

The analysis presented in this report was prepared for Dr Guy Wright, Big Island Research P/L, as a contribution to the broader Fishing Industry Impact Study for the Kimberley LNG Project.

Pearling, commercial fishing and fishing related tourism activities operate within the West Kimberley region. The development of a liquefied natural gas (LNG) processing facility in the region has the potential to impact these existing fishing related activities. The purpose of this analysis is to calculate the economic and population impacts of the construction and operation of a LNG facility on the fishing industry in the West Kimberley region.

The objectives of the analysis were to:

- construct a standard input-output model for the West Kimberley regional economy for 2007/08 and extend it as a DECON model; and
- estimate the regional economic and population impacts for a range of fishing industry scenarios arising from the Kimberley LNG Project.

Section 2 outlines a range of direct impact scenarios arising from the construction and operation of the LNG facility. These direct impacts are simulated in a model of the regional economy to enable estimation of the broader economic and population impacts. Section 3 outlines the method of analysis used in estimating these regional economic and population impacts.

Sections 4 to 10 provide results of the impact analysis undertaken for each scenario for the component sectors within the broader fishing industry of the West Kimberley region, namely:

- aquaculture and pearling
- commercial fisheries
 - Broome Prawn fishery
 - Kimberley Gillnet and Barramundi fishery
 - Northern Demersal Scalefish fishery
 - Mackerel fishery
- Charter Boat fishery
- recreational fishing

2. Impact Scenarios from LNG Facility Development

2.1 Industry Consultation

Consultation was undertaken with key fishing industry representatives, including:

- key commercial fishery stakeholder groups
 - Pearl Producers Association
 - Kimberley Professional Fishermens' Association
 - Western Australian (WA) Fishing Industry Council
 - Kimberley Charter Fishing Association
 - Aquaculture Council of WA
- regional recreational fishing stakeholder groups
- commercial fishery licence holders
- charter boat operators
- aquaculture lease holders
- recreational fishers

The purpose of this consultation was to determine the potential impact on fishing industry activities of the proposed LNG development.

Consultation was undertaken in May 2009 by Dr Guy Wright (Big Island Research P/L) and Christian Pyke.

2.2 Scenarios for Economic and Population Impact Analysis

Based on the industry consultation outlined above, six scenarios were developed to highlight the potential economic and population impacts of the LNG facility development. These hypothetical scenarios were based on consultation with industry representatives. Extensive environmental and biological studies would need to be undertaken to determine the actual potential impact of the LNG development on fish stocks and migration.

The scenarios used as a basis for the calculation of economic and population impacts are summarised in Table 2.1 and outlined in detail for each industry sector in Sections 6 to 9.

Table 2.1 Fishing industry impact scenarios from LNG facility development ^a

Scenario No.	Industry Sector	Description	Report Section
One	Broome Prawn Fishery	Catch declines by 25 per cent from current levels.	Section 5.2
Two	Kimberley Gillnet and Barramundi Fishery	Catch of Threadfin Salmon declines by 20 per cent from current levels and number of boats operating in the area falls from three to two.	Section 6.2
Three	Northern Demersal Scalefish Fishery	Level of activity associated with the fishery in the West Kimberley region declines by 10 per cent.	Section 7.2
Four	Mackerel Fishery	Catch of Mackerel declines by 20 per cent from current levels and number of boats operating in the area falls from four to three.	Section 8.2
Five	Charter Boat Fishery	Increase in number of charters by 10 per cent during construction phase.	Section 9.2
Six	Charter Boat Fishery	Decrease in number of charters by 10 per cent.	Section 9.3

^a Rationale for each scenario is included in the main report prepared for the broader study.

3. Method and Regional Definition

For the purpose of assessing the economic and population impacts of a range of fishing industry scenarios in the West Kimberley region, a regional input-output (I-O) model was constructed for the year 2007/08. The regional boundaries, data sources and method are detailed below.

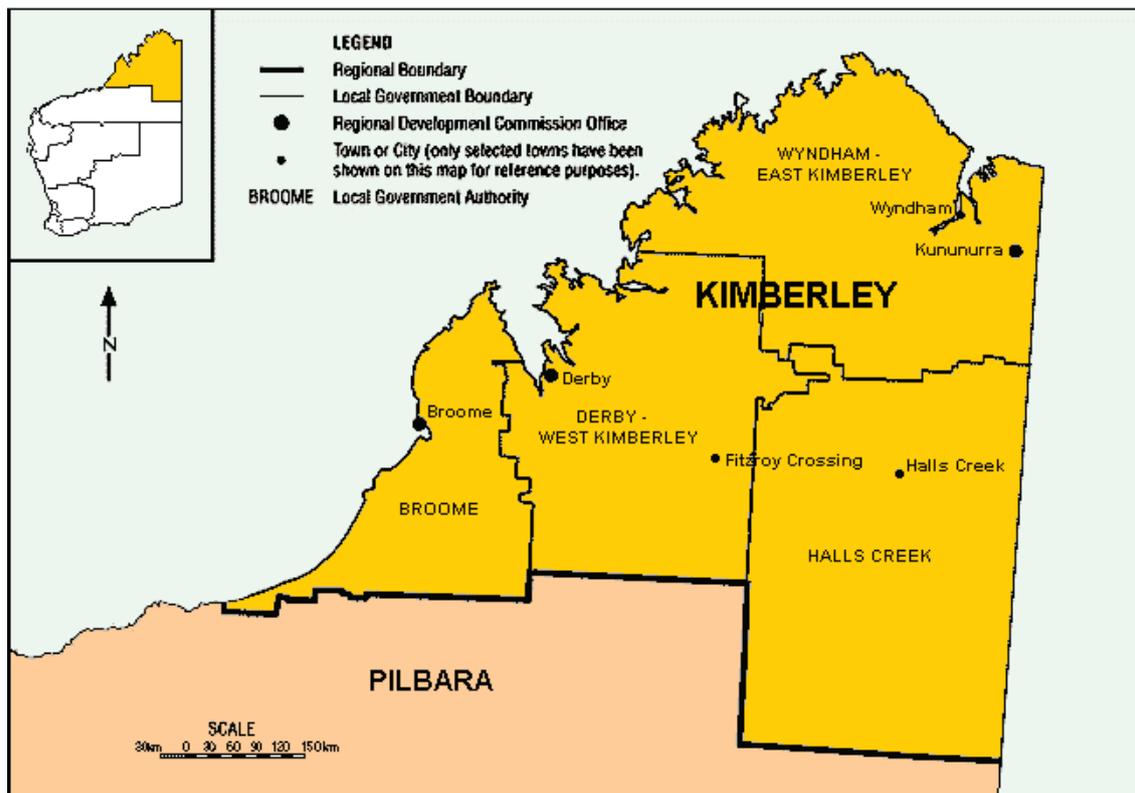
3.1 Regional Boundaries

The West Kimberley region was defined in terms of the following Statistical Local Areas (SLAs):

- Derby-West Kimberley (S)
- Broome (S)

These SLAs are illustrated on a map of the broader Kimberley area in Figure 3.1.

Figure 3.1 Statistical local areas in the Kimberley region



Source: Department of Local Government, Western Australia

3.2 The Standard Input-Output Model

A standard I-O model for the West Kimberley region was developed for 2007/08 using the GRIT (Generation of Regional Input-Output Tables) method, a 'hybrid' method which utilises local data and computer methods to generate I-O tables. Whilst the majority of data compilation and manipulation was undertaken in *Microsoft Excel®*

spreadsheets, the GRIT procedure was undertaken using *IOW* software (West 2005). The parent table for the GRIT procedure was the Australian I-O table for 2004/05.

Sources of local data for the model included:

- the Australian Bureau of Statistics (ABS)
 - 2006 Census of Population and Housing¹;
 - 2006 Agricultural Census (ABS 2008a)²;
 - 1998/99 and 2003/04 Household Expenditure Survey (ABS 2005);
 - 2004/05 National Input-Output Table (ABS 2008b);
 - ABS (2008c and d);
- Department of Employment and Workplace Relations (DEWR 2008); and
- the Australian Taxation Office (ATO 2008).

The I-O model was initially developed at a 109-sector level of aggregation, consistent with the national I-O model for 2004/05 (ABS 2008b). As there is limited or no activity in some of these sectors in the West Kimberley region, a 66-sector I-O model was developed for the purpose of this project. Sector definitions in terms of the 109 national I-O sectors are provided in Appendix 1.

3.3 Extending the I-O Model as a DECON Model

Based on work undertaken by Mangan and Phibbs (1989), the I-O model developed for this project was extended as demographic-economic (DECON) model. The two key characteristics of the DECON model, when compared with a standard economic model, are as follows.

1. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on local population levels of employment growth or decline.
2. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

The structure of the DECON model and the nature of these additional sectors are described in Appendix 2 of the report.

3.4 Measures of Economic Impact

Estimates of economic impact are presented in terms of the following indicators³:

- output;
- contribution to gross regional product;

¹ Detailed employment data from the *2006 Census of Population and Housing* were obtained by special request (Sonja Williams, ABS, pers. comm.) and represent place of remuneration rather than place of residence. That is, they are a measure of the number of jobs in the region rather than the number of employed residents.

² These data have been updated to 2007/08 using price indices in ABARE (2008).

³ See Appendix 3 for a more detailed glossary of input-output terminology.

- employment; and
- household income.

Employment is a measure of the number of working proprietors, managers, directors and other employees, in terms of the number of full-time equivalents and total (i.e. full-time and part-time) jobs. Employment is measured by place of remuneration rather than place of residence.

(Value of) Output is a measure of the gross revenue of goods and services produced by commercial organisations (e.g. farm-gate value of production) and gross expenditure by government agencies. Total output needs to be used with care as it can include elements of double counting when the output of integrated industries is added together (e.g. the value of winery output includes the farm-gate value of grapes). For sectors where superior regional data were not available, value of output by industry has been allocated across regions on an employment basis, rather than in terms of the location of other factors of production such as land and capital.

Gross state product (GRP) is a measure of the net contribution of an activity to the regional economy. GRP is measured as value of output less the cost of goods and services (including imports) used in producing the output. In other words, it can be measured as household income plus other value added. It represents payments to the primary inputs of production (labour, capital and land). Using GRP as a measure of economic impact avoids the problem of double counting that may arise from using value of output for this purpose.

Household income is a component of GSP and is a measure of wages and salaries paid in cash and in-kind, drawings by owner operators and other payments to labour including overtime payments, employer's superannuation contributions and income tax, but excluding payroll tax.

Direct impacts are the initial round of output, employment and household income generated by an economic activity, in this case the fishing industry scenarios.

Flow-on (or indirect) impacts are the sum of production-induced effects and consumption-induced effects. Production-induced effects are additional output, employment and household income resulting from re-spending by firms (e.g. contractors to the smelter) that receive payments from the sale of goods and services to firms undertaking, for example, plantation forestry activities. Consumption-induced effects are additional output, employment and household income resulting from re-spending by households that receive income from employment in direct and indirect activities.

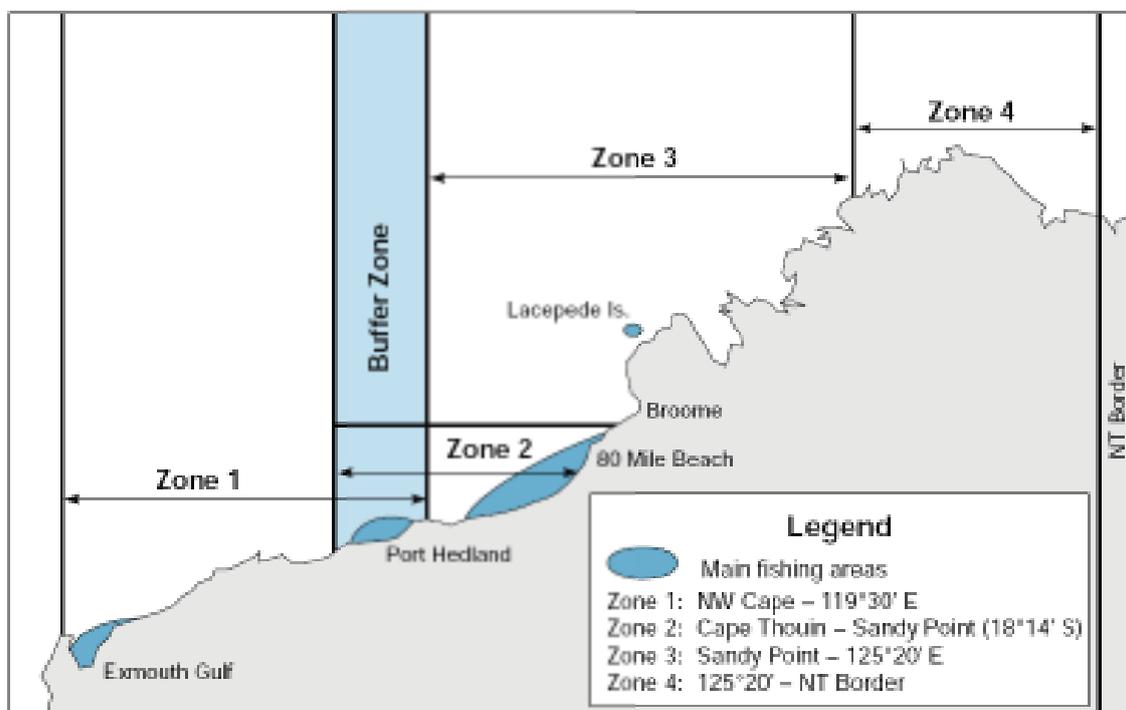
Total impacts are the sum of direct and flow-on impacts.

Note that this report provides a statement of regional economic impact (i.e. so many jobs, so much income, etc.) arising from fishing industry scenarios relating to the LNG facility. The results of the analysis do not indicate whether the costs to the region of changing the current level of activity outweigh the benefits. An assessment of this nature would require a comprehensive cost-benefit analysis.

4. Pearl Oyster Fishery and Aquaculture

The Pearl Oyster fishery is divided into four zones, these zones are illustrated in Figure 4.1.

Figure 4.1 Pearl Oyster fishery zones



Source: Department of Fisheries (2008).

In addition to pearl oyster collection from the wild fishery there are a number of pearl oyster aquaculture leases in the West Kimberley region.

A completed survey response was received from the only pearling operator directly adjacent to the proposed precinct. Information regarding the industry and the likely impact of the proposed LNG facility were also gathered from some of the smaller operators in the region. For confidentiality reasons due to the limited number of operators and the industry mix (i.e. one large operator dominating production in the region), it is not possible to present detailed information on income and expenditure.

4.1 Contribution of the Pearl Oyster Fishery and Aquaculture to the West Kimberley Economy

Production and value...

The value of the Pearl Oyster fishery across all zones, including the value of cultured pearls and by-product, was estimated to be approximately \$113 million in 2007 (Department of Fisheries 2008). A significant proportion of this is thought to be attributable to operations in the West Kimberley region.

Regional expenditure and employment...

The pearling industry undertakes significant expenditure in the West Kimberley region. Major expenditure items include:

- labour;
- contractors (e.g. divers and seeders);
- fuel; and
- repairs and maintenance.

Regional employment in the industry is also significant. It is estimated that the pearling industry generates employment for approximately 500 people in the North Coast Bioregion as a whole (Department of Fisheries 2008). It is thought that a significant proportion of these jobs are generated in the West Kimberley region.

4.2 Impact of the LNG Facility on the Pearl Oyster Fishery

Some pearling operators, particularly those located within close proximity to the proposed development site, indicated that there are a number of high-level potential risks to their operations associated with the construction and operation of the LNG facility. Pearling operators indicated that there are a number of factors that have the potential to affect pearl oyster health and productivity and pearl quality and value, including:

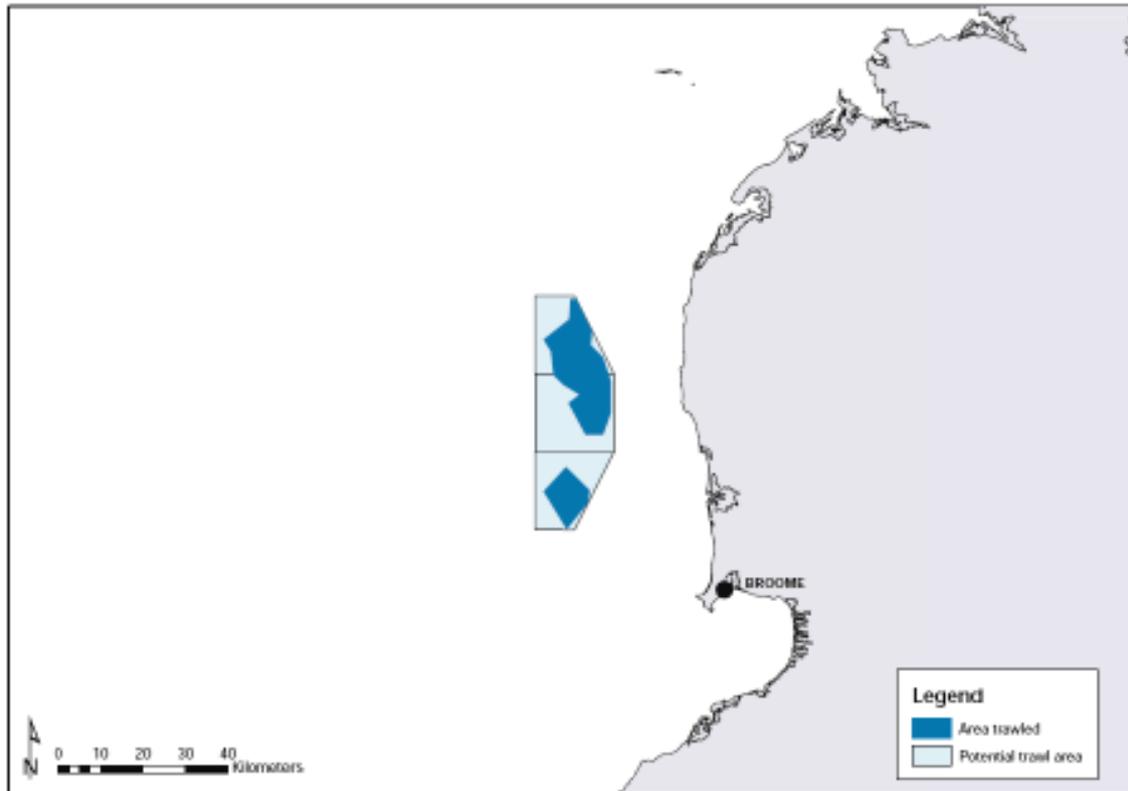
- dredging of the shipping channel
 - sedimentation
 - siltation
 - turbidity
 - water quality
- changes in water chemistry
- introduction of foreign marine pests and diseases
- potential spillage of contaminants
- explosive excavation
- changes in water nutrient levels.

Due to limited information being available and uncertainty surrounding the likely impact of the facility on pearling operations, quantitative economic and population impacts have not been calculated.

5. Broome Prawn Fishery

The Broome Prawn fishery operates in a designated trawl area off Broome. The boundaries of the fishery are illustrated in Figure 5.1.

Figure 5.1 Broome Prawn Fishery boundaries



Source: Department of Fisheries (2008).

Licence holders in the Broome Prawn fishery have access to the fishery for approximately three months of the year. The open season coincides with the seasonal closures in other prawn fisheries including the Commonwealth managed Northern Prawn fishery and the Kimberley Prawn fishery. All Broome Prawn licence holders also hold one or more licence in other prawn fisheries. Accordingly, boats and gear used in the Broome Prawn fishery are also used in other fisheries.

The economic activity generated by the Broome Prawn fishery relates to the expenditure by operators during the fishing season, including:

- fuel;
- repairs and maintenance;
- provisions; and
- on-shore support.

None of the five Broome Prawn fishery licence holders are based within the study area. Accordingly, it was assumed that fixed business expenditure (e.g. insurance, interest

and other overheads) and employment occurred outside the study area. This implies that these fixed inputs and labour are “imported” into the region.

5.1 Contribution of the Broome Prawn Fishery to the West Kimberley Economy

Catch and value...

Reported catch and value of catch for the period 2002/03 to 2006/07 are detailed in Table 5.1.

Table 5.1 Broome Prawn fishery catch and value of catch in the West Kimberley region, 2002/03 to 2006/07

Year	Catch (t)			Value \$m
	King Prawns	Coral Prawns	Total	
2002/03	73	128	201	1.3
2003/04	48	76	124	0.9
2004/05	28	19	47	0.4
2005/06	40	6	46	0.5
2006/07	33	39	72	0.5
<i>5-year average^a</i>	<i>44</i>	<i>54</i>	<i>98</i>	<i>0.7</i>

^a Estimate based on 5-year average catch and weighted average adjusted price in the fishery. The weighted average price was adjusted by CPI to reflect changes in the purchasing power of money over time.

Source: Department of Fisheries (2008), ABS (2009) and EconSearch analysis

Catch and value of catch in the fishery followed a declining trend over the five years 2002/03 to 2006/07 (Table 5.1).

Regional expenditure and employment...

As no completed survey responses were received from Broome Prawn Fishery licence holders, estimates of regional expenditure and employment were imputed based on data available for other Australian prawn trawl fisheries.

As mentioned previously, none of the boats/businesses are based within the West Kimberley region. Accordingly, regional expenditure is most likely to relate only to fishing consumables such as fuel and provisions.

Estimates of average annual regional expenditure by Broome Prawn fishery licence holders are summarised in Table 5.2.

Table 5.2 Estimated average annual expenditure in the West Kimberley region, Broome Prawn fishery

Expenditure Item	Annual Regional Expenditure (\$)	
	Average per Tonne ^a	Estimated Fishery Total ^b
Fuel	1,882	184,500
Repairs and Maintenance	705	69,100
Provisions	155	15,100
Onshore Labour	523	51,300
Other	329	32,200
Total	5,685	557,159

^a Based on average fishing costs per tonne in the South Australian Spencer Gulf and West Coast Prawn Fisheries.

^b Based on 5-year average catch and value in the fishery (Table 5.1).

Source: EconSearch (2009b) and EconSearch analysis

Based on information from industry sources it is assumed that a local skipper and crew are not employed specifically for the Broome Prawn fishery season. It is assumed that a small proportion of labour expenditure by licence holders occurs within the region and relates to shore based and incidental labour.

Estimated regional economic and population contribution...

The estimated annual economic and population impact of the Broome Prawn fishery on the West Kimberley region is summarised in Table 5.3.

Table 5.3 Average annual contribution of the Broome Prawn fishery to the West Kimberley regional economy ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	0.7	1.7 56%	0.05 41%	0.09 42%	2 56%
Flow-on effects					
Trade		0.6 21%	0.03 24%	0.04 19%	1 21%
Manufacturing		0.2 6%	0.01 9%	0.02 7%	0 6%
Accomm, Rest, Cafes		0.1 3%	0.00 4%	0.01 3%	0 3%
Transport		0.1 5%	0.01 6%	0.01 5%	0 5%
Other Sectors		0.3 9%	0.02 16%	0.05 22%	0 9%
<i>Total Flow-on ^b</i>		1.4 44%	0.07 59%	0.12 58%	2 44%
Total ^b		3.1 100%	0.12 100%	0.21 100%	4 100%

^a Based on 5-year average catch and value of catch (Table 5.1) and estimated average annual regional expenditure (Table 5.2).

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Output...

The total value of output generated directly in the West Kimberley region by Broome Prawn fishery enterprises summed to \$0.7 million. Flow-on (indirect) and total output impacts are not reported as there are problems with double counting which can give a misleading impression of the significance of the fishery to the region.

Employment and Household Income...

The Broome Prawn fishery was responsible for direct employment of 1.7 full-time equivalents in the West Kimberley region. Flow-on activity was estimated to generate a further 1.4 fte jobs in the region (Table 5.3).

Personal income of approximately \$50,000 was earned in the fishing sector in the West Kimberley region (excludes wages of skipper and crew from outside the region). An additional \$70,000 was earned by wage earners in other businesses in the region as a result of fishing activities. The total household income impact was \$120,000 in the West Kimberley region (Table 5.3).

Gross Regional Product...

Total GRP generated by the Broome Prawn fishery in the West Kimberley region was estimated to be approximately \$214,000, \$91,000 in fishing directly and \$123,000 in other sectors of the regional economy.

Population...

The direct population impact provides an estimate of the population levels associated directly with the business activities of the Broome Prawn fishery in the West Kimberley region. The direct population impact was estimated to be 2 persons.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. flow-on business activities generated by the Broome Prawn fishery) and related non-market activities (i.e. population driven services such as education). The flow on population impact was estimated to be 2 persons.

The aggregated population impact (direct and flow-ons) was estimated to be 4 persons (Table 5.3).

5.2 Scenario One: 25 per cent Decline in Catch in the Broome Prawn Fishery

Estimates of economic and population impact were calculated to highlight the effects of a decline in catch of 25 per cent from the 5-year average. This scenario was developed through consultation with industry representatives and the Department of Fisheries about the likely impact of the proposed LNG facility.

Catch and value...

Estimated catch and value of catch in the Broome Prawn fishery under Scenario One is shown in Table 5.4.

Table 5.4 Broome Prawn fishery catch and value of catch in the West Kimberley region: Scenario One

	Catch (t)	Value (\$m)
5-Year Average	98	0.7
Scenario 1	74	0.5
Change (%)	-25%	-25%

Source: Table 5.1 and EconSearch analysis

Based on the 5-year average catch reported in Table 5.1, a 25 per cent decline in catch would reduce total catch in the fishery to approximately 74 tonnes. For the purpose of this analysis it was assumed that the 25 per cent reduction in catch would result in a 25 per cent decline in the value of the fishery (i.e. no price effects). Based on the 5-year weighted average price for the fishery, the value of under Scenario One would be approximately \$0.5 million (Table 5.4).

Regional expenditure and employment...

Under Scenario One there is likely to be a decline in regional expenditure on fishing consumables (e.g. fuel and provisions) as a result of a decrease in catch in the fishery.

Estimated regional economic and population Impacts

The estimated net economic and population impact of a 25 per cent decline in catch in the Broome Prawn fishery is summarised in Table 5.5 and outlined in the following text.

Table 5.5 Net economic and population impact of Scenario One, Broome Prawn fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	-0.2	-0.4	-0.01	-0.05	-1
Flow-on effects					
Trade		-0.2	-0.01	-0.01	0
Manufacturing		0.0	0.00	0.00	0
Accomm, Rest, Cafes		0.0	0.00	0.00	0
Transport		0.0	0.00	0.00	0
Other Sectors		-0.1	0.00	-0.01	0
<i>Total Flow-on ^b</i>		-0.3	-0.02	-0.03	0
Total ^b		-0.8	-0.03	-0.08	-1

^a Based on a decline in catch and value of 25 per cent (from 5-year average) and corresponding decline in fishing related expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Output...

In response to a reduction in Broome Prawn fishery activity in the region the direct value of output is expected to decrease by approximately \$0.2 million, a decline of 25 per cent relative to the current value.

Employment and Household Income...

In response to a 25 per cent reduction in Broome Prawn fishery activity, direct employment in the sector is expected to fall by 0.4 fte jobs. Flow-on employment is also expected to fall by 0.3 fte jobs. The total employment impact (-0.8 fte jobs) represents a 25 per cent decline relative to current levels.

Associated with the net loss in employment, direct and flow-on household income generated is also expected to fall by approximately 25 per cent.

Gross Regional Product...

In response to a reduction in Broome Prawn fishery activity, total contribution to GRP by the fishing industry is expected to fall by \$0.08 million.

Population...

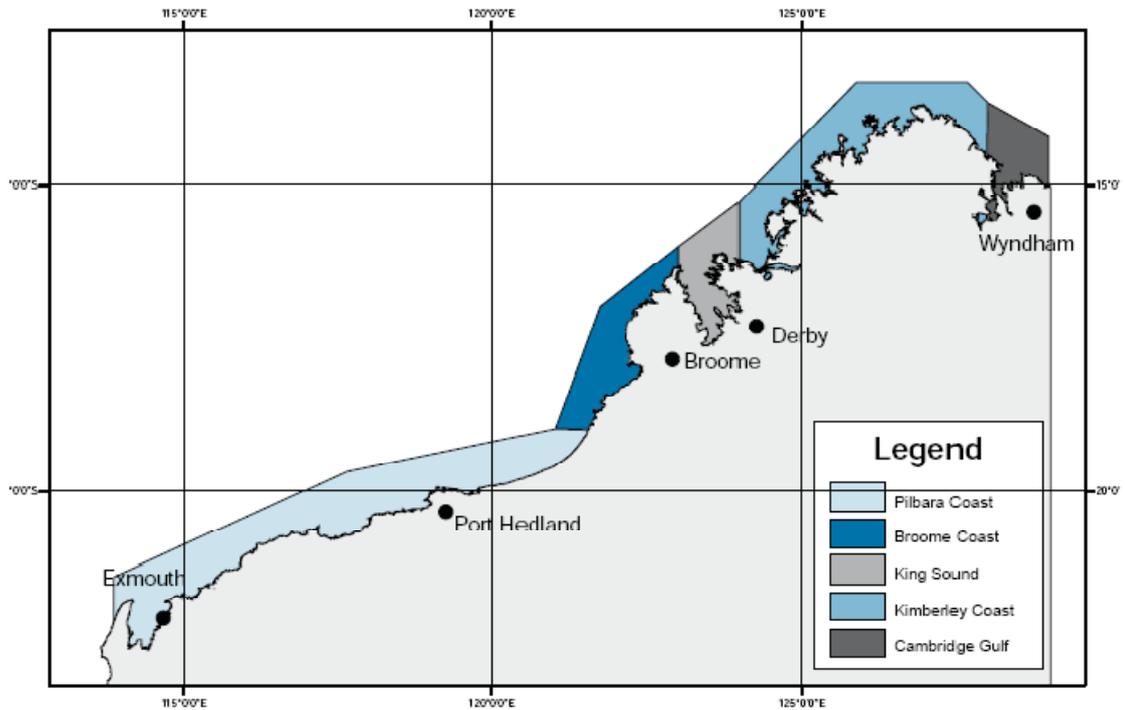
The direct population impact (loss) of a 25 per cent decrease in production activity by the Broome Prawn fishery was estimated to be 1 person. This estimate was based on the assumption that 20 per cent of employees would remain in the region after they lose their jobs and the remainder would leave the region.

The total population impact (direct and flow-on) was estimated to be a loss of 1 person from the region (Table 5.5).

6. Kimberley Gillnet and Barramundi Fishery

The Kimberley Gillnet and Barramundi fishery is divided into five fishing areas along the north coast. The boundaries of these areas are illustrated in Figure 6.1.

Figure 6.1 Kimberley Gillnet and Barramundi fishery boundaries



Source: Department of Fisheries (2008)

For the purpose of this analysis the Broome Coast and King Sound fishing areas were deemed to be within the West Kimberley region.

6.1 Contribution of the Kimberley Gillnet and Barramundi Fishery to the West Kimberley Economy

Catch and value

Kimberley Gillnet and Barramundi catch and estimated value of catch in West Kimberley region are detailed in Table 6.1 for the period 2003 to 2007.

Table 6.1 Kimberley Gillnet and Barramundi fishery catch, effort and value of catch in the West Kimberley region, 2003 to 2007

Year	Catch (tonnes)			Total	Value \$
	Barramundi	Threadfin Salmon	Other Species		
Broome Coast					
2003	10.6	83.0	2.8	96.4	549,089
2004	16.7	65.6	2.3	84.6	543,679
2005	10.1	64.3	5.6	80.0	484,211
2006	11.1	61.2	3.6	75.9	476,967
2007	6.7	72.6	3.1	82.4	494,551
<i>5-year average^a</i>	<i>11.0</i>	<i>69.3</i>	<i>3.5</i>	<i>83.9</i>	<i>525,931</i>
King Sound					
2003	6.4	2.8	3.6	12.8	72,908
2004	6.1	1.0	2.4	9.5	61,051
2005	5.0	1.1	2.6	8.7	52,658
2006	4.9	2.3	0.0	7.2	45,246
2007	5.2	1.1	0.2	6.5	39,012
<i>5-year average^a</i>	<i>5.5</i>	<i>1.7</i>	<i>1.8</i>	<i>8.9</i>	<i>56,068</i>
Total West Kimberley					
2003	17.0	85.8	6.4	109.2	621,997
2004	22.8	66.6	4.7	94.1	604,731
2005	15.1	65.4	8.2	88.7	536,868
2006	16.0	63.5	3.6	83.1	522,213
2007	11.9	73.7	3.3	88.9	533,563
<i>5-year average^a</i>	<i>16.6</i>	<i>71.0</i>	<i>5.2</i>	<i>92.8</i>	<i>581,999</i>

^a Estimate based on 5-year average catch and average price in the fishery for 2007 adjusted for inflation. Source: Department of Fisheries (2008), ABS (2009) and EconSearch analysis

Regional employment and expenditure...

In order to calculate the economic impacts for the fishery it was necessary to estimate the level of expenditure by licence holders in the regional economy. Insufficient information was available from the industry consultation and additional data was required to calculate the economic impacts.

Estimates of average annual regional expenditure by Kimberley Gillnet and Barramundi fishery licence holders are summarised in Table 6.2.

Based on information from industry sources it is estimated that on average approximately 7 persons are employed in the fishery within the region on a part-time basis (approximately 3 full-time equivalents).

Table 6.2 Estimated average annual expenditure in the West Kimberley region, Kimberley Gillnet and Barramundi fishery.

Expenditure Item	Annual Regional Expenditure (\$)	
	Average per Tonne ^a	Estimated Fishery Total ^b
Fishing Costs		
Fuel	503	46,700
Repairs & Maintenance	482	44,800
Bait/Ice	128	11,900
Provisions	18	1,600
Labour ^c	2,023	187,800
Total Fishing Costs	3,154	292,800
Overhead Costs		
Licence Fee		23,500
Insurance		6,300
Interest		11,400
Labour ^c		16,300
Legal & Accounting		5,700
Telephone etc.		7,500
Slipping & Mooring		2,300
Travel		1,500
Office, Admin & Other		23,500
Total Overheads		98,000
Total		390,800

^a Based on consultation with Kimberley Gillnet and Barramundi fishery licence holders and average fishing costs in the South Australian Marine Scalefish Fishery (Net Sector).

^b Based on 5-year average catch and value in the fishery (Table 6.1).

^c Labour costs are separated into variable (fishing and repairs and maintenance) and fixed (administration and management) costs.

Source: Survey responses, EconSearch (2009c) and EconSearch analysis

Estimated regional economic and population contribution...

Estimates of the economic and population impact generated by the Kimberley Gillnet and Barramundi fishery in the West Kimberley region are summarised in Table 6.3. These estimates were calculated using the input-output model prepared for the West Kimberley region and were based on published information on catch and value of catch in the fishery (see Table 6.1) and information provided by licence holders in the fishery.

Output...

The value of output generated directly in the West Kimberley region by Kimberley Gillnet and Barramundi fishing activity averaged \$0.6 million over the 5 years to 2007 (Table 6.3).

Table 6.3 Average annual contribution of the Kimberley Gillnet and Barramundi fishery to the West Kimberley regional economy ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	0.6	3.0 67%	0.20 71%	0.40 70%	4 67%
Flow-on effects					
Trade		0.5 11%	0.02 8%	0.03 5%	1 11%
Manufacturing		0.1 3%	0.01 3%	0.01 2%	0 3%
Accomm, Rest, Cafes		0.1 3%	0.01 2%	0.01 1%	0 3%
Transport		0.1 1%	0.00 1%	0.01 1%	0 1%
Other Sectors		0.7 15%	0.04 16%	0.11 19%	1 15%
<i>Total Flow-on ^b</i>		1.5 33%	0.08 29%	0.17 30%	2 33%
Total ^b		4.5 100%	0.29 100%	0.56 100%	6 100%

^a Based on 5-year average catch and value of catch (Table 6.1) and estimated average annual regional expenditure (Table 6.2).

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Employment and household income...

The Kimberley Gillnet and Barramundi fishery was responsible for the direct employment of 3.0 full-time equivalents (fte) in the West Kimberley region. Flow-on business activity was estimated to generate a further 1.5 fte jobs in the region.

Personal income of \$0.20 million was earned in the fishing sector (wages of employees and estimated drawings by owner/operators). An additional \$0.08 million was earned by wage earners in other businesses in the region as a result of fishing in the Kimberley Gillnet and Barramundi fishery.

GRP...

GRP is measured as value of output less the cost of goods and services (including imports) used in producing the output. Total Kimberley Gillnet and Barramundi fishery related contribution to GRP in the West Kimberley region was \$0.56 million, \$0.40 million generated by fishing directly and \$0.17 million in other sectors of the regional economy.

Population...

The direct population impact provides an estimate of the population levels associated directly with the business activities of the Kimberley Gillnet and Barramundi fishery in

the West Kimberley region. This was calculated by applying the average family size in the region to the number of persons employed directly in the fishery. The direct population impact of the fishery was estimated to be 4 persons.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. flow-on business activities generated by the Kimberley Gillnet and Barramundi fishery) and related non-market activities (i.e. population driven by services such as education). The flow-on population impact was estimated to be 2 persons.

The aggregate population impact (direct and flow-ons) was estimated to be 6 persons.

6.2 Scenario Two: 20 per cent Decline in Threadfin Salmon Catch in the Broome Coast Fishing Area

Estimates of economic and population impact were calculated to highlight the effects of a decline in Threadfin Salmon catch in the Broome Coast fishing area of 20 per cent (from the 5-year average). This impact scenario was developed based on consultation with licence holders in the fishery and with the Department of Fisheries regarding the potential effects of construction and operation of the LNG facility.

Catch and value...

Estimates of economic impact were calculated based on a 20 per cent decline in catch of Threadfin Salmon in the Broome Coast fishing region. The catch and value of catch used in calculating the economic impacts of Scenario Two are detailed in Table 6.4.

Table 6.4 Kimberley Gillnet and Barramundi fishery catch and value of catch in the West Kimberley region: Scenario Two

	Catch (tonnes)			Total	Value \$
	Barramundi	Threadfin Salmon	Other Species		
5-Year Average					
Broome Coast	11.0	69.3	3.5	83.9	525,931
King Sound	5.5	1.7	1.8	8.9	56,068
Total West Kimberley	16.6	71.0	5.2	92.8	581,999
Scenario 2					
Broome Coast	11.0	55.5	3.5	70.0	438,958
King Sound	5.5	1.7	1.8	8.9	56,068
Total West Kimberley	16.6	57.1	5.2	78.9	495,025
Change (%)					
Broome Coast	0%	-20%	0%	-17%	-17%
King Sound	0%	0%	0%	0%	0%
Total West Kimberley	0%	-20%	0%	-15%	-15%

Source: Table 6.1 and EconSearch analysis

Regional employment and expenditure...

In response to a decline in catch in the region the level of expenditure on fishing costs (e.g. fuel, provisions and labour) is likely to fall. The profitability of fishing businesses operating in the region may fall in response to lower value of production in the fishery. This is likely to result in a decline in the number of boats operating in the fishery, particularly in the long term.

Overall there is likely to be a fall in regional expenditure and employment generated by the fishery activities under Scenario Two.

Estimated regional economic and population impacts...

Estimates of the economic and population impact of a 20 per cent decline in catch of Threadfin Salmon in the West Kimberley region are summarised in Table 6.5 and outlined in the following text.

Table 6.5 Net economic and population impact of Scenario Two, Kimberley Gillnet and Barramundi fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	-0.1	-1.2	-0.03	-0.04	-2
Flow-on effects					
Trade		-0.1	0.00	-0.01	0
Manufacturing		0.0	0.00	0.00	0
Accomm, Rest, Cafes		0.0	0.00	0.00	0
Transport		0.0	0.00	0.00	0
Other Sectors		-0.1	-0.01	-0.02	0
<i>Total Flow-on ^b</i>		-0.3	-0.02	-0.03	0
Total ^b		-1.5	-0.05	-0.08	-2

^a Based on a decline in total production (Table 6.4) and corresponding decline in regional expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Estimates of economic and population impact were calculated using the input-output model prepared for the West Kimberley region and were based on estimates of catch and value of catch in the fishery and estimated expenditure by licence holders.

Output...

In response to a reduction in Threadfin Salmon catch in the Broome Coast area (by 20 per cent) the direct value of output of the fishery in the region would decrease by \$0.1 million, a decline of 15 per cent relative to the 5-year average annual value of output.

Employment and Household Income...

In response to a reduction in production in the fishery, direct employment is expected to fall by 1.2 fte jobs, a decline of 40 per cent relative to the average levels of employment.

Flow-on employment is expected to fall by 0.3 fte jobs, a decline of 19 per cent relative to average levels. In aggregate, direct and flow-on employment was estimated to fall by 1.5 fte jobs, a decline of 33 per cent.

Associated with the net loss in direct employment, direct household income generated in the region by fishery activities is expected to fall by \$0.03 million. Household income flow-ons are also expected to decline by approximately \$0.02 million. Total net household income impact (-\$0.05 million) represents a 17 per cent decline from average levels.

Gross Regional Product...

In response to a decline in catch in the fishery, contribution to GRP by the fishing sector is expected to decrease by approximately \$0.04 million, a fall of approximately 11 per cent compared to its average value.

Flow-on GRP is estimated to decline by approximately \$0.03 million in response to a decrease in Threadfin Salmon catch. In aggregate, direct and flow-on GRP is expected to decline by \$0.08 million.

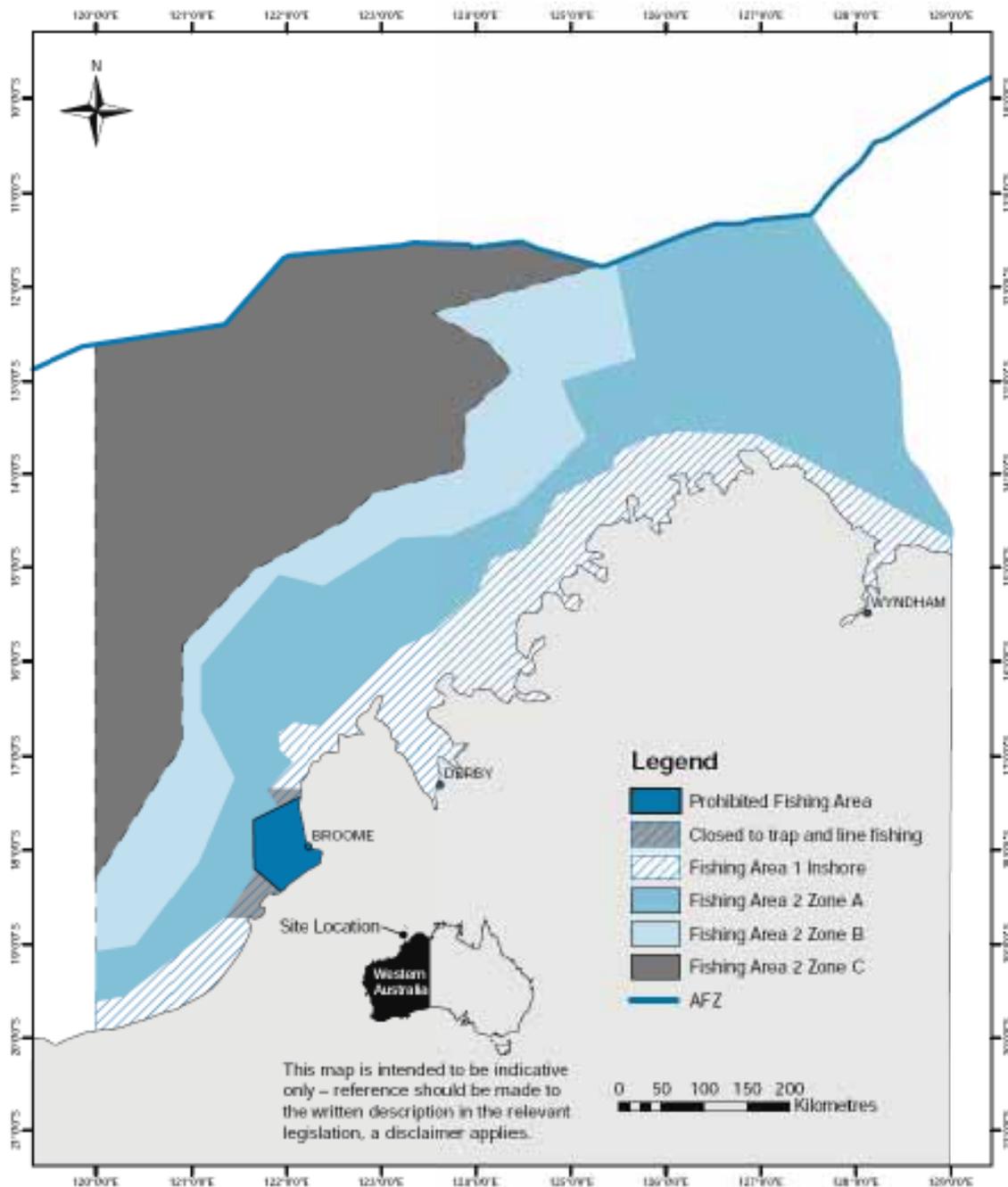
Population...

The direct population impact (loss) of a 20 per cent decrease in Threadfin Salmon catch was estimated to be 2 persons. This estimate is based on the assumption that 20 per cent of employees who would remain in the region after they lose their jobs and the remainder would leave the West Kimberley region.

7. Northern Demersal Scalefish Fishery

The Northern Demersal Scalefish fishery is divided into three fishing zones located off the north-west coast of Western Australia. The boundaries of the fishery and the individual zones are illustrated in Figure 7.1.

Figure 7.1 Northern Demersal Scalefish fishery boundaries



Source: Department of Fisheries (2008)

In 2007, seven vessels fished in the Northern Demersal Scalefish fishery. Industry consultation indicated that five of these vessels unload and operate out of Broome.

7.1 Contribution of the Northern Demersal Scalefish Fishery to the West Kimberley Economy

Catch, effort and value...

Estimates of catch, effort and value of catch in the West Kimberley region are detailed in Table 7.1 for 2007/08.

Table 7.1 Northern Demersal Scalefish fishery catch, effort and value of catch in the West Kimberley region, 2007/08 ^a

Year	Catch (tonnes)	Effort (days)	Value (\$m)
2007/08	649	661	5.3

^a Based on the assumption that five of the seven boats in the fishery operate and unload out of Broome. Source: Department of Fisheries (2008), Survey responses and EconSearch analysis

Completed survey responses were received from four of the five boats that operate in the West Kimberley region. Estimates of total regional catch, effort and value of the fishery for 2007/08 were derived from these responses. Total catch landed in the region was estimated to be almost 650 tonnes in 2007/08. The total value of this catch was estimated to be approximately \$5.3 million (Table 7.1).

Regional expenditure...

Estimates of regional expenditure by Northern Demersal Scalefish fishery licence holders in 2007/08 are summarised in Table 7.2. These estimates of average and total expenditure in the West Kimberley are based on completed survey responses.

Employment per vessel ranged from 6 to 8 full-time and part-time employees. Average employment is estimated to be approximately 5 full-time equivalents (ftes) per boat.

Table 7.2 Northern Demersal Scalefish fishery expenditure in the West Kimberley region, 2007/08 ^a

Expenditure Item	Regional Expenditure in 2007/08 (\$)		
	Average per Tonne	Average per Boat	Estimated Fishery Total ^a
Fishing Costs			
Fuel	1,284	179,700	832,700
Repairs & Maintenance	730	102,200	473,400
Bait/Ice	212	29,700	137,500
Provisions	146	20,500	95,000
Labour ^b	2,813	404,400	1,873,500
Other	76	68,800	318,900
Total Fishing Costs	5,185	805,400	3,730,900
Overhead Costs			
Licence Fee		22,800	114,000
Insurance		29,000	144,800
Interest		59,000	295,100
Labour ^b		7,600	38,200
Legal & Accounting		24,000	119,900
Telephone etc.		6,700	33,400
Slipping & Mooring		22,100	110,400
Travel		19,600	98,200
Admin & Other		70,300	351,700
Total Overheads		261,200	1,305,800
Total		1,066,600	5,036,700

^a Based on 5 boats in the region.

^b Labour costs are separated into variable (fishing and repairs and maintenance) and fixed (administration and management) costs.

Source: Survey responses and EconSearch analysis

Estimated regional economic and population contribution...

The estimated annual economic and population impact of the Northern Demersal Scalefish fishery on the West Kimberley region is summarised in Table 7.3.

Output...

The total value of output generated directly in the West Kimberley region by Northern Demersal Scalefish fishery enterprises summed to \$5.3 million in 2007/08. Flow-on (indirect) and total output impacts are not reported as there are problems with double counting which can give a misleading impression of the significance of the fishery to the region.

Table 7.3 Average annual contribution of the Northern Demersal Scalefish fishery to the West Kimberley regional economy ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m) %	(\$m)	(no)
<i>Total direct effects</i>	5.3	24 56%	1.9 64%	2.2 53%	35 56%
Flow-on effects					
Trade		8 18%	0.4 12%	0.5 11%	11 18%
Manufacturing		2 4%	0.1 3%	0.1 3%	2 4%
Accomm, Rest, Cafes		2 4%	0.1 2%	0.1 3%	2 4%
Transport		1 1%	0.0 1%	0.1 2%	1 1%
Business Services		2 5%	0.2 5%	0.6 15%	3 5%
Other Sectors		6 13%	0.3 12%	0.6 13%	8 13%
<i>Total Flow-on ^b</i>		19 44%	1.1 36%	2.0 47%	28 44%
Total ^b		43 100%	3.0 100%	4.2 100%	63 100%

^a Based on estimated catch, value of catch, regional expenditure and employment for 2007/08. .

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Employment and Household Income...

The Northern Demersal Scalefish fishery was responsible for direct employment of 24 full-time equivalents in the West Kimberley region. Flow-on activity was estimated to generate a further 19 fte job in the region. These regional jobs were concentrated in the trade (8), manufacturing (2), accommodation, restaurants and cafes (2), and business services (2) sectors (Table 7.3).

Personal income of approximately \$1.9 million was earned in the fishing sector (wages of employees and estimated drawings by owner/operators) in the West Kimberley region. An additional \$1.1 million was earned by wage earners in other businesses in the region as a result of fishing activities. The total household income impact was \$3.0 million (Table 7.3).

Gross Regional Product...

In 2007/08, total Northern Demersal Scalefish fishing industry related GRP in the West Kimberley region was estimated to be approximately \$4.2 million, \$2.2 million in fishing directly and \$2.0 million generated in other sectors of the regional economy.

Population...

The direct population impact provides an estimate of the population levels associated directly with the business activities of the Northern Demersal Scalefish fishery in the West Kimberley region. This was estimated to be 35 persons.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. flow-on business activities generated by the Northern Demersal Scalefish fishery) and related non-market activities (i.e. population driven

services such as education). The flow on population impact was estimated to be 28 persons.

The aggregated population impact (direct and flow-ons) was estimated to be 63 persons (Table 7.3).

7.2 Scenario Three: Decline in Fishery Activity in the Region

Licence holders indicated that there are already existing issues with accessibility of the port facilities. An increase in activity at the port, associated with the LNG facility, is likely to exacerbate existing issues.

Fishery licence holders indicated that the construction and operation of the facility is unlikely to have a significant impact catch and catchability of key species. The LNG facility is, however, expected to result in a decline in the use of the port for landing fish and other fishery activities (e.g. refuelling).

Estimates of economic impact were calculated to highlight the effect of a decline in the Northern Demersal Scalefish fishery activity in the West Kimberley region of 10 per cent.

Catch and value...

Estimates of catch and value of catch unloaded in the West Kimberley region are summarised in Table 7.4.

Table 7.4 Northern Demersal Scalefish fishery catch and value of catch in the West Kimberley region: Scenario Three ^a

	Catch (tonnes)	Value (\$m)
2007/08	649	5.3
Scenario 5	584	4.8
Change (%)	-10%	-10%

^a Note the total production and value refers to catch by boats based within or landing their catch within the region. Total catch in the fishery is assumed to remain unchanged and is likely to be landed elsewhere (e.g. Darwin).

Source: Survey responses and EconSearch analysis

Regional expenditure and employment...

As a result of a decrease in the level of fishery activity in the region there is likely to be a corresponding decline in regional expenditure on fishing inputs (e.g. fuel and repairs and maintenance). The level of employment in the regional is also expected to fall in response to a decline in fishing activity in the region.

Estimated regional economic and population impacts...

The estimated net economic and population impact of a decline in fishery activity in the region is summarised in Table 7.5.

Table 7.5 Net economic and population impact of Scenario Three, Northern Demersal Scalefish fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	-0.5	-4	-0.2	-0.3	-6
Flow-on effects					
Trade		0	0.0	0.0	0
Manufacturing		0	0.0	0.0	0
Accomm, Rest, Cafes		0	0.0	0.0	0
Transport		0	0.0	0.0	0
Business Services		0	0.0	0.0	0
Other Sectors		0	0.0	0.0	0
<i>Total Flow-on ^b</i>		-1	0.0	-0.1	-1
Total ^b		-5	-0.2	-0.4	-7

^a Based on a decline in the level of fishery activity in the region and corresponding decline in regional expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Output...

In response to a reduction in Northern Demersal Scalefish fishery activity in the region the direct value of output is expected to decrease by approximately \$0.5 million, a decline of 10 per cent relative to the current (2007/08) value.

Employment and Household Income...

In response to a reduction in fishery in the region, direct employment in the sector is expected to fall by 4 fte jobs, a decline of 17 per cent compared to current levels.

Flow-on employment is expected to fall by 1 fte job, a decline of 4 per cent relative to current levels. In aggregate, direct and flow-on employment is expected to fall by 5 jobs, an 11 per cent decline relative to current levels.

Associated with the net loss in direct employment, direct household income generated by the fishery is expected to fall by \$0.2 million, a decline of 10 per cent relative to its current value.

In aggregate, direct and flow-on household income is expected to decline by \$0.2 million, a fall of 8 per cent.

Gross Regional Product...

In response to a reduction in the number of Northern Demersal Scalefish fishery boats in the region, contribution to GRP by the fishing industry is expected to decrease by approximately \$0.3 million, a decline of around 16 per cent relative to the current value.

Flow-on GRP is expected to decline by approximately \$0.1 million, a decrease of 4 per cent relative to the current flow-ons generated by the fishery. In aggregate, direct and flow-on GRP is expected to decline by \$0.4 million, a fall of 10 per cent.

Population...

The direct population impact (loss) of the decrease in number of boats in the region was estimated to be 6 persons. This estimate is based on the assumption that 20 per cent of employees who would remain in the region after they lose their jobs and the remainder would leave the region.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. decreased flow-on business activity generated by a decline in fishing activity) and related non-market activities (i.e. population driven services such as education). The flow-on population impact was estimated to be a loss of 1 person from the region.

8. Mackerel Fishery

The Mackerel fishery is divided into three fishing zones namely the Kimberley (Area 1), Pilbara (Area 2) and Gascoyne and West Coast (Area 3). For the purpose of this analysis, the Kimberley fishing zone (Area 1) of the Mackerel fishery was deemed to be within the study area.

8.1 Contribution of the Mackerel Fishery to the West Kimberley Economy

Catch and value...

Catch and estimated value of catch are detailed in Table 8.1 for the period 2003 to 2007.

Table 8.1 Mackerel fishery catch, effort and value of catch in the West Kimberley region, 2003 to 2007

Year	Catch (tonnes)			Value (\$m)
	Spanish	Grey & Other	Total	
2003	267.0	16.2	283.2	1.51
2004	249.9	18.9	268.8	1.48
2005	173.4	19.8	193.2	1.59
2006	177.9	12.2	190.1	1.73
2007	216.6	8.0	224.6	2.45
<i>5-year average^a</i>	<i>217.0</i>	<i>15.0</i>	<i>232.0</i>	<i>2.64</i>

^a Estimate based on 5-year average catch and 2007 average price in the fishery adjusted for inflation.

Source: Department of Fisheries (2008), ABS (2009) and EconSearch analysis

Industry consultation indicated that four boats operated in the Mackerel fishery in the West Kimberley region in 2007/08.

Regional expenditure and employment...

Estimates of regional expenditure by Mackerel fishery licence holders in 2007/08 is summarised in Table 8.2. These estimates of average and total expenditure in the West Kimberley are based on completed survey responses from two of the four Mackerel fishery licence holders in the region.

Average employment per vessel is estimated to be four full-time employees. Based on four boats operating in the region, total employment in the fishery in the West Kimberley region is estimated to be 16 full-time equivalents.

Table 8.2 Estimated average annual expenditure in the West Kimberley region, Mackerel fishery ^a

Expenditure Item	Annual Regional Expenditure (\$)	
	Average per Tonne	Estimated Fishery Total ^b
Fishing Costs		
Fuel	1,500	352,100
Repairs & Maintenance	1,600	365,400
Bait/Ice	200	39,800
Provisions	300	60,500
Labour ^c	5,200	1,046,300
Other	300	73,700
Total Fishing Costs	9,100	1,864,100
Overhead Costs		
Licence Fee		42,000
Insurance		55,500
Interest		63,200
Labour ^c		30,700
Legal & Accounting		9,600
Telephone etc.		16,100
Slipping & Mooring		21,600
Travel		0
Office, Admin & Other		36,000
Total Overheads		274,700
Total		2,138,800

^a Based on consultation with Mackerel fishery licence holders in the West Kimberley region.

^c Based on 5-year average catch and value in the fishery.

^b Labour costs are separated into variable (fishing and repairs and maintenance) and fixed (administration and management) costs.

Source Survey responses, Department of Fisheries (2008) and EconSearch analysis

Estimated regional economic and population contribution...

The estimated economic and population impact of the Mackerel fishery on the West Kimberley region is summarised in Table 8.3.

Output...

The total value of output generated directly in the West Kimberley region by Mackerel fishery enterprises summed to \$2.6 million. Flow-on (indirect) and total output impacts are not reported as there are problems with double counting which can give a misleading impression of the significance of the fishery to the region.

Table 8.3 Average annual contribution of the Mackerel fishery to the West Kimberley regional economy ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	2.6	16 65%	1.1 70%	1.5 62%	23 65%
Flow-on effects					
Trade		3 14%	0.2 10%	0.2 9%	5 14%
Manufacturing		1 4%	0.1 4%	0.1 4%	2 4%
Accomm, Rest, Cafes		1 3%	0.0 2%	0.1 2%	1 3%
Transport		0 1%	0.0 1%	0.0 1%	0 1%
Business Services		1 2%	0.0 3%	0.3 12%	1 2%
Other Sectors		2 10%	0.2 10%	0.2 10%	4 10%
<i>Total Flow-on ^b</i>		9 35%	0.5 30%	0.9 38%	13 35%
Total ^b		25 100%	1.5 100%	2.4 100%	36 100%

^a Based on 5-year average catch and value of catch (Table 8.1) and estimated average annual expenditure (Table 8.2).

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Employment and Household Income...

The Mackerel fishery was responsible for direct employment of 16 full-time equivalents in the West Kimberley region. Flow-on activity was estimated to generate a further 9 fte job in the region. These regional jobs were concentrated in the trade (3), manufacturing (1), accommodation, restaurants and cafes (1), business services (1) sectors (Table 9.3).

Personal income of approximately \$1.1 million was earned in the fishing sector (wages of employees and estimated drawings by owner/operators) in the West Kimberley region. An additional \$0.5 million was earned by wage earners in other businesses in the region as a result of fishing activities. The total household income impact was \$1.5 million in the West Kimberley region (Table 8.3).

Gross Regional Product...

Total Mackerel fishing industry related GRP in the West Kimberley region was estimated to be approximately \$2.4 million, \$1.5million in fishing directly and \$0.9 million generated in other sectors of the regional economy.

Population...

The direct population impact provides an estimate of the population levels associated directly with the business activities of the Mackerel fishery in the West Kimberley region. The direct population impact of the Mackerel fishery in the West Kimberley region was estimated to be 23 persons.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. flow-on business activities generated by the Mackerel

fishery) and related non-market activities (i.e. population driven services such as education). The flow on population impact was estimated to be 13 persons.

The aggregated population impact (direct and flow-ons) was estimated to be 36 persons (Table 8.3).

8.2 Scenario Four: 20 per cent Decline in Mackerel Fishery Catch

Licence holders and operators in the Mackerel fishery indicated that approximately 60 per cent of their catch is caught in fishing grounds near the Lacepede Islands. Proximity of the proposed LNG development to the Lacepede Island fishing grounds could significantly reduce catch from this area. Consultation with industry indicated that catch of Mackerel in the Lacepede Island fishing grounds could be reduced to zero.

Estimates of economic impact were calculated to highlight the effect of a decline in average Mackerel catch of 20 per cent and associated with this a fall in the number of Mackerel fishery boats operating in the West Kimberley region. For the purpose of this analysis it was assumed that the number of boats would fall from the current level (four boats) to three boats.

Catch and value...

Estimates of catch, effort and value of catch were based on the assumption that catch declines by 20 per cent from the 5-year average and only three of the four boats continue to fish in the West Kimberley region. These estimates are summarised in Table 8.4.

Table 8.4 Mackerel fishery catch and value of catch in the West Kimberley region: Scenario Four

Year	Catch (tonnes)			Value (\$m)
	Spanish	Grey & Other	Total	
5-Year Average	217.0	15.0	232.0	2.64
Scenario 4	173.6	12.0	185.6	2.11
Change	-20%	-20%	-20%	-20%

Source: Department of Fisheries (2008) and EconSearch analysis

Regional expenditure and employment...

As a result of a decrease in catch and number of boats operating in the region there is likely to be a corresponding decline in regional expenditure. Fishing costs (e.g. fuel and gear) are assumed to decline in response to a decline in catch in the fishery. Local expenditure on overhead (fixed) costs is also assumed to fall in response to a decrease in the number of boats/businesses operating in the local fishery.

Associated with a decline in fishing activity under Scenario Four is likely to be a fall in the level of employment associated with fishing and other related activities (e.g. repairs and maintenance and management).

Estimated regional economic and population impacts...

The estimated net economic and population impact of a 20 per cent decline in catch and a corresponding fall in the number of boats in the region (from four to three) are summarised in Table 8.5 and outlined in the following text.

Table 8.5 Net economic and population impact of Scenario Four, Mackerel fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	-0.5	-4	-0.1	-0.3	-6
Flow-on effects					
Trade		0	0.0	0.0	-1
Manufacturing		0	0.0	0.0	0
Accomm, Rest, Cafes		0	0.0	0.0	0
Transport		0	0.0	0.0	0
Business Services		0	0.0	0.0	0
Other Sectors		0	0.0	0.0	0
<i>Total Flow-on ^b</i>		-1	-0.1	-0.1	-2
Total ^b		-5	-0.1	-0.4	-7

^a Based on a decline in catch and value of 20 per cent (from 5-year average) and corresponding decline in fishing related expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Output...

In response to a reduction in catch in the fishery the direct value of output is expected to decrease by approximately \$0.5 million, a decline of 20 per cent relative to the 5-year average.

Employment and Household Income...

In response to a reduction in catch and the number of boats operating in the region, direct employment in the sector is expected to fall by 4 fte jobs, a decline of 25 per cent compared to the average.

Flow-on employment is expected to fall by 1 fte job, a decline of 13 per cent relative to current levels. In aggregate, direct and flow-on employment is expected to fall by 5 jobs, a 21 per cent decline relative to current levels.

Associated with the net loss in direct employment, direct household income generated by the fishery is expected to fall by \$0.1 million, a decline of 5 per cent relative to the average.

Household income flow-ons generated by the decline in the number of boats in the region are expected to be approximately -\$0.1 million, a fall of 13 per cent relative to

average flow-ons. In aggregate, direct and flow-on household income is expected to decline by \$0.1 million, a decrease of 7 per cent.

Gross Regional Product...

In response to a reduction in catch and in the number of Mackerel fishery boats in the region, contribution to GRP by the fishing industry is expected to decrease by approximately \$0.3 million, a decline of around 19 per cent relative to the average value.

Flow-on GRP is expected to decline by approximately \$0.1 million, a decrease of 12 per cent relative to the current flow-ons generated by the fishery. In aggregate, direct and flow-on GRP is expected to decline by \$0.4 million, a fall of 16 per cent.

Population...

The direct population impact (loss) of the decrease in number of boats in the region was estimated to be 6 persons. This estimate is based on the assumption that 20 per cent of employees who would remain in the region after they lose their jobs and the remainder would leave the region.

The flow-on population impact provides an estimate of population levels associated with market-driven activities (i.e. decreased flow-on business activity generated by a decline in fishing activity) and related non-market activities (i.e. population driven services such as education). The flow-on population impact was estimated to be a loss of 2 persons from the region.

9. Charter Boat Fishery

9.1 Contribution of the Charter Boat Fishery to the West Kimberley Economy

Number of visitors and charter income...

Estimated number of visitors and visitor expenditure on charter fishing activities for 2007/08 are detailed in Table 9.1.

Table 9.1 Charter fishery visitor numbers and charter income in the West Kimberley region, 2007/08

	Number of Operators (no)	Visitors per Operator (no)	Expenditure per Visitor (\$)	Total Number of Visitors (no)	Total Charter Income (\$m)
2007/08	10	1,342	329	13,420	4.4

Source: Survey responses

Consultation was undertaken with the charter boat sector and 5 completed survey responses were received. It is estimated that these responses account for approximately 50 per cent of total charter fishing industry in the West Kimberley region.

Regional expenditure and employment...

Estimates of annual regional expenditure by charter boat operators in the West Kimberley region are summarised in Table 9.2. These estimates are based on completed survey responses received from operators within the region.

Employment per operator ranged from 1 to 9 full-time and part-time employees (1 to 6 full-time equivalents). Average employment is estimated to be approximately 3 full-time equivalents per operator.

Table 9.2 Estimated average annual expenditure in the West Kimberley region, Charter Boat fishery

Expenditure Item	Estimated Regional Expenditure (\$)	
	Average per Visitor	Estimated Total
Variable Costs		
Fuel	57	768,000
Repairs & Maintenance	29	387,400
Bait/Ice	3	37,000
Provisions	13	171,200
Labour	144	1,925,900
Other	5	67,600
Total Variable Costs ^b	250	3,357,100
Fixed Costs		
Licence Fee		81,700
Insurance		75,700
Interest		48,400
Labour		282,500
Legal & Accounting		40,700
Telephone etc.		122,200
Slipping & Mooring		201,000
Travel		0
Office & Admin		199,100
Total Fixed Costs ^b		1,051,200
Total ^b		4,408,300

^a Based on consultation with industry and estimated number of visitors detailed in Table 9.1.

^b Totals may not sum due to rounding.

Source: Survey responses and EconSearch analysis.

Estimates of economic and population contribution...

The estimated economic and population impact of the Charter Boat fishery on the West Kimberley region is summarised in Table 9.3.

Table 9.3 Average annual contribution of the Charter Boat fishery to the West Kimberley regional economy

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
<i>Total direct effects</i>	4.4	31 65%	2.2 70%	2.2 55%	45 64%
Flow-on effects					
Trade		7 14%	0.3 10%	0.4 10%	10 14%
Manufacturing		1 3%	0.1 3%	0.1 3%	2 3%
Accomm, Rest, Cafes		2 4%	0.1 2%	0.1 3%	3 4%
Transport		1 1%	0.0 1%	0.1 1%	1 1%
Other Sectors		7 14%	0.4 14%	1.1 28%	10 14%
<i>Total Flow-on</i>		17 35%	0.9 30%	1.8 45%	25 36%
Total		48 100%	3.1 100%	4.0 100%	70 100%

^a Based on estimated number of visitors for 2007/08 and estimated charter income (Table 9.1).

^b Totals may not sum due to rounding.

Source: EconSearch analysis

9.2 Scenario Five: Economic and Population Impact of a 10 per cent Increase in Charters

Estimates of economic and population impact were calculated to highlight the effects of a 10 per cent increase in fishing charters compared to the current (2007/08) level. This scenario was developed through consultation with industry representatives about the likely impact of the LNG facility construction phase.

Charter operators in the West Kimberley region indicated that there could potentially be an increase in demand for charters during the construction phase. This was based on the assumption that workers from outside the region would be brought in during the construction phase and these workers would generate a temporary increase in demand for charter boat services.

Number of visitors and charter income...

Estimated number of charters and charter income under Scenario Five is illustrated in Table 9.4.

Based on the estimated charter activity for 2007/08 (Table 9.1), a 10 per cent increase in charters would result in an increase in the total number of charter visitors and total charter income. It should be noted that this potential increase in charter activity and income is estimated to occur during the construction phase of the LNG project only.

Table 9.4 Charter fishery visitor numbers and charter income in the West Kimberley region: Scenario Five

	Number of Operators	Visitors per Operator	Expenditure per Visitor ^a	Total Number of Visitors	Total Charter Income
	(no)	(no)	(\$)	(no)	(\$m)
2007/08	10	1,342	329	13,420	4.4
Scenario 5	10	1,476	329	14,762	4.9
Change (%)	0%	10%	0%	10%	10%

Source: Survey responses and EconSearch analysis.

Regional expenditure and employment...

Under Scenario Five there is likely to be an increase in regional expenditure and employment as a result of the increase in charter activities.

Estimates of economic and population impact...

The estimated net economic and population impact of a 10 per cent increase in charter activities in the West Kimberley region is summarised in Table 9.5 and outlined in the following text.

Table 9.5 Net economic and population impact of Scenario Five, Charter Boat fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
Total direct effects	0.4	2	0.2	0.3	2
Flow-on effects					
Trade		1	0.0	0.0	1
Manufacturing		0	0.0	0.0	0
Accomm, Rest, Cafes		0	0.0	0.0	0
Transport		0	0.0	0.0	0
Other Sectors		0	0.0	0.1	1
<i>Total Flow-on</i>		1	0.1	0.1	2
Total		3	0.3	0.4	4

^a Based on an increase in charter numbers and income of 10 per cent (from the 2007/08 estimate) and corresponding increase in expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis.

As mentioned previously, Scenario Five relates to the construction phase on the LNG project only. The potential ongoing impact (i.e. after construction is completed) of the LNG facility on the charter industry is discussed under Scenario Six.

Output...

In response to an increase in Charter Boat fishery activity in the region the direct value of output is expected to increase by \$0.4 million, an increase of 10 per cent compared to the estimated value for 2007/08.

Employment and Household Income...

In response to a 10 per cent increase in Charter Boat fishery activity, direct employment in the sector is expected to rise by 2 fte jobs. Flow-on employment is also expected to rise by 1 fte job. The total employment impact (3 fte jobs) represents a 6 per cent increase relative to current levels.

Associated with the net gain in employment, direct and flow-on household income generated is expected to rise by approximately 8 per cent.

Gross Regional Product...

In response to an increase in Charter Boat fishery activity, total contribution to GRP by the fishing industry is expected to rise by \$0.3 million.

Population...

The direct population impact (gain) of a 10 per cent increase in fishery activity was estimated to be 2 persons. This estimated was based on the assumption that 20 per cent of new jobs in the sector would be filled by previously unemployed locals.

The total population impact (direct and flow-on) was estimated to be a gain of 4 persons to the region.

9.3 Scenario Six: Economic and Population Impact of a 10 per cent Decline in Charters

Estimates of economic and population impact were calculated to highlight the effects of a 10 per cent decline in Charter Boat fishery activity. This scenario was developed based on consultation with industry representatives about the likely ongoing impact of the proposed LNG facility.

Charter boat operators indicated that the operation of the LNG facility has the potential to impact of stocks and catchability of Sailfish species. They also expected that there would be some loss to the visual amenity in the region especially in the immediate proximity of the LNG facility. Based on these two factors, charter boat operator expected a decline in their levels of activity.

Number of visitors and charter income...

Estimated number of charters and charter income under Scenario Six is detailed in Table 9.6.

Based on the estimated charter income for 2007/08 reported in Table 9.1, a 10 per cent decline in charter visitors would reduce charter income to \$4.0 million. For the purpose of this analysis it was assumed that there would be a reduction in the number of charter operators in the region (from 10 to 9) in response to the reduction in charter visitors (Table 9.6).

Table 9.6 Charter fishery visitor numbers and charter income in the West Kimberley region, Scenario Six

	Number of Operators	Visitors per Operator	Expenditure per Visitor ^a	Total Number of Visitors	Total Charter Income
	(no)	(no)	(\$)	(no)	(\$m)
2007/08	10	1,342	329	13,420	4.4
Scenario 6	9	1,342	329	12,078	4.0
Change (%)	-10%	0%	0%	-10%	-10%

Source: Survey responses and EconSearch analysis

A decline in charter fishing activity has the potential to affect the overall number of visitors to the West Kimberley region. A significant proportion of those who participate in fishing charters are visitors from outside the region. Some of these visitors may continue to visit the region to undertake alternative activities while others may choose to reduce the duration of their stay or not visit the region at all.

For the purpose of this analysis it is assumed that there is a reduction in the number of visitors to the West Kimberley region equivalent to one visitor night per lost charter visitor (approximately 1,300 nights).

Regional expenditure and employment

Under Scenario Six there is likely to be a decline in regional expenditure in response to a reduction in visitor numbers and the fall in the number of operators. Associated with the decline in activity there is also expected to be a fall in owner-operator and employed labour.

Associated with the expected decline in visitor nights in the region there is expected to be a decline in visitor expenditure (e.g. accommodation, meals, travel, etc.).

Estimated regional economic and population impacts...

The estimated net economic and population impact of a 10 per cent decline in charter boat visitors is summarised in Table 9.7.

Output...

In response to a decrease in Charter Boat fishery activity in the region the direct value of output is expected to decrease by \$0.4 million, a decrease of 10 per cent compared to the estimated value for 2007/08. Associated with a fall in charter visitors is an estimated decline in tourism related output of \$0.1 million. The combined direct output impact is a decline of \$0.6 million.

Employment and Household Income...

In response to a 10 per cent decrease in Charter Boat fishery activity, direct employment in the sector is expected to fall by 3 fte jobs. Associated with the fall in charter visitors to the region is a decline in tourism related employment of 1 fte jobs.

Flow-on employment is expected to fall by 2 fte jobs. The total employment impact (direct plus flow-ons) is estimated to be 6 fte jobs lost in the West Kimberley region.

Associated with the net loss in employment, direct and flow-on household income generated is expected to fall by approximately \$0.4 million.

Table 9.7 Net economic and population impact of Scenario Six, Charter Boat fishery, West Kimberley region ^a

Sector	Output	Employment	Household Income	GRP	Population
	(\$m)	(fte jobs)	(\$m)	(\$m)	(no)
Direct effects					
Charter Operations	-0.4	-3 53%	-0.2 60%	-0.2 45%	-5 53%
Tourism Related	-0.1	-1 12%	0.0 9%	-0.1 11%	-1 12%
<i>Total Direct ^b</i>	<i>-0.6</i>	<i>-4 65%</i>	<i>-0.3 69%</i>	<i>-0.3 55%</i>	<i>-6 65%</i>
Flow-on effects					
Trade		-1 13%	0.0 10%	0.0 10%	-1 13%
Manufacturing		0 3%	0.0 3%	0.0 3%	0 3%
Accomm, Rest, Cafes		0 4%	0.0 2%	0.0 3%	0 4%
Transport		0 1%	0.0 1%	0.0 2%	0 1%
Business Services		0 2%	0.0 3%	0.0 3%	0 2%
Other Sectors		-1 12%	0.0 12%	-0.1 25%	-1 12%
<i>Total Flow-on ^b</i>		<i>-2 35%</i>	<i>-0.1 31%</i>	<i>-0.2 45%</i>	<i>-3 35%</i>
Total ^b		-6 100%	-0.4 100%	-0.5 100%	-9 100%

^a Based on a decrease in charter visitors and income of 10 per cent (from the 2007/08 estimate) and corresponding decrease in expenditure and employment.

^b Totals may not sum due to rounding.

Source: EconSearch analysis

Gross Regional Product...

In response to a decrease in Charter Boat fishery activity, total contribution to GRP by the fishery activity is expected to fall by \$0.5 million.

Population...

The direct population impact (loss) of a 10 per cent decrease in fishery activity was estimated to be 5 persons. The associated decline in visitors to the region was estimated to result in a population decline of 1 person. These estimates were based on the assumption that 20 per cent of employees would remain in the region after they lose their jobs and the remainder would leave the region.

The total population impact (direct and flow-on) was estimated to be a loss of 9 persons to the region.

10. Recreational Fishing

10.1 Value of Western Australia's Recreational Fisheries

Data collected by the Fisheries Department of WA on catch and effort of recreational fishers has shown a rapid increase in demand for recreational fishing and the associated pressure on fish stock for target species. A recent estimate of the value of recreational fishing in WA was prepared based on data from the National Survey of Recreational Fishing (2000/01). The survey was based on logbooks completed by recreational fishing households. In WA a total of 48 recreational fishing sites were identified, Broome and West Kimberley were identified amongst the most frequently visited sites (Zhang et al. 2003).

Estimates of the value of access to recreational fishing sites were made based on the recreational fishers utility derived from fishing activity. Travel cost, based on distance travelled to recreational fishing sites, were also considered in the valuation of recreational fishing. At the time of publication of the study (2003) the annual access value for the Broome fishing site was estimated to be \$2.47 million (Zhang et al. 2003).

10.2 Construction Phase Impact of the LNG Facility on Recreational Fishing

Survey participants were asked whether they thought their fishing effort would be reduced during the construction phase of the proposed LNG project. Thirty five per cent of respondents indicated that they thought their fishing effort would be reduced during construction, approximately 40 per cent of respondents thought their fishing effort would be reduced and the remaining 25 per cent were unsure of the impact on their fishing effort.

10.3 Ongoing Impact of the LNG Facility on Recreational Fishing

Survey participants were asked whether they thought the operation of the proposed LNG would reduce their fishing effort in the long term. The majority of respondents (53 per cent) thought that their fishing effort would not be affected by the operation of the LNG facility. Approximately 35 per cent of respondents thought that their fishing effort would be reduced in the long term as a result of the operation of the LNG facility. The remainder of respondents (12 per cent) were unsure of the ongoing impact on their fishing effort.

Just over half of respondents indicated that they thought there would be benefits associated with the development of the LNG facility. Benefits listed include:

- development within the town;
- improved boat launching facilities (Broome and James Price Point);
- better road to launching site (James Price Point);
- increased income for local businesses;
- increased employment in local businesses; and
- creation of an artificial reef.

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Appendix 1 Sector Definitions for the West Kimberley Input-Output Model

West Kimberley, 2007/08 (66 sectors)	National Input-Output Table, 2004/05 (109 sectors)
1 Sheep	1 0101 Sheep
2 Grains	2 0102 Grains
3 Beef cattle	3 0103 Beef cattle
4 Dairy cattle	4 0104 Dairy cattle
5 Pigs	5 0105 Pigs
6 Poultry (meat)	6 0106 (part) Poultry
7 Poultry (eggs)	0106 (part) Poultry
8 Winegrapes	7 0107 (part) Other agriculture
9 Vegetables	0107 (part) Other agriculture
10 Fruit and nuts	0107 (part) Other agriculture
11 Other agriculture	0107 (part) Other agriculture
12 Services to agriculture	8 0200 Services to agric., hunting & trapping
13 Forestry	9 0300 Forestry and logging
14 Commercial fishing	10 0400 (part) Commercial fishing
15 Aquaculture	0400 (part) Commercial fishing
16 Coal, oil and gas	11 1101 Coal
	12 1201 Oil and gas
17 Iron ores	13 1301 Iron ores
18 Non-ferrous metal ores	14 1302 Non-ferrous metal ores
19 Other mining	15 1400 Other mining
20 Services to mining	16 1500 Services to mining
21 Food products	17 2101 Meat & meat products
	18 2102 Dairy products
	19 2103 Fruit and vegetable products
	20 2104 Oils and fats
	21 2105 Flour mill products & cereal foods
	22 2106 Bakery products
	23 2107 Confectionery
	24 2108 Other food products

West Kimberley, 2007/08 (66 sectors)	National Input-Output Table, 2004/05 (109 sectors)
22 Wine	25 2113 Wine, spirits and tobacco products
23 Other beverages	26 2109 Soft drinks, cordials and syrups
	27 2110 Beer and malt
24 Textiles, clothing and footwear	28 2201 Textile fibres, yarns etc.
	29 2202 Textile products
	30 2203 Knitting mill products
	31 2204 Clothing
	32 2205 Footwear
	33 2206 Leather & leather products
25 Sawmill and other wood products	34 2301 Sawmill products
	35 2302 Other wood products
26 Pulp, paper and paper products	36 2303 Pulp, paper & paperboard
	37 2304 Paper containers and products
27 Printing & services to printing	38 2401 Printing & services to printing
28 Publishing, recorded media, etc.	39 2402 Publishing; recorded media etc
29 Petrochemical and other chemical products	40 2501 Petroleum & coal products
	41 2502 Basic chemicals
	42 2503 Paints
	43 2504 Medicinal and pharmaceuticals products, pesticides
	44 2505 Soap & detergents
	45 2506 Cosmetics & toiletry preparations
	46 2507 Other chemical products
	47 2508 Rubber products
	48 2509 Plastic products
30 Non-metallic mineral products	49 2601 Glass & glass products
	50 2602 Ceramic products
	51 2603 Cement, lime and concrete slurry
	52 2604 Plaster & other concrete products
	53 2605 Other non-metallic mineral products
31 Iron and steel	54 2701 Iron & steel

West Kimberley, 2007/08 (66 sectors)	National Input-Output Table, 2004/05 (109 sectors)
32 Basic non-ferrous metals and products	55 2702 Basic non-ferrous metals and products
33 Metal products	56 2703 Structural metal products
	57 2704 Sheet metal products
	58 2705 Fabricated metal products
34 Motor vehicles & parts; other transport equip	59 2801 Motor vehicles & parts; other transport equip
35 Other machinery and equipment	60 2802 Ships and boats
	61 2803 Railway equipment
	62 2804 Aircraft
	63 2805 Photographic & scientific equipment
	64 2806 Electronic equipment
	65 2807 Household appliances
	66 2808 Other electrical equipment
	67 2809 Agricultural, mining etc. machinery
	68 2810 Other machinery & equipment
	36 Furniture
37 Other manufacturing	70 2901 Prefabricated buildings
	71 2903 Other manufacturing
38 Electricity supply	72 3601 Electricity supply
39 Gas supply	73 3602 Gas supply
40 Water supply, sewerage and drainage services	74 3701 Water supply, sewerage and drainage services
41 Residential building	75 4101 Residential building
42 Other construction	76 4102 Other construction
43 Construction trade services	77 4201 Construction trade services
44 Wholesale trade	78 4501 Wholesale trade
	79 4502 Wholesale mechanical repairs
	80 4503 Other wholesale repairs
45 Retail trade	81 5101 Retail trade
	82 5102 Retail mechanical repairs
	83 5103 Other retail repairs
46 Accommodation, cafes & restaurants	84 5701 Accommodation, cafes & restaurants
47 Road transport	85 6101 Road transport
48 Rail, pipeline & other transport	86 6201 Rail, pipeline & other transport

West Kimberley, 2007/08 (66 sectors)	National Input-Output Table, 2004/05 (109 sectors)
49 Water transport	87 6301 Water transport
50 Air & space transport	88 6401 Air & space transport
51 Services to transport; storage	89 6601 Services to transport; storage
52 Communication services	90 7101 Communication services
53 Finance	91 7301 Banking
	92 7302 Non-bank finance
54 Insurance	93 7401 Insurance
55 Services to finance investment and insurance	94 7501 Services to finance investment and insurance
56 Ownership of dwellings	95 7701 Ownership of dwellings
57 Other property services	96 7702 Other property services
58 Scientific research, technical and computer serv.	97 7801 Scientific research, technical and computer serv.
59 Legal, accounting, marketing and business serv.	98 7802 Legal, accounting, marketing and business serv.
60 Other business services	99 7803 Other business services
61 Government administration	100 8101 Government administration
62 Defence	101 8201 Defence
63 Education	102 8401 Education
64 Health and community services	103 8601 Health services
	104 8701 Community services
65 Cultural and recreational services	105 9101 Motion picture, radio and television services
	106 9201 Libraries, museums & the arts
	107 9301 Sport, gambling and recreational services
66 Personal services	108 9501 Personal services
	109 9601 Other services

Appendix 2 Input-Output Methodology

An Overview of Input-Output Analysis

Input-output analysis provides a comprehensive economic framework that is extremely useful in the resource planning process. Broadly, there are two ways in which the input-output (I-O) method can be used.

First, the I-O model provides a numerical picture of the size and shape of an economy and its essential features. The I-O transactions model (or table) can be used to describe some of the important features of an economy, the interrelationships between sectors and the relative importance of the individual sectors.

Second, I-O analysis provides a standard approach for the estimation of the economic impact of a particular activity. The I-O model is used to calculate industry multipliers that can then be applied to various development or change scenarios.

The input-output transactions table

Input-output analysis, as an accounting system of inter-industry transactions, is based on the notion that no industry exists in isolation. This assumes, within any economy, each firm depends on the existence of other firms to purchase inputs from, or sell products to, for further processing. The firms also depend on final consumers of the product and labour inputs to production. An I-O transactions table is a convenient way to illustrate the purchases and sales of goods and services taking place in an economy at a given point in time.

As noted above, input-output models provide a numerical picture of the size and shape of the economy. Products produced in the economy are aggregated into a number of groups of industries and the transactions between them recorded in the transactions table. The rows and columns of the I-O table can be interpreted in the following way:

- The rows of the I-O table illustrate sales for intermediate usage (i.e. to other firms in the region) and for final demand (e.g. household consumption, exports or capital formation).
- The columns of the I-O table illustrate purchases of intermediate inputs (i.e. from other firms in the region), imported goods and services and purchases of primary inputs (i.e. labour, land and capital).
- Each item is shown as a purchase by one sector and a sale by another, thus constructing two sides of a double accounting schedule.

In summary, the I-O transactions table can be used to describe some of the important features of a regional economy, the interrelationships between sectors and the relative importance of the individual sectors. The model is also used for the calculation of sector multipliers and the estimation of economic impacts arising from some change in the regional economy.

Using input-output analysis for estimation of regional economic impacts

The standard approach for the estimation of the regional economic impact of a particular activity, such as wine grape production, for example, is to employ I-O analysis. The I-O model conceives the economy of the region as being divided up into a number of sectors and this allows the analyst to trace expenditure flows.

To illustrate this, consider the example of a vineyard that, in the course of its operation, purchases goods and services from other sectors. These goods and services would include fertiliser, chemicals, transport services, and, of course, labour. The direct employment created by the vineyard is regarded in the model as an expenditure flow into the household sector, which is one of several non-industrial sectors recognised in the I-O model.

Upon receiving expenditure by the vineyard, the other sectors in the regional economy engage in their own expenditures. For example, as a consequence of winning a contract for work with vineyard, a spraying contractor buys materials from its suppliers and labour from its own employees. Suppliers and employees in turn engage in further expenditure, and so on. These indirect and induced (or flow-on) effects⁴, as they are called, are part of the impact of the vineyard on the regional economy. They must be added to the direct effects (which are expenditures made in immediate support of the vineyard itself) in order to arrive at a measure of the total impact of the vineyard.

It may be thought that these flow-on effects (or impacts) go on indefinitely and that their amount adds up without limit. The presence of leakages, however, prevents this from occurring. In the context of the impact on a regional economy, an important leakage is expenditure on imports, that is, products or services that originate from outside the region, state or country (e.g. machinery).

Thus, some of the expenditure by the vineyard (i.e. expenditure on imports to the region) is lost to the regional economy. Consequently, the flow-on effects get smaller and smaller in successive expenditure rounds due to this and other leakages. Hence the total expenditure created in the regional economy is limited in amount, and so (in principle) it can be measured.

Using I-O analysis for estimation of regional economic impacts requires a great deal of information. The analyst needs to know the magnitude of various expenditures and where they occur. Also needed is information on how the sectors receiving this expenditure share their expenditures among the various sectors from whom they buy, and so on, for the further expenditure rounds.

In applying the I-O model to economic impact analysis, the standard procedure is to determine the direct or first-round expenditures only. No attempt is made to pursue such inquiries on expenditure in subsequent rounds, not even, for example, to trace the effects in the regional economy on household expenditures by vineyard employees on food, clothing, entertainment, and so on, as it is impracticable to measure these effects for an individual case, here the vineyard.

The I-O model is instead based on a set of assumptions about constant and uniform proportions of expenditure. If households in general in the regional economy spend, for example, 13.3 per cent of their income on food and non-alcoholic beverages, it is assumed that those working in vineyards do likewise. Indeed, the effects of all expenditure rounds after the first are calculated by using such standard proportions

⁴ A glossary of I-O terminology is provided in Appendix 3.

(i.e. multiplier calculations). Once a transactions table has been compiled, simple mathematical procedures can be applied to derive multipliers for each sector in the economy.

Input-output multipliers

Input-output multipliers are an indication of the strength of the linkages between a particular sector and the rest of the regional economy. As well, they can be used to estimate the impact of a change in that particular sector on the rest of the economy.

Detailed explanations on calculating I-O multipliers, including the underlying assumptions, are provided in any regional economics or I-O analysis textbook (see, for example, Jensen and West (1986)). They are calculated through a routine set of mathematical operations based on coefficients derived from the I-O transactions model, as outlined below.

The transactions table may be represented by a series of equations thus:

$$\begin{aligned}
 X_1 &= X_{11} + X_{12} + \dots + X_{1n} + Y_1 \\
 X_2 &= X_{21} + X_{22} + \dots + X_{2n} + Y_2 \\
 X_n &= X_{n1} + X_{n2} + \dots + X_{nn} + Y_n
 \end{aligned}$$

- where X_i = total output of intermediate sector i (row totals);
- X_{ij} = output of sector i purchased by sector j (elements of the intermediate quadrant); and
- Y_j = total final demand for the output of sector i .

It is possible, by dividing the elements of the columns of the transactions table by the respective column totals to derive coefficients, which represent more clearly the purchasing pattern of each sector. These coefficients, termed 'direct' or 'I-O' coefficients, are normally denoted as a_{ij} , and represent the direct or first round requirements from the output of each sector following an increase in output of any sector.

In equation terms the model becomes:

$$\begin{aligned}
 X_1 &= a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n + Y_1 \\
 X_2 &= a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n + Y_2 \\
 X_n &= a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nn}X_n + Y_n
 \end{aligned}$$

where a_{ij} (the direct coefficient) = X_{ij}/X_j . This may be represented in matrix terms:

$$X = AX + Y$$

where $A = [a_{ij}]$, the matrix of direct coefficients.

The previous equation can be extended to:

$$(I-A)X = Y$$

where $(I-A)$ is termed the Leontief matrix,

$$\text{or } X = (I-A)^{-1}Y$$

where $(I-A)^{-1}$ is termed the 'general solution', the 'Leontief inverse' or simply the inverse of the open model.

The general solution is often represented by:

$$Z = (I-A)^{-1} = [z_{ij}]$$

The I-O table can be 'closed' with respect to certain elements of the table. Closure involves the transfer of items from the exogenous portions of the table (final demand and primary input quadrants) to the endogenous section of the table (intermediate quadrant). This implies that the analyst considers that the transferred item is related more to the level of local activity than to external influences. Closure of I-O tables with respect to households is common and has been adopted in this project.

The 'closed' direct coefficients matrix may be referred to as A^* . The inverse of the Leontief matrix formed from A^* is given by:

$$Z^* = (I - A^*)^{-1} = [z^*_{ij}]$$

Z^* is referred to as the 'closed inverse' matrix.

A multiplier is essentially a measurement of the impact of an economic stimulus. In the case of I-O multipliers the stimulus is normally assumed to be an increase of one dollar in sales to final demand by a sector. The impact in terms of output, contribution to gross regional product, household income and employment can be identified in the categories discussed below.

- (i) The initial impact: refers to the assumed dollar increase in sales. It is the stimulus or the cause of the impacts. It is the unity base of the output multiplier and provides the identity matrix of the Leontief matrix. Associated directly with this dollar increase in output is an own-sector increase in household income (wages and salaries, drawings by owner operators etc.) used in the production of that dollar. This is the household income coefficient h_j . Household income, together with other value added (OVA), provide the total contribution to gross regional product from the production of that dollar of output. The contribution to gross regional product coefficient is denoted v_j . Associated also will be an own-sector increase in employment, represented by the size of the employment coefficient. This employment coefficient e_j represents an employment/output ratio and is usually calculated as 'employment per million dollars of output'.

- (ii) The first round impact: refers to the effect of the first round of purchases by the sector providing the additional dollar of output. In the case of the output multiplier this is shown by the direct coefficients matrix $[a_{ij}]$. The disaggregated effects are given by individual a_{ij} coefficients and the total first-round effect by Σa_{ij} . First-round household income effects are calculated by multiplying the first-round output effects by the appropriate household income coefficient (h_j). Similarly, the first-round contribution to gross regional product and employment effects are calculated by multiplying the first-round output effects by the appropriate contribution to gross state product (v_j) and employment (e_j) coefficients.
- (iii) Industrial-support impacts. This term is applied to 'second and subsequent round' effects as successive waves of output increases occur in the economy to provide industrial support, as a response to the original dollar increase in sales to final demand. The term excludes any increases caused by increased household consumption. Output effects are calculated from the open Z inverse, as a measure of industrial response to the first-round effects. The industrial-support output requirements are calculated as the elements of the columns of the Z inverse, less the initial dollar stimulus and the first-round effects. The industrial support household income, contribution to gross regional product and employment effects are defined as the output effects multiplied by the respective household income, contribution to gross regional product and employment coefficients. The first-round and industrial-support impacts are together termed the production-induced impacts.
- (iv) Consumption-induced impacts: are defined as those induced by increased household income associated with the original dollar stimulus in output. The consumption-induced output effects are calculated in disaggregated form as the difference between the corresponding elements in the open and closed inverse (i.e. $z^*_{ij} - z_{ij}$, and in total as $\Sigma(z^*_{ij} - z_{ij})$). The consumption-induced household income, contribution to gross regional product and employment effects are simply the output effects multiplied by the respective household income, contribution to gross regional product and employment coefficients.
- (v) Flow-on impacts: are calculated as total impact less the initial impact. This allows for the separation of 'cause and effect' factors in the multipliers. The cause of the impact is given by the initial impact (the original dollar increase in sales to final demand), and the effect is represented by the first-round, industrial-support and consumption-induced effects, which together constitute the flow-on effects.

Each of the five impacts are summarised in Appendix Table 2.1. It should be noted that household income, contribution to gross regional product and employment multipliers are parallel concepts, differing only by their respective coefficients h_j , v_j and e_j .

The output multipliers are calculated on a 'per unit of initial effect' basis (i.e. output responses to a one dollar change in output). Household income, contribution to gross regional product and employment multipliers, as described above, refer to changes in household income per initial change in output, changes in contribution to gross regional product per initial change in output and changes in employment per initial change in output. These multipliers are conventionally converted to ratios, expressing a 'per unit' measurement, and described as Type I and Type II ratios. For example, with respect to employment:

Type I employment ratio = [initial + first round + industrial support]/initial

and

Type II employment ratio = [initial + production induced⁵ + consumption induced]/initial

Appendix Table 2.1 The structure of input-output multipliers for sector *i*^a

Impacts	General formula
<i>Output multipliers (\$)</i>	
Initial	1
First-round	$\sum_i a_{ij}$
Industrial-support	$\sum_i z_{ij} - 1 - \sum_i a_{ij}$
Consumption-induced	$\sum_i z_{ij}^* - \sum_i z_{ij}$
Total	$\sum_i z_{ij}^*$
Flow-on	$\sum_i z_{ij}^* - 1$
<i>Household Income multipliers (\$)</i>	
Initial	h_i
First-round	$\sum_i a_{ij} h_i$
Industrial-support	$\sum_i z_{ij} h_i - h_i - \sum_i a_{ij} h_i$
Consumption-induced	$\sum_i z_{ij}^* h_i - \sum_i z_{ij} h_i$
Total	$\sum_i z_{ij}^* h_i$
Flow-on	$\sum_i z_{ij}^* h_i - h_i$
<i>Contribution to gross regional product multipliers (\$)</i>	
Initial	v_i
First-round	$\sum_i a_{ij} v_i$
Industrial-support	$\sum_i z_{ij} v_i - v_i - \sum_i a_{ij} v_i$
Consumption-induced	$\sum_i z_{ij}^* v_i - \sum_i z_{ij} v_i$
Total	$\sum_i z_{ij}^* v_i$
Flow-on	$\sum_i z_{ij}^* v_i - v_i$
<i>Employment multipliers (full time equivalents)</i>	
Initial	e_i
First-round	$\sum_i a_{ij} e_i$
Industrial-support	$\sum_i z_{ij} e_i - e_i - \sum_i a_{ij} e_i$
Consumption-induced	$\sum_i z_{ij}^* e_i - \sum_i z_{ij} e_i$
Total	$\sum_i z_{ij}^* e_i$
Flow-on	$\sum_i z_{ij}^* e_i - e_i$

^a In a DECON model, Z^* (the ‘closed inverse’ matrix), includes a population and an unemployed row and column (see Section 3 of the report for details).

⁵ Where (first round + industrial support) = production induced.

Input-output model assumptions

There are a number of important assumptions in the I-O model that are relevant in interpreting the analytical results. These are discussed below.

Industries in the model have a linear production function, which implies constant returns to scale and fixed input proportions. This assumption applies in the calculation of flow-on effects. However, for the purpose of this project, adjustments to differing climate change adaptation responses have been modelled outside the I-O framework and have involved changes in both aggregate sales and input coefficients.

Another model assumption is that firms within a sector are homogeneous, which implies they produce a fixed set of products that are not produced by any other sector and that the input structure of the firms are the same. It is preferable to have as many sectors as possible specified in the regional models and the models for this study was compiled with 33 sectors (see Appendix 1 for further detail).

The model is a static model that does not take account of the dynamic processes involved in the adjustment to an external change, such as a permanent change in climate. The dynamic processes involve both investment and time to facilitate the adjustment. The model is silent on the timeframe of adjustment and assumes that the investment required for the forecast change is not an impediment to the realisation of that change. Thus, estimates of economic impact in this report are presented as net impacts, that is, relative to a baseline year (i.e. 2006/07).

Extending the Input-Output Model as a DECON Model

Based on work undertaken by Mangan and Phibbs (1989), the I-O model developed for this project was extended as a demographic-economic (DECON) model. The two key characteristics of the DECON model, when compared with a standard economic model, are as follows.

1. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on local population levels of employment growth or decline.
2. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

The Population Sector

The introduction of a population 'sector' to the traditional I-O model allows for the calculation of population multipliers. These multipliers measure the flow-on population impact resulting from an initial population change attributable to employment growth or decline in a particular sector of the regional economy.

Calculation of population multipliers is made possible by inclusion of a population row and column in the 'closed' direct coefficients matrix of the I-O model.

Population row: the population coefficient (p_j) for sector j of the DECON model is represented as:

$$p_j = -\rho_j * e_j * \text{family size}_j$$

where ρ_j = the proportion of employees in sector j who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector j filled by previously unemployed locals (positive employment impact);

e_j = the employment coefficient for sector j ; and

family size_j = average family size for sector j .

Population column: the population column of the DECON model is designed to account for growth or decline in those sectors of the economy that are primarily population-driven (i.e. influenced by the size of the population) rather than market-driven (i.e. dependent upon monetary transactions). Clearly, many of the services provided by the public sector fit this description and, for the purpose of this analysis, it was assumed that the following sectors (see Appendix 1), at the regional level, were primarily population-driven:

- public administration and defence;
- education;
- health and community services; and
- cultural and recreational services.

Thus, the non-market coefficient for sector j of the DECON model is represented as expenditure on that non-market service (by governments) in \$million per head of population.

The population multiplier for sector j is represented as: z_{pj}^* / p_{pj}

where z_{pj}^* = coefficient of the 'closed inverse' matrix in the population row for sector j ; and

p_{pj} = coefficient of the direct coefficients matrix in the population row for sector j

Sources of local data for the population sector of the DECON models used in this study included the following.

- rho: little or no published data were available to assist with estimation of this variable, particularly at a regional level, thus it was subjectively determined based on the consultants' knowledge of the regions used in the study and experience in the field of regional economic impact analysis. The analyst can modify this estimate if superior data is available.
- Family size: in order to estimate average family size by industry relevant data were obtained by special request from the Australian Bureau of Statistics (*2006 Census of Population and Housing*).

The Unemployed Sector

As outlined above, the introduction of an unemployed 'sector' to the traditional I-O model makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

Through the inclusion of an unemployed row and column in the 'closed' direct coefficients matrix of the traditional I-O model it is possible to calculate Type IV multipliers (for output, contribution to GRP, household income and employment).

The key point to note is that, in the situation where at least some of the unemployed remain in a region after losing their job (negative employment impact) or some of the new jobs in a region are filled by previously unemployed locals (positive employment impact), Type IV multipliers will be smaller than the more frequently used Type II multipliers.

Unemployed row: the unemployed coefficient (u_j) for sector j of the DECON model is represented as:

$$u_j = -\rho_j * (1 - \text{ess}_j) * e_j$$

where ρ_j = the proportion of employees in sector j who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector j filled by previously unemployed locals (positive employment impact);

ess_j = the proportion of employed in sector j who are not eligible for welfare benefits when they lose their job; and

e_j = the employment coefficient for sector j .

Unemployed column: the unemployed column of the DECON model is an approximation of total consumption expenditure and the consumption pattern of the unemployed. It is represented as dollars per unemployed person rather than \$million for the region as a whole, as is the case for the household expenditure column in a traditional I-O model.

Sources of local data for the unemployed sector of the DECON models used in this study included the following.

- ess : in order to estimate the proportion of employed by industry who are not eligible for welfare benefits when they lose their job, relevant data were obtained by special request from the Australian Bureau of Statistics (2006 *Census of Population and Housing*).
- Unemployed consumption: total consumption expenditure by the unemployed was based on an estimate of the *Newstart Allowance* whilst the pattern of consumption expenditure was derived from household income quintiles in the ABS 1998/99 *Household Expenditure Survey*.

Appendix 3 Glossary of Input-Output Terminology

Basic value is the price received for a good or service by the producer. It is also known as producers' price. It excludes indirect taxes and transport, trade and other margins.

Consumption-induced impacts are additional output and employment resulting from re-spending by households that receive income from employment in direct and indirect activities. Consumption-induced effects are sometimes referred to as 'induced effects'.

Contribution to gross regional product (GRP) is a measure of the net contribution of an activity to the regional economy. Contribution to GRP is measured as value of output less the cost of goods and services (including imports) used in producing the output. In other words, it can be measured as household income plus other value added (gross operating surplus and all taxes, less subsidies). It represents payments to the primary inputs of production (labour, capital and land). Using contribution to GSP as a measure of economic impact avoids the problem of double counting that may arise from using value of output for this purpose.

DECON model is a demographic-economic model based on a traditional input-output model. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on local population levels of employment growth or decline. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

Direct (or initial) impacts⁶ are the initial round of output, employment and income generated by an economic activity (e.g. wine grape production).

Employment is a measure of the number of working proprietors, managers, directors and other employees, in terms of the number of full time equivalent jobs.

ess is an estimate of the proportion of employed who are not eligible for welfare benefits when they lose their job.

Exports refers to the sale of goods and services to final consumers outside the region of interest. In a regional input-output model exports refers to the sale of goods and services interstate, overseas and to other regions within the state.

First-round impacts are estimates of the requirement for (or purchases of) goods and services from other sectors in the economy generated by the initial economic activity (e.g. purchases of transport services and labour by the wine grape production sector).

Flow-on impacts are the sum of first-round and industrial support impacts, together called production-induced impacts, and consumption-induced impacts.

Household income is a component of GRP and is a measure of wages and salaries paid in cash and in kind, drawings by owner operators and other payments to labour including overtime payments, employer's superannuation contributions and income tax, but excluding payroll tax.

⁶ Note that the terminology 'impacts' and 'effects' can be used interchangeably.

Imports refers to the purchase of goods and services (including labour) from outside the region of interest. In a regional input-output model imports refers to the purchase of goods and services from interstate, overseas and from other regions within the state.

Industrial-support impacts are additional output and employment resulting from re-spending by firms that receive payments from the sale of goods and services to firms undertaking, for example, wine grape production.

Input-output analysis is an accounting system of inter-industry transactions based on the notion that no industry exists in isolation.

Input-output model is a transactions table that illustrates and quantifies the purchases and sales of goods and services taking place in an economy at a given point in time. It provides a numerical picture of the size and shape of the economy and its essential features. Each item is shown as a purchase by one sector and a sale by another, thus constructing two sides of a double accounting schedule.

Multiplier is an index (ratio) indicating the overall change in the level of activity that results from an initial change in economic activity. They are an indication of the strength of the linkages between a particular sector and the rest of the regional economy. They can be used to estimate the impact of a change in that particular sector on the rest of the economy.

Other Final Demand includes government expenditure, private and public sector investment (gross fixed capital formation) and change in stocks (inventories).

Other Value Added includes gross operating surplus and all taxes, less subsidies.

Output (Value of) is a measure of the gross revenue of goods and services produced by commercial organisations (e.g. farm-gate value of wine grape production) and gross expenditure by government agencies. Total output needs to be used with care as it includes elements of double counting (e.g. the value of winery output includes the farm-gate value of wine grape production).

Purchasers' price is the price paid for a good or service paid by the purchaser. It includes indirect taxes and transport, trade and other margins.

Production-induced impacts are additional output, employment and income resulting from re-spending by firms that receive income from the sale of goods and services to firms undertaking, for example, wine grape production. Production-induced impacts are sometimes referred to as 'indirect effects'.

rho is an estimate of the proportion of employees who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs filled by previously unemployed locals (positive employment impact).

Total impacts are the sum of direct and flow-on impacts.

Type I multiplier is calculated as (direct effects + production-induced effects)/direct effects.

Type II multiplier is calculated as (direct effects + production-induced effects + consumption-induced effects)/direct effects.

Type IV multiplier is a modified Type II multiplier, calculated by including a population and unemployed row and column in the 'closed' direct coefficients matrix of the traditional input-output model.