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Fishing Industry Impact Study

James Price Point Proposed Liquefied Natural Gas Precinct

Prepared for the Department of Fisheries, Western Australia

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2009

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It should be noted that the views identified in this document regarding possible impacts and suggested mitigation and management arrangements are those expressed by organisations and individuals who participated in the study and do not necessarily reflect the views of government.

Disclaimer

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EXECUTIVE SUMMARY

The proposed development of a liquefied natural gas (LNG) precinct at, or near, James Price Point (JPP), about 60 kilometres north of Broome has potential to create significant impacts on all fisheries sectors. This Fishing Industry Impact Study (FIS) provides baseline information on issues and trends in recreational, charter, and commercial fisheries, pearling and aquaculture that may be affected by the development of the precinct. A study of the customary sector will be reported separately and form an addendum to this report.

The detailed findings of the FIS are summarised in tables below. Detailed discussion of the issues is provided in the chapters of the report.

The principle method of data collection was one-on-one interview with those fishing interest holders who are most likely to be affected by the proposed JPP LNG Precinct. Inevitably much of the information that is collected this way will be qualitative and anecdotal in character. The authors consider that the report is an accurate and reasonable reflection of the impacts expected by the people who were interviewed.

A detailed economic survey of several commercial fisheries was also conducted. An input-output analysis attempted to gauge the potential economic impacts of the proposed JPP LNG Precinct on these fisheries, and possible changes to their contributions to the West Kimberley economy. The economist's report is presented as an annex of this report.

Although the proposed JPP LNG Precinct may have significant impacts on regional fisheries, many local Broome recreational fishers perceive positive general outcomes as a result of the JPP LNG Precinct's development. Although estimated on small samples it appears that the recreational fishing community is split about 50/50 as to whether the proposed development is expected be good, or at least fairly benign, for fishing - or detrimental. The main positive outcome that people hope for is substantial improvement in the marine and boating infrastructure at Broome.

Key findings

The main findings of the FIS may be summarised as follows:

The proposed LNG precinct at JPP has potential to significantly impact all fisheries that are active in the West Kimberly to the west of Koolan Island, and/or use the Port of Broome as a home port. There

may be some reduction in the levels of fishing activity as a result, with some flow-on effects to the economy of the region. Mitigating these negative impacts are potential positive elements for fishers that may result from the JPP LNG Precinct's development. Many fishers in the various sectors and fisheries look forward to improvements to Broome boating and fishing facilities as a result of the precinct's development.

Some impacts that may be associated with the JPP LNG Precinct are more certain to occur than others; but it is not possible, with the currently available levels of information, to know in detail what the eventual physical effects of the dredging, wharf construction, tanker and tender traffic will be on:

- Local oceanographic currents
- Benthic habitat
- Patterns of pelagic fish movement
- Coastal freshwater hydrography, and similar issues.

According to most of the fishing interests, the ocean within about 15 nautical miles to the west of the Quondong-JPP coastal area is a highly productive zone that appears to concentrate the marine life found in the region. It hosts spectacular recreational fisheries for billfish, and attracts a wide range of other fish and marine animals, a prawn fishery, and pearling.

The issues raised by fishers consulted highlight the need for more integrated, regionally based, marine and coastal planning. Such planning needs to include all stakeholders in marine and coastal issues.

Environmental issues

The ecological relationships have not yet been studied formally. However, the anecdotal opinion of many of the fishers, and the relevant Department of Fisheries (DoF) scientist, is that Roebuck Bay plays a key role in driving a chain of events that results in the high levels of marine biota found to the west of the Quondong-JPP coast.

Roebuck Bay is the ancient former mouth of the Fitzroy River. According to the view of knowledgeable participants in the FIS, the biological detritus that collects in the plain surrounding the Bay during the dry season, is washed by the wet season's rain into the warm waters of Roebuck Bay. There it adds to the base of a food chain that results in aggregations known locally as "bait balls," of small fish and other creatures. Charter and recreational fishers say the bait balls move northwards along the coastline to approximately the area near Quondong; the bait then travels north-westward towards an area locally known as the "Peanut" - because it has the characteristic shape of a peanut on the hydrographic chart.

The Peanut is about 12 nautical miles west of JPP, or about the distance between Fremantle and Thomson Bay at Rottnest Island. Although the whole coastal area appears to be rich in marine fauna, the waters adjacent the Quondong-JPP coastal area are reported to be particularly prolific:

- A large sailfish aggregation that is important to charter and recreational fishing occurs each dry season in the waters adjacent the Quondong-JPP coastal area. The sailfish are found in association with juvenile black marlin, but a wide range of other fish and marine animals are also apparently attracted to this area.

- The Broome Prawn Managed Fishery takes place periodically in a designated trawl zone located immediately west of the Quondong-JPP area. Although this is a small prawn fishery, its fishers say that the king prawns they take from it are significantly more valuable than other king prawns because of their high level of visual appeal.

- A key oceanic pearl farm is located about two nautical miles west of JPP. The farm extends to the south about 8.5 nautical miles, adjacent the coast between JPP and Quondong. Clipper Pearls estimates that its total production based at the Quondong-James Price Point coastal area accounts for approximately 17% of the total value of pearls produced in Western Australia (A. Ogg pers. comm.).[1] Its owners and managers say it is the largest single producer of Australian South Sea pearls after the Paspaley Pearling Company.

The environmental issue that was of greatest concern to the fishers that were interviewed was the dredging that will be necessary for port construction and tanker access. Given the lack of oceanographic and engineering detail, fishers were worried that the large scale of the dredging that they perceived would be necessary would harm the unique marine environment of the Quondong-JPP coastal area.

Other key environmental issues raised by participants included:

- fears that seismic testing would disturb fish behaviour and make fish harder to catch,
- fears that marine pests and disease could be brought to the area by international tankers, and
- concern regarding changes to local benthic habitat and species mix as a result of submarine infrastructure such as pipelines.

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[1] This is an estimated figure based on production value, not volume, because the overall price returned is greater than the industry average (A. Ogg pers. comm.)

Resource Sharing

Resource sharing issues were raised in the context of increasing demands on available, relatively finite, fish resources. Recreational fishers were concerned that the recreational fishing needs of oil and gas employees could be substantial and reduce opportunities for existing fishers. The potential for this problem is obvious near the JPP site, where a large construction camp is likely to be located. It is less obvious that workers on rig tenders and other oil and gas vessels associated with the Browse Basin gas generally might exert significant recreational fishing pressure. A management plan to regulate fishing associated with the oil and gas industries should be developed with the participation of all relevant parties.

Broome Port

The opportunity to upgrade the facilities in the Port of Broome was the main positive outcome that fishers from all sectors saw as benefiting fisheries in the area. Virtually all fishers interviewed considered the current facilities to be inadequate. They were concerned that the large and imposing Broome Wharf is difficult to use, for both physical and administrative reasons; the existing boat ramps are difficult to use due to their awkward locations. The beach at Gantheume Point appears to be the main mooring and launching facility for recreational, charter, and small to medium sized commercial vessels. There is an obvious need for medium scale boating facilities in Broome to be developed. Many of the interviewees supported the idea of a mid-sized marina or similar facility that could cater to recreational and charter vessels, commercial fishers, and pearling vessels.

A useful suggestion was that the JPP Precinct itself could support a boat ramp with secure parking facilities. Such a facility could help alleviate some of the recreational fishing pressure that is inevitably concentrated around Broome. However, it seems likely that security issues may need to be considered in relation to this idea.

In the short term, the development of the JPP LNG Precinct is expected to exacerbate the existing problems at Broome Wharf. There were significant numbers of complaints that oil and gas related traffic gets priority treatment at the wharf. It is possible that this perception could be addressed through policy development and an agreed plan to manage traffic.

Vehicle traffic around the JPP LNG Precinct

Recreational fishers feel a strong need to retain access to coastal places north of JPP. Many people expressed fears that the "exclusion zones" associated with the JPP LNG Precinct would limit access to favoured fishing and camping places north to Carnot Bay. This issue would appear to be simple to accommodate, with an appropriate road that skirts the eastern boundary of the precinct. However, such a road or track may raise other conservation and planning issues relevant to increased access and use of the west coast of the Dampier Peninsula, including the expectations of Traditional Owners.

Vessel traffic

Most fisheries sectors felt that the increased vessel traffic associated with the JPP LNG Precinct would cause navigation challenges. There were concerns expressed that oil and gas vessel operators tended to have a bit of 'attitude' when in proximity with local traffic. There were some fears that vessels such as prawn trawlers 'with their gear down' would have limited maneuverability, as would the large LNG tankers. Most fishers were concerned generally about increased congestion.

Pearl farms had particular concerns about making mariners more aware of their presence. Apparatus to make the farms more visible may be required. The pearlers considered that any increased costs should be borne by the oil and gas industry.

Economic study

The economic study completed by EconSearch Pty Ltd was informed by detailed information provided by a limited number of commercial fishers, and regional information provided by the Australian Bureau of Statistics. The complete report is annexed to this report (see Annex).

A number of economic scenarios were developed, based on possible outcomes from the development of the proposed JPP LNG Precinct. These scenarios were based on the interviews with fishers whose commercial interests may be affected by the proposed precinct. The following six scenarios were run in an input-output economic analysis (see Annex for a detailed account of this methodology).

The specific reasons for each of these rationales are discussed in the relevant sections of the report. It was necessary to attempt to make reasonable assumptions about the effects of the proposed JPP LNG Precinct's development. The assumptions are based mainly on what the fishers explained about their situations during the interviews. However, it is important to understand that these are merely educated

guesses, based on information taken from the interview process. There are as yet far too many variables and unknowns associated with the proposed development of the JPP LNG Precinct to be able to estimate its effects on local fisheries with any level of precision.

Economic Scenarios

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

The key economic results are as follows:

	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**

The FIS has concluded that there may be decline in most commercial fisheries as a result of the proposed JPP LNG Precinct's development. Some of the decline may come about through environmental changes, for example from the (as yet unknown) effects on the prawns, mackerel, and pelagic gamefish, and nearby pearling operations. Other aspects of the decline may come from the increased levels of frustration resulting from further loading of the already stretched maritime facilities in and around Broome. Ultimately, fishers are likely to adapt to changed circumstances and equilibrium will be reached that incorporates the new reality, should it occur. However, it is expected there will be considerable inconvenience caused to existing fisheries interests in the short and medium terms. This will have flow on effects to the regional economy.

Table 3: Key issues raised by recreational fishers and suggested mitigation strategies

Issue raised	Potential Impact/ Benefit	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Local overfishing during construction phase	Local depletion of fish due to recreational overfishing by construction workers	Construction	Critical	A plan to protect the Quondong-JPP area from overfishing during the construction phase should be developed in consultation between DoF, Proponents, and recreational fishing groups including the Broome Fishing Club.	Proponent Department of Fisheries
Access to areas north of JPP LNG Precinct potentially hindered	The LNG plant could prevent normal coastal traffic north of the Precinct. Historically there has been access up the west coast of the Dampier Peninsula beyond JPP.	Construction & Operation	High	Maintain coastal vehicle access around the JPP LNG Precinct.	Proponents Department of State Development Department of Transport Department of Planning

Better boating facilities for Broome	Upgrade of boating facilities in Broome (currently inadequate)	Construction & Operation	Critical	Investigate options for JPP LNG Precinct development to contribute funds towards new recreational boating facilities.	Proponents Department of Transport Broome Port Authority
Possible marine facility at JPP LNG Precinct	Shift of some recreational fishing effort away from Broome	Operation	Medium	Establish a recreational boating facility near to the JPP LNG Precinct.	Proponent Department of Transport Department of Planning
Sailfish aggregations potentially disturbed.	Increased activity, dredging, and disturbance near areas of known aggregations of sailfish and other pelagic species could impact on existing marine environment. Lack	Construction & Operation	Critical	Fund research into potential effects of LNG precinct construction and on-going operations on pelagic fish stocks, including sailfish. Make the outcomes of this research publicly available – in accessible language.	Proponent in consultation with Department of Fisheries

	of scientific data to assess potential impacts.				

Table 4: Key issues raised by charter fishers and suggested mitigation strategies

Issue raised	Potential Impact/ Benefit	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Fear that seismic and other disturbance will damage fishery.	Lack of clarity about actual effects of construction/dredging etc. is fuelling concern about potential effects.	Construction & Operation	Critical	Promote public understanding of engineering and construction processes, and strategies to minimise potential environmental impacts when the final design and location have been determined. Relevant science should be summarised and made available to public.	Proponent Department of State Development

Dredging will be disruptive.	Charter fishers think that dredging will not be limited to the immediate port areas and will need to be extended to nearer to the main pelagic fishing grounds, and may impact on pelagic fish stocks including sailfish.	Construction	Critical	Prepare a dredge management plan, which includes details of spoil disposal, timing, disposal of spoil and on-going maintenance dredging requirements in consultation with potentially affected stakeholders including charter fishers, prior to construction.	Proponent Department of Fisheries Department of State Development Department of Transport
Dredged channels will need to be maintained.	Fishers are concerned about benthic disturbance associated with maintenance dredging for vessel access.	Operation	Critical	See above	See above
Better science on sailfish aggregations.	Charter fishers rely on pelagic fish aggregations, which may be disturbed, with unknown consequences.	Construction & Operation	Critical	Fund substantial publicly available research into the potential effects of LNG precinct construction and on-going operations on pelagic fish stocks, including sailfish and marlin.	Proponent, in consultation with Department of Fisheries.

Table 5: Key issues raised by pearling industry and suggested mitigation strategies

Issue	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies	Responsibility/Key Drivers
Suspension of solids in water column, sedimentation and changes to water quality and flow	Reduces feeding efficiency of oysters and reduces pearl growth and lustre.	Construction & operation	High – critical for Clipper	Prepare a dredge management plan, which includes details of spoil disposal, in consultation with potentially affected stakeholders including pearling companies, prior to construction	Proponent Department of Fisheries
Possible introduction of marine pests	Introduction of black striped mussel , Asian green lipped mussel, and similar pests that could make it difficult or impossible to maintain oyster health and cleanliness.	Operation	Critical	Biofoul inspections (Quarantine Pre-arrival Report) to be conducted by Australian inspectors as a condition of entry to Australian waters. Specific relevant regulations relating to biofoul inspections should be reviewed and enhanced, if possible, to achieve highest possible levels of protection.	Proponent Australian Quarantine Inspection Service (AQIS) Department of Agriculture Fisheries and Forestry (DAFF) Department of Fisheries
Possible introduction of oyster disease.	Increased incidence of disease affecting *P. maxima* due to transfer of	Operation	High	Promote research and assess possible effects of pearl oyster disease.	Australian Quarantine Inspection Service (AQIS) Department of

	pathogens on LNG carriers.			Implement aquatic animal health surveillance requirements.	Agriculture Fisheries and Forestry (DAFF)
Risk of collision with pearl farms.	Pearl farms damaged by collision with LNG related marine traffic	Construction & operation	Medium	Increase visibility of Pearl lease site through use of markers and lights	Project proponents in consultation with pearling industry
Increased competition for wharfage in Broome	Pearling vessels forced from existing wharf because of limited space and priority given to LNG related traffic.	Construction & operation	Critical	Investigate and promote alternative berthing facilities to service pearling and other marine interests in Broome.	Broome Port Authority Departments of Transport and Planning
Increased competition for marine oriented staff.	Pearling staff will be attracted to higher wages associated with LNG Precinct employment at JPP and elsewhere.	Construction & operation	Critical	Use 457 visa exemption to permit pearling companies to engage overseas workers as they have in the past.	Dept. of State Development Dept. Immigration and Citizenship (C'th)
General living costs increased.	Increasing costs of living in Broome will generate inflationary pressure on pearling wages.	Construction & operation	Medium	Contribute to the SIA management plan to attract and retain lower paid workers.	Department of State Development
Environmental	Gradual reduction	Construction &	High	Establish integrated coastal and marine	WA Government plus

offsets limit options for pearl farms.	of pearling lease areas as a result of increasing marine environmental management arrangements.	Operation		planning mechanisms on regional scales, to address concerns arising from potentially conflicting coastal and marine user groups.	relevant agencies

Table 6: Key issues raised by Specimen Shell and Marine Aquarium Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Loss of productive area at JPP.	Direct loss of productive area with reduced options for replacing it.	Construction & Operation	Critical	Investigate opportunities to collect hermit crabs and other species from the JPP site prior to construction, and keep them alive for subsequent replacing when construction is finished. Maintain highest level environmental practices so that loss of productive marine habitat is minimised.	Proponent Department of Fisheries WAFIC
Loss of areas for collection due to environmental offsets	"Death by a thousand cuts" as productive areas are taken by environmental	Construction & Operation	Critical	Promote integrated coastal and marine planning initiatives on a regional scale, which provide opportunities for all potentially affected stakeholders to input into long term coastal zone management	Department of Fisheries WA Department of Environment and

	offsets resulting from coastal development approvals.			strategies	Conservation
Dredging may result in loss of habitat	Direct loss of benthic habitat, and pollution of JPP and surrounding area	Construction & Operation	High	Prepare a dredge management plan, which includes details of extent of dredging and spoil disposal, in consultation with potentially affected stakeholders including the MAF, prior to construction	Proponent Department of Fisheries Department of Transport

Table 7: Key issues raised by Broome Prawn Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Increased traffic.	Increased risk of collision	Construction & operation	Low	Restrict LNG tankers movement in vicinity of LNG Precinct to daylight hours only.	Department of Transport
Pipelines may disturb local area.	Possible direct disturbance to prawns	Construction & operation	Medium	Promote public understanding of engineering and construction processes, and strategies to minimise potential impacts on fish populations, when the	Proponent in consultation with Department of

	Possible shift in species mix near pipelines.			final design and location has been determined. Develop a plan to minimise and manage the potential for disturbance to prawns.	Fisheries
Sediment plumes may be extensive	Suspended sediments may disturb prawns – especially juveniles	Construction & operation	Low	Prepare a dredge management plan, which includes details of on-going maintenance dredging requirements, in consultation with potentially affected stakeholders including the WA Fishing Industry Council, prior to construction	Proponent Department of Fisheries Department of Transport
Infrastructure problems, including wharfage in Broome	Existing problems with marine infrastructure in Broome exacerbated.	Construction & operation	High	Investigate and promote alternative berthing facilities to service commercial fishing and other marine interests in Broome.	Broome Port Authority Department of Transport

Table 8: Key issues raised by Mackerel Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/ Need	Potential Mitigation Strategies/	Responsibility/Key

			Factor	Opportunities	Drivers
Loss of access to inshore passage	Inconvenience, potential loss of towed dinghies	Construction & operation	Medium	Develop an accord between industry and commercial fishers to allow access to waters in proximity to port and rig related infrastructure.	Proponen Department of Transport WAFIC
Fish – "turned off" by noise, spillages and sediment plume from dredging	Reduced catch near areas of disturbance	Construction & operation	High	Establish baseline data, and undertake on-going monitoring to determine effects of construction and operation of LNG facility (including noise, spillages, dredging and sonic activity) on fish stocks Compensation should be considered where direct impacts are demonstrated.	Proponent Department of Fisheries Department of Transport

Table 10: Key issues that may affect Barramundi and Gillnet Managed Fishery

Issue raised	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
JPP Precinct infrastructure causes changes to local habitat	Temporary local depletion of threadfin species	Construction & operation	Medium	Provide funding to build on the existing scientific database for near-shore finfish stocks. Provide funding to increase understanding of role of environmental factors in movement and distribution of near shore finfish stocks.	Proponent Department of Fisheries
Increased recreational fishing due to increased population may exacerbate resource sharing issues	Controversy about netting in Roebuck Bay	Construction	Medium	Conduct formal stock assessment of threadfin species. If necessary conduct mediation between recreational and commercial sectors.	Department of Fisheries

Table 12: Key issues raised by Northern Demersal Scalefish Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Increased vessel traffic.	Increased risk of collision. Risk of gear being damaged	Construction & operation	Medium	Prepare a Port Management Plan, in consultation with all marine users, to address port related issues including vessel movement. Ensure AIS technology fitted on all oil and gas related vessels. Investigate options for visible markers for NDSF trap lines in congested areas.	Department of Transport Proponent WAFIC
Exclusion areas around rigs and infrastructure.	Loss of available fishing space Currently productive fishing places may become off-limits.	Operation	High	Develop an accord between industry and commercial fishers to allow access to waters in proximity to port and rig related infrastructure.	Proponent. WAFIC Department of Fisheries Department of Transport.
Creation of new undersea structures	Possible change to local habitats Possible shift in species mix near	Construction & operation	Medium	Promote public understanding of engineering and construction processes, and strategies to minimise potential impacts on fish populations, when the final design and location has been	Proponent Department of Fisheries

	pipelines.			determined.	
Seismic activity	Risk of damage to fishery uncertain to fishers at present.	Construction & operation	High	Establish data base, and undertake on-going monitoring to determine effects of construction and operation of LNG facility (including noise, spillages, dredging and sonic activity) on fish stocks	Proponent in consult with Department of Fisheries
Resource sharing with rig tenders.	Recreational fishing by rig tenders could raise total catch above TAC.	Operation	Critical	Develop an accord between industry and commercial and recreational fishers regarding recreational access by oil and gas employees and contractors.	Proponent WAFIC Recfishwest APPEA Department of Fisheries
Infrastructure, including wharfage in Broome.	Existing problems with marine infrastucture in Broome exacerbated.	Construction & operation	High	Investigate and promote alternative berthing facilities to service commercial fishing and other marine interests in Broome	Proponent Broome Port Authority Department of Transport WAFIC

Table 14: Key Issues raised by Aquaculturalists and ACWA and suggested mitigation strategies

Issue raised	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Loss of fresh water and potential contamination from use of aquifers by JPP LNG Precinct.	Less fresh water available for aquaculture on the Dampier Peninsula.	Construction & Operation	unknown	Minimise potential impacts, including water use and management strategies when the final design and location has been determined	Proponent Department of State Development Department of Water
Dredging may result in loss of habitat	Direct pollution of JPP and surrounding area	Construction & Operation	High	Prepare a dredge management plan, which includes details of on-going maintenance dredging requirements.	Proponent Department of State Development
Marine pests possibly introduced	Introduction of black striped mussel and similar pests that could cause marine aquaculture to be made more difficult in this area.	Construction & Operation	High	Ballast water to be discharged well away from aquaculture operations. Biofoul inspections (Quarantine Pre-arrival Report) to be conducted by Australian inspectors as a condition of entry to Australian waters. Specific relevant regulations relating to biofoul inspections should be reviewed and	Australian Quarantine Inspection Service (AQIS) Department of Agriculture Fisheries and Forestry (DAFF) Department of Fisheries

				enhanced, if possible, to achieve highest possible levels of protection.	
Displacement of commercial fisheries should be offset with encouragements for aquaculture to maintain continuity of seafood supply (Aquaculture Council).	Loss of local seafood as result of diminution of fishing industry.	Construction & Operation	HIgh	Promote integrated coastal and marine planning initiatives on a regional scale, which provide opportunities for all potentially affected stakeholders to input into long term coastal zone management	Departments of Fisheries, Environment and Conservation, Planning, WAFIC, ACWA,PPA, KLC, and others

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Stakeholders Consulted

The study team interviewed 58 people with fisheries interests that could be affected by the proposed JPP LNG Precinct:

Acronyms

AAHC	Aquatic Animal Health Committee
AETOL	Aquatic Eco-tour Operators Licence
AIS	Automatic Identification System
APPEA	Australian Petroleum Production & Exploration Association
AQIS	Australian Quarantine Inspection Service
BPMF	Broome Prawn Managed Fishery
CPUE	Catch Per Unit of Effort
DAFF	Department of Agriculture Fisheries and Forestry
DoF	Department of Fisheries
FAD	Fish Aggregating Devices
FIS	Fisheries Impact Study
FTOL	Fishing Tour Operator's Licences
IMO	International Maritime Organisation
ITQ	Individual Transferable Quota
JPP LNG Precinct	Liquefied Natural Gas facility proposed for James Price Point
KGBF	Kimberly Gillnet and Barramundi Fishery
MPA	Marine Protected Areas
NDSF	Northern Demersal Scalefish Managed Fishery
PPA	Pearl Producers Association
PTS	Permanent Threshold Shift
Quondong-JPP	Quondong - James Price Point coastal area.
SIA	Social Impact Assessment
SFR	State of the Fisheries Report 2007/08
SS&MA	Specimen Shell and Marine Aquarium Fisheries
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TTS	Temporary Threshold Shift
WAFIC	Western Australian Fishing Industry Council

1 INTRODUCTION

This Fishing Industry Impact Study (FIS) has been prepared as part of the Social Impact Assessment (SIA) being undertaken by the Western Australian Department of State Development in order to identify and manage the local impacts of the Kimberley LNG Project. The SIA has been undertaken in accordance with the Strategic Assessment Agreement between the State of Western Australia and the Commonwealth Government.

Two complementary impact studies have also been commissioned, an:

- Indigenous Social Impact Study, conducted by the Kimberley Land Council; and a
- Tourism Impact Assessment Study conducted by KPP Business Development.

SIA is a research and planning process that typically involves a series of detailed consultations with multiple stakeholders in communities undergoing significant change. The purpose of this consultation process is to seek input about proposed developments from those groups, individuals and institutions most likely to be effected by them. It allows key issues and concerns to be identified in advance so that appropriate strategies for monitoring, mitigating and managing potential social impacts can be put in place throughout the implementation of the new development project (Taylor, Bryan and Goodrich 1990).

This FIS provides detailed information about how those fishing stakeholders that are most likely to be affected by development of the proposed JPP LNG Precinct expect their businesses and recreational activities to be affected.

If it is built as proposed, the JPP LNG Precinct will be a substantial project that will permanently alter the character of Broome and the west coast of the Dampier Peninsula. Those fisheries that are nearby can expect to be directly affected by environmental changes resulting from the scale of the construction, the need to dredge channels, and construct massive wharves and breakwaters. Other fisheries will be less directly affected but will be impacted by the increase in marine traffic, changes in priorities for use of existing facilities, and similar issues. For some, it may be increasingly difficult to source reliable marine oriented workers as the oil and gas industries attract the best of those available, with high wages and good conditions.

All fishers share the concern that the unique and spectacular marine environment that is adjacent James Price Point (JPP) should be impacted as little as possible. Currently there is little information available about the potential underwater effects of the proposed development. A substantial amount of environmental science may need to be generated in a short period in order to establish how the underwater engineering associated with the project will affect this environment.

Many fishers see good opportunities for the proposed JPP LNG Precinct to improve fisheries in the Broome area. This is especially so for about half the recreational fishers that were interviewed, whose main hope is that the development will bring better boating facilities to Broome. These people are confident that their fishing is unlikely to be affected. Indeed some think that it will improve as a result of the LNG facility providing various underwater structures that will act as fish aggregating devices. The other half of recreational fishers appears implacably opposed to the development and sees it as a negative. Some of these people think the inevitable disturbances to the marine environment will result in a significant decline in fish catches.

In order to try to assess the potential impacts on commercial fishing the Adelaide-based resource economics firm EconSearch was engaged to provide an economic analysis (see Annex). Many of the commercial fishing interests, and some recreational fishers, were provided with questionnaires and asked to provide detail of their business income and expenses. These were collated and used to generate an input-output analysis, which shows the economic flow-on effects of various hypothetical scenarios in which the JPP LNG Precinct has an effect on fisheries in the Broome/West Kimberley region. The scenarios are merely "educated guesses" based on the results of questionnaires and interviews with commercial fishers.

Following the chapter describing the study's methodology, below, a chapter entitled "Biological and Oceanographic Overview" attempts to describe the unique interplay between coastal and oceanographic environments that appears to affect the coast from Roebuck Bay to north of JPP. This is based on an interpretation of the variety of anecdotal evidence provided by fishers, and the informed estimations of fisheries scientists. It points to a fascinating marine ecology in this region, but the science that might validate or extend this view remains to be done.

The remaining chapters are simply organised by fishery, beginning with the recreational fishery. Each describes the fishery; most rely heavily on DoF information, especially the State of the Fisheries Report 2007/08 (SFR), and each contains some comment and/or rationale about the derivation of the estimates for the economic analysis.

2 METHODOLOGY

The brief for the study envisaged documentation of baseline data focused on the quantification of fisheries impacts of the proposed JPP LNG Precinct. This included economic modeling in the form of an input-output analysis (See Annex, Appendix 2 for a detailed discussion of input-output methodology). Current issues and trends in the fisheries were also to be investigated and discussed in order to better inform the planning process. This required substantial consultation with the fisheries stakeholders most likely to be affected by the precinct's development, and qualitative research techniques.

2.1 Engagement with representational agencies

Most commercial fishers, pearl producers, and aquaculturalists in Western Australia are represented by formal industry organisations. Recfishwest represents recreational fishers more generally. Recfishwest is a well-known agency that says that it "represents the interests of all Western Australian recreational fishers at the local, state and federal level" (www.recfishwest.org.au 10/09).

Initial meetings were held with these organisations. The purpose of the meetings was to introduce the project, learn the issues that concerned the organisations, and generate lists of appropriate contacts. This information complemented and augmented information provided by the Department of Fisheries (DoF), the current State of the Fisheries Report (SFR), and DoF staff.

Initial meetings were held with relevant industry organizations:

- Aquaculture Council of WA (ACWA)
- Pearl Producers Association (PAA)
- Recfishwest[2]
- Western Australian Fishing Industry Council (WAFIC)

[2] Telephone discussion with Kane Moyle of Recfishwest

These groups had already worked together on fishing, pearling and aquaculture-related issues during the Northern Development Taskforce (NDT) process.[3] The discussions with them were helpful for gaining an appreciation of the context of the proposed LNG development near Broome, and for establishing first contacts with the key informants of the study: the various holders of interests in fisheries, pearling and aquaculture. From these meetings, lists of specific contacts of those fishers thought to be most affected by the JPP LNG Precinct proposal were developed. Preliminary contacts with key individuals, mainly in the Broome area, were made.

In addition to the contacts made directly, a letter was sent to approximately 390 individuals and companies who had been identified in spreadsheets provided by the DoF as having Kimberley fishing licences of any sort. The letter introduced the project and its aims and sought contact with the addressees if they wished to follow up and contribute to the project (See Appendix Four). Ten letters were returned as unknown addresses. Ten contacts were made as a result of the letter, and these were followed up with interviews. Most of the interviews were conducted as a result of the contacts made through the various organisations, including the DoF, and subsequent follow ups from individuals who were recommended by interviewees.

2.2 Sampling strategy

Early in the project it became obvious that it would not be possible to talk to everyone with a fisheries interest that could be affected in some way by the choice to locate an LNG Precinct at James Price Point (JPP). Nor did a rigorous sampling strategy seem appropriate since this would restrict the scope of the work. It was important to speak to those people who were most likely to be directly affected by the proposed location of the JPP LNG Precinct near JPP. This meant limiting the project's interactions with those who were expected to be less affected. For this reason, for example, we determined not to contact the many interests in the Kimberley Prawn Managed Fishery. This fishery takes place entirely east of King Sound. Although the fishers may be affected in a secondary sense by needing to deal with the increased traffic the precinct may bring to the Port of Broome, and similar issues, they are unlikely to be affected in a direct way, like the Broome Prawn Fishery could be. The Broome Prawn Fishery takes place within a restricted area about 10-15 nautical miles due west of the Quondong JPP Area and appears much more likely to suffer potential effects from the precinct.

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[3] The NDT process assessed several possible sites for an LNG Precinct, and resulted in the selection of the Quondong-JPP area as the favoured option.

The sole licence holder in the *beche-de-mer* fishery was contacted. The Department of Fisheries indicated that the proposed JPP LNG Precinct is unlikely to directly affect this fishery.

Advice from the Department of Fisheries indicated that the WA portion of the northern shark fishery is unlikely to be affected in a significant way by the proposed development of the JPP LNG Precinct. There are thought to be two or three active fishers operating in this fishery in the Kimberley at present.

Recreational fishers were located for interview via the Broome Fishing Club and through key contacts recommended by Recfishwest. Individuals in the Broome recreational fishery were nominated and they, in turn, suggested others to interview. Those people who suggested others to contact were concerned that those they recommended for interview were reasonably representative, both of the range of fishing interests in the Broome area, and of opinion about whether the JPP LNG Precinct would be positive or negative to recreational fishing interests in and around Broome.

The representative nature of the "sample" established by this method was shown by the almost equal "for" and "against" spread of opinion among those interviewed. This appears to reflect the opinions present in the Broome general community, where a relatively even distribution of opinion, either strongly for, or strongly against, the proposed JPP LNG Precinct is evident.

2.3 Interviews

The one-on-one interviews were held at various locations around Broome, including coffee shops, people's homes, and offices. Each interview began with an explanation of the proposed JPP LNG Precinct based on information provided by the Department of State Development (DSD) and the DoF prior to the fieldwork. On each occasion, a sketch plan showing the approximate extent and location of the precinct was provided as context for discussions. It was always explained that this was conceptual only, and that the final location, size, and configuration of the precinct had yet to be determined. No copies of this plan were left with people. The dimensions of the precinct and relevant features such as the harbour, dredged channel, and wharf were explained with the help of the plan. The interviewees were then asked to comment on how they thought the proposed development would affect their fisheries interest. These questions would generate a discussion about the JPP LNG Precinct and its' potential effects. Interviewees were probed to consider both positive and negative potential effects and to suggest appropriate

mitigation strategies where possible. The discussions were recorded in notes. Normally the interviews would last an hour to an hour and a half.

Following the initial discussions, blank photocopies of the Australian Hydrographic chart Aus 324 that had been taken to many of the interviews were provided and fishers were invited to draw on them, to show where their fishing takes place, and how their activities may be affected by the proposed JPP LNG Precinct development. Figure 1 in the following chapter "Oceanographic Overview" shows a map of the coastline north of Broome based on information taken from the drawn maps of several recreational and charter fishers. It summarises their understandings of local environmental conditions and their interactions with these conditions. The mapping was more successful for the recreational and charter sectors than for the commercial fisheries because, with the exception of the Broome Prawn fleet, and a marine aquarium fisher, no commercial fishing specifically targets the coastal areas adjacent to the JPP LNG Precinct.

2.4 Broome fishing tournament

Interviews were held prior to and immediately following the Broome Fishing Club May fishing tournament. The fishing club is very active, and presented an opportunity to speak to a wide range of recreational fishing interests. With the help of an experienced local recreational fisher a one-page questionnaire was prepared, which sought some basic information about the values of recreational fishing, the species that the fishers typically targeted, and the areas relevant to the JPP LNG Precinct that were typically fished (see Appendix 5).

2.5 Follow-up

Following the field component of the research, de-briefing meetings or telephone discussions were held with the relevant representative agencies, WAFIC, Recfishwest, the Pearl Producers Association, and the Aquaculture Council of WA. Minor amendments were made as appropriate.

Each of the chapters dealing with specific managed fisheries were provided to the DoF for expert advice and suggestions for improvement, which were considered and adopted where appropriate. The exception to this was the Specimen Shell and Marine Aquarium Fisheries. This section was discussed with the relevant manager by telephone.

2.6 Customary fishing

This Fisheries Impact Study cannot be considered complete without inclusion of the potential impacts of the LNG Precinct on the customary fishing sector, which is considered to be equal in importance with the other fishing sectors. However, it has been necessary to delay consideration of these interests in the proposed JPP LNG Precinct while negotiations take place between Traditional Owners and Government. It is intended that customary fishing issues will be addressed in subsequent fieldwork and consultation in the very near future. A report on the customary sector will be an addendum to this Study when completed.

The table below sets out the numbers of fishing interests and those that were interviewed. It should be noted that some fisheries, such as charter fishing, have large numbers of possible operators, of which only a small number are active.

Table 1. Sample Details

Fishery	Number of operators	No. Interviewed	Approx % interviewed
Recreational fishing	Thousands, if tourists included. 1,200 boat owners in Broome, 400 members of Broome Fishing Club	26	N/A
Tackle shops	Three in Broome that specialise in fishing tackle	3	100%
Charter fishing	Approximately 10-15 operators-vessels in Broome – this is variable.	8	<50%
Pearling	Nine in West Kimberley area	6	66%
Specimen shell and Marine Aquarium	42 Statewide – many fewer active in West Kimberley	4	N/A
Broome Prawn	Five	4	80%
Mackerel	Three currently active in Kimberley zone – although many more licences	3	100%

	statewide		
Gillnet and Barramundi	One operator in "Broome Coast" area	1	100%
Northern Demersal	Seven active vessels in 2007	5	70%
Aquaculture	Three licences on Dampier Peninsula – none active	1	N/A

3 OCEANOGRAPHIC AND BIOLOGICAL OVERVIEW

There is a lack of detailed oceanographic and biological information relating to the west coast of the Dampier Peninsula. It is expected that these studies will be required as part of the JPP LNG Precinct planning process.

In the absence of detailed oceanographic and engineering studies, a great deal of experience-based and anecdotal observations and hypotheses have been developed by the people who use these waters more than anyone else: the customary, recreational, and commercial fishers, and the pearlers. The Fisheries Impact Study (FIS) interviewed a range of people with longstanding experience of these waters. The following is a summary overview of this information drawn from interested people in each of the fisheries sector groups.

3.1 Tidal movement

The obvious and dominant feature in this coastal environment is the tidal movement. The tidal range at Broome can be up to 10.5 metres on spring tides, and are among the most extreme tides on earth. The tidal movement is not a simple 'up-down' relationship with the coast, which would mean, in this case, that the tide would run west-east-west. Tides run north-north-west by south-south-east, creating strong currents along the length of the west coast of the Dampier Peninsula.

Several of the fishers interviewed anticipate that the tidal currents will have significant impact on the movement of sediments that will need to be dredged to create a shipping channel to the JPP LNG Precinct, and any associated dredging work, for example for pipelines. The fishers expect that any material suspended in the water column will be carried twice a day up and down the coast. It is understood that the tides flow at between 1.2-1.5 knots; however big spring tides can create currents faster than this.

A pearl farmer with long-term experience on the west coast of Dampierland characterised the marine environment off JPP as "robust". He noted that, in his view, the tidal flow would run roughly perpendicular to any dredged shipping channel seeking the shortest route to deep water and this would likely cause the channel to require constant dredging. He said that although the bottom consisted of coarse sand, which is considered to be relatively stable in normal conditions,

cyclonic conditions stirs the sand into suspension within the water column. He pointed out that the pearl oyster has adapted to the sandy conditions by evolving its shape into a wing foil, which helps it keep the sand at bay.

The length of time that particulate matter is suspended depends on the nature of the sediments. Coarse sand can be expected to settle quite quickly, while fine particulates and silt may remain suspended for a much longer time, and consequently settle over a much wider area. This has implications for dredging operations associated with the proposed JPP LNG Precinct. Some of the people interviewed, including the pearl farmer above, were of the view that the long-term effects of fine particulates suspended as a result of dredging could extend the negative environmental consequences of the proposed JPP LNG Precinct widely along the west coast of the Dampier Peninsula. The pearl farmer was particularly concerned about the effects on the pearl beds, and coralline structures in the Lacepede Channel, about 30 nautical miles to the north.

Advice from DoF research staff suggests that the scale of the development at JPP is likely to have some effect on the local oceanography (S. Newman pers. comm. 6/09). It is noted that the tidal and current flow moving past the large structures necessary for the JPP LNG Precinct could potentially alter water flows locally, and so directly impact on this near-shore littoral drift movement. This impact will need to be assessed as part of the planning and development process. In addition, there is a need for before and after impact studies to be conducted, so that the physical effects of the coastal infrastructure associated with the proposed precinct can be determined.

3.2 Does Roebuck Bay drive the system?

A consistent theme among knowledgeable recreational fishers, supported by DoF research staff, indicates that Roebuck Bay plays an important role in generating a unique and highly productive marine eco-system west of the Quondong-JPP coast.

The wide Roebuck plain east of Roebuck Bay is an ancient former mouth of the Fitzroy River. Now dry, the wet season's torrential rains inundate it every year and carry the detritus of the dry season: insects and larvae and vegetation, into Roebuck Bay. These nutrients fuel a system that generates phytoplankton that is consumed by zooplankton, that provides food for juvenile fish, and so forth. The result is that the Bay generates "bait balls" of small fish and other creatures. Some people say there is also movement of baitfish up the Eighty Mile Beach, and that this intersects with the baitfish from Roebuck Bay. The bait balls leave the bay during the dry season

and move north along the coast past Cable Beach and Willie Creek to the waters west of Quondong and JPP during the dry season.

3.3 Bait balls

Recreational and charter fishers have observed that the bait balls follow relatively predictable routes, though there remains some conjecture about the precise routes they follow. Some appear to move "out wide" of the coast, while some remain closer to the coast. The constant theme is that the bait balls move northwards. They appear to be made up of sardines/pilchards and other juvenile fish. The fishers say that as the bait balls reach the area near Quondong they move towards the northwest and head toward the feature known locally as the "Peanut."

3.4 Predatory fish

The bait-balls appear to attract substantial numbers of large predatory pelagic fish. A substantial billfish aggregation occurs annually in the waters west of the Quondong-JPP coast. The main species are sailfish, with some juvenile black marlin.[4] The sailfish aggregations are highly predictable in both abundance and catch-ability, according to recreational and charter fishers.

The area off JPP is the only known concentration of billfish in the area. Some recreational fishers consider there may be opportunities for catching more black marlin further out to sea, however this does not appear to have been tested. Some recreational fishers also believe that the bait balls attract the humpback whales into the area. Several charter fishers, in their advertising, use the phrase "Where there's whale's there's sails".

The area also supports substantial numbers of other pelagic fish species including Spanish mackerel, tuna, cobia, and whaler sharks. Although the locations of greatest activity changes through the season, fishermen enthusiastically refer to areas such as "Mac Central" and "Mayhem Reef", to underscore the drama of catching large numbers of pelagics when the areas are "firing."

[4] Charter fishers commented that they thought the ratio of sailfish to black marlin to be about 10:1.

3.5 The Peanut and the Puddle

Two key bathymetric features are located west of the stretch of coast between James Price Point (JPP) and Quondong. The "Peanut" is a ridge of about three miles length, located about 12 nautical miles west of JPP and about two miles south. It has a characteristic peanut shape on the

chart. The "Puddle" is an oval depression of about 3.5 miles length, about five miles west of Quondong. Both features are shown on Australian Hydrographic chart Aus324 (See Fig.1). There is a general consensus among boat-based recreational fishers that these features are important for making the areas to the west of Quondong- JPP a special place for recreational fishing out of Broome.

The areas between Quondong and JPP are an optimum distance for a boating day-trip from Broome. It takes about two hours to get there, travelling at 22-26 knots. The combination of proximity and fishing productivity make them especially valuable to the recreational fishing sector.

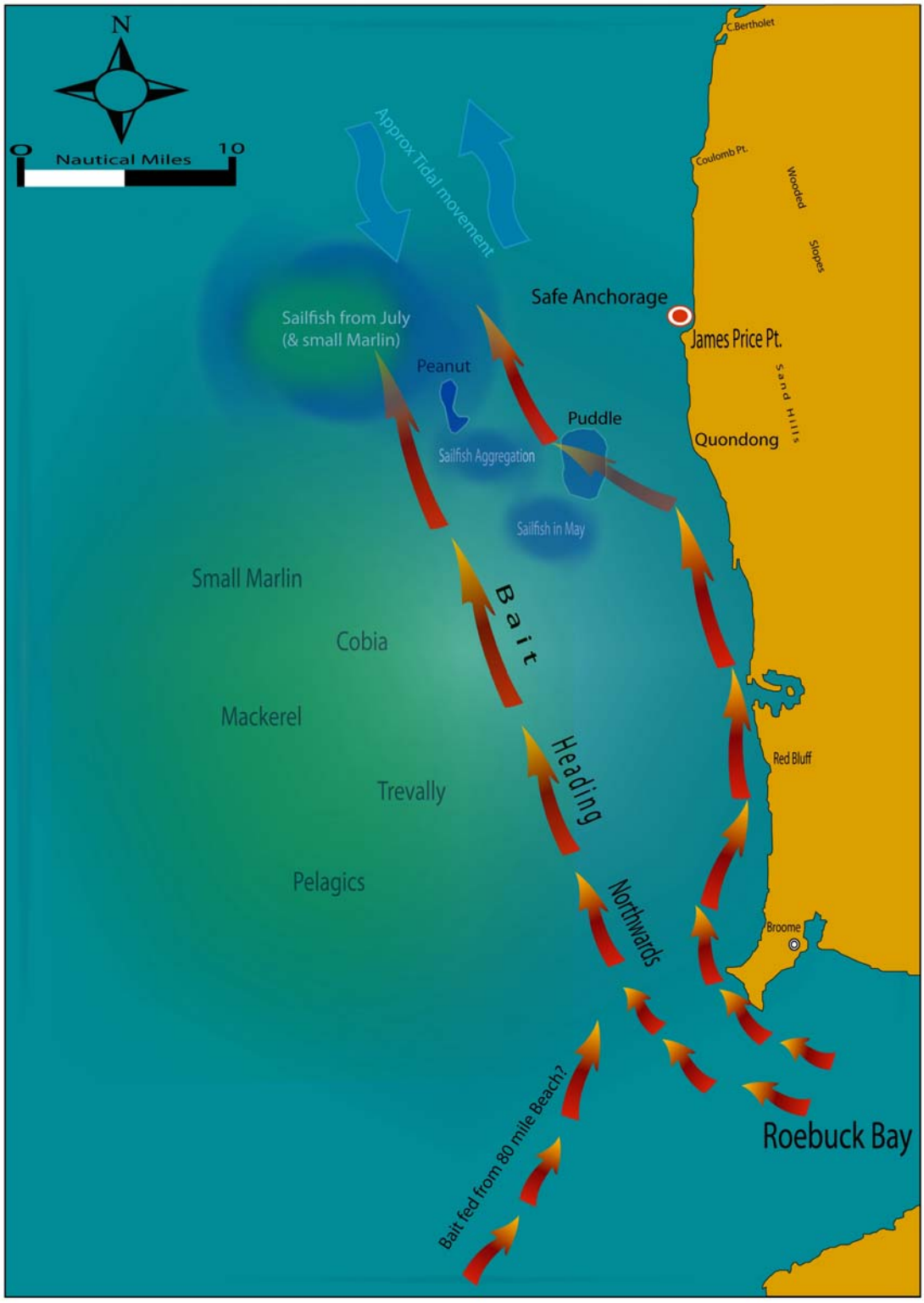


Figure 1: Hypothetical view of the movement of bait from north of south - based on fishers information

The most significant catch here is sailfish, although many other species of pelagic fish are also caught. Charter fishers, and keen recreational fishers, said they could typically "raise" 30-40 sailfish per day, and land up to 10, during most productive part of the season, September/October. There are anecdotal reports of boats raising 150 sailfish in a day near the Peanut.

Sailfishing activity begins in May, and remains active throughout the Dry season. Some fishers claim the best fishing is in the later months, September and October, while charter fishers report that areas around the Puddle off Quondong provide good fishing areas in the early part of the season. It is thought that the bait balls move north towards the Quondong-JPP area early in the Dry and then head northwest towards the Peanut later on.

Other key pelagic recreational finfish species caught in the general area include:

- Black marlin,
- Spanish mackerel,
- Cobia
- Tuna
- Trevally
- Whaler sharks

Demersal and reef species include:

- Coral Trout
- Snapper
- Blue-bone
- Rankin Cod

Occasionally an unusual sighting is made. One charter fisher, for example, recently spotted a large white pointer shark just to the east of the Peanut. This is well outside the normal range of this predominantly temperate water species. Leather back turtles have been seen, as have whale sharks and killer whales (*Orca* spp.).

Large marlin are thought to be found in deeper water to the west of the Peanut, however the comments about this were less conclusive than for the areas closer inshore. One charter fisher reported hooking up a large marlin estimated at 1,000 lbs (455kg), at the Peanut.

The Peanut is also recognised by the Broome Prawn Managed Fishery (BPMF) – although the prawn fishermen call it "The Kidney". The BPMF operates in this area for about three months from June to August in the years that it is fished. The bottom around the "Kidney" is thought to be hard sand, and produces large King Prawns that are visually more appealing than other King Prawns. The BPMF fishermen claim to get a premium price of $1.50 per kilogram more for Broome prawns because the prawns look so good, and because they have an unusual "white" or translucent gut string.

3.6 Upwellings

In addition to the unusual concentration of billfish and other large pelagics west of Quondong-JPP, the waters there produce pearls that their producers refer to as "ultra-premium." Clipper Pearls attributes much of its success at its current location to the unique oceanographic situation west of the Quondong – JPP area. Clipper considers that waters flow from the edge of the continental shelf through the seas at Quondong-JPP and bathe this area in phyto-plankton rich waters from the East-Indo Trench (Clipper FIS submission).

3.7 Freshwater aquifers?

Charter fishers and others say there are underwater freshwater springs west of Barred Creek. Only a small number of former "hard-hat" divers and a few local enthusiasts know about these. Whether they play a significant role in attracting the apparently unusual levels marine activity in the area is unknown.

4 RECREATIONAL FISHING

4.1 Overview

Recreational fishing in Broome is both an enthusiastically embraced passion for many residents, and a keenly sought after experience for many visitors. Broome has approximately 1,200 licensed recreational boats (1270 as at August 2009 – Dept. of Transport). Broome Fishing Club is among the most active clubs in Western Australia, and has nearly 400 members. Tackle shop owners report: "most visitors to Broome want to do some fishing." The caravan parks contain many of the "grey nomad" group, retirees who are keen to spend much of their time fishing.

The Grey Nomad phenomenon is increasingly evident around Australia and reflects, at least partly, a widespread pattern of seasonal migration whereby travelers from the south of the country seek out warmer environments of the north (Onyx and Leonard 2005).

While there is little published data available on the impacts of the Grey Nomad phenomenon in Western Australia, Stoeckl, Greiner and Mayocchi (2006) have examined the effects of the equivalent tourist sector on fisheries in Carpentaria Shire in the North of Queensland. They report that retirees constitute the most visible sector of this group. They tend to stay for the longest number of days, and that fishing constitutes one of their primary interests. This new demand, they argue, is putting increased pressure on local fish stocks (see also Greiner, Stoeckl and Schweigert 2004).

Collins (2008) reports that marine tourism in general is steadily increasing in the Kimberley region. `

> *"Marine tourism includes all activities associated with the coast and adjacent waters. It includes a wide range of activities such as four-wheel driving, beach camping, sea-kayaking, marine wildlife observation, sport fishing and sightseeing trips*" (Collins 2008:112).

He estimates that marine tourism was worth $100 million in 2005. As a result, coastal waters are being more heavily fished, although Collins reports that there is little data available on the impacts of recreational fishing in the region.

The Tourism Impact Assessment prepared by KPP Business Development (2009:16) reports that tourist numbers recorded for Broome in 2008 were approximately 250,000, with the projection for 2012 reaching 342,905 (p.56). Given this projected rise in numbers of tourists visiting Broome, along with Collins' (2008) evidence for increased participation in marine tourism in the region, it seems reasonable to assume that recreational fishing in the areas immediately surrounding Broome will also increase over the next decade.

Many of the tourists who come by car bring a small boat with them, on a trailer or as a roof-top. However it was not possible to estimate the numbers of these. Generally it could be expected that most tourists who bring a boat to Broome will expect to do some fishing. However, the lack of local knowledge and the limited size and capacity of most tourist boats likely means that most of these people engage in the "wide range of activities" noted by Collins, above, of which fishing is a part, and do not become ardent Broome fishers. Nonetheless, a portion will return to Broome year after year and build up their local fishing expertise, and consequently have a more significant fishing effect.

4.2 Creel survey 1999-2000

Recreational fishing around Broome is significant. In 1999-2000 the DoF undertook a survey of recreational fishing effort and catch between Onslow and Broome. Recreational fishers were interviewed at boat ramps and patrols along the coastline. The study divided the Pilbara region into two zones: Onslow-Dampier and Dampier-Broome. The Broome portion of the survey included interviews at Broome Jetty, Entrance Point, Gantheaume Point, Cable Beach, Town Beach, Riddell Beach and Crab Creek (Williamson et al. 2006). The study estimated that across the Pilbara region there were approximately 201,000 fisher days, of which:

- 109,000 were from boats launched from ramps,
- 26,000 were from boats launched from beaches, and
- 67,000 days by shore-based anglers.

The study found that the major centres of Dampier and Broome were the most actively fished areas, and that the dry season was the favoured fishing season (Williamson et al. 2006:11).

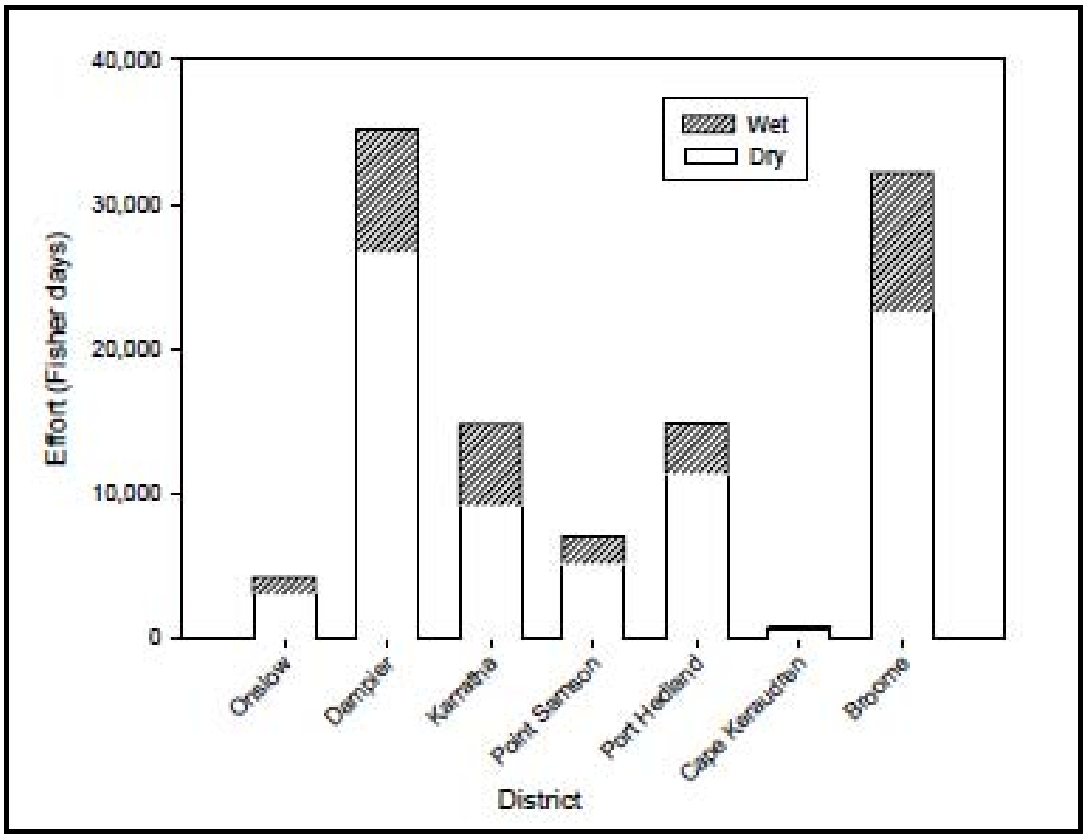
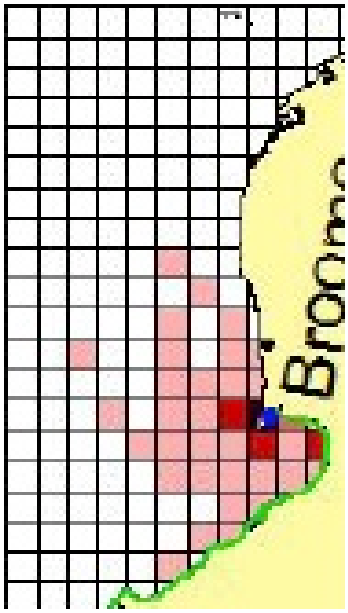


Figure 2: Recreational fishing effort - Pilbara ports 1999-2000 Source: Williamson et al. 2006:35



The recreational fishing "heat map" (Figure 3) is taken from Williamson *et al.* 2006. The pink values represent 1-400 "boats per block," while the darker red represent values of 800-1500 "boats per block." The figure shows clearly that the greatest recreational fishing intensity occurs close to Broome and dissipates further away. Nonetheless, there was substantial recreational fishing over a wide area in 1999-2000. It can be assumed, based on Collin's advice above that the total level of recreational fishing will have steadily increased over the past decade, though the recreational study is yet to be repeated. The 1999-2000 survey focused on finfish and does not appear to have accounted for the bill-fish fishery in this area. The wider Pilbara map from which it is taken forms Appendix 1.

Figure 3. Recreational Fishing Heat Map

4.2.1 Local Broome boat fishing

The general predictability of the weather during the dry season (April-October) means that relatively small boats can be used to access areas some distance from the coast, though this is limited when the prevailing strong easterly or south-easterly winds are blowing. Small trailerable runabouts are the most popular vessel. Broome does not have a marina, and moorings and anchorages are very limited. It is not normally advisable to have a small boat in the sea during the Wet, or in the cyclone season, although fishing does continue into the Wet.

Some Broome Fishing Club members speak of traveling up to forty nautical miles out to sea to reach favoured fishing grounds during the Dry, but most people are less intrepid – and safety depends on the size and reliability of the vessel. Their options are to fish for reef-fish at various inshore locales or to travel further afield in order to find more productive waters. It is common for recreational fishers to travel up the west coast of the Dampier Peninsula, which is relatively protected from the prevailing easterly winds.

There is also substantial use of the system of tracks and roads up the western side of the Dampier Peninsula to access fishing grounds. Most of the access to these areas is from the shore only because it is difficult to tow a boat up the coastal tracks, though some do. The capacity to maintain this access, past the proposed JPP LNG Precinct, is a major local fishing concern.

4.2.2 Mini - survey

A knowledgeable Broome recreational fisher helped to construct a one-page questionnaire for delivery to interested participants of the Broome Fishing Club May tournament. The questionnaire sought to glean basic information from the tournament participants about their fishing activities that might be affected by the JPP LNG Precinct's development. The questionnaire sought information in three basic areas:

- Level of investment in fishing boats and gear,
- Level of fishing that might be affected by JPP LNG Precinct development, and
- General attitude towards JPP LNG Precinct development.

The sample size of 15 was small, and the survey was limited to Broome Fishing Club members who were participants in the tournament. It can therefore be assumed that this was a sample of some of the more enthusiastic fishers in the community.

Half of respondents said they had invested between $5,000 and $20,000 in fishing gear. Half had invested more than $40,000 in their boat, and about a third of respondents had spent more than $70,000 on their boat.

The survey asked questions aimed at determining whether the JPP LNG Precinct was thought to be detrimental to recreational fishing activity. Despite the small sample, the answers appeared to reflect the general views of the community, which were picked up in the more detailed interviews. Essentially, the Broome recreational fishing community appears divided about equally about whether the JPP LNG Precinct will have a positive or negative effect on fishing interests.

Table 2. Questions about how JPP LNG Precinct will affect fishing, and whether there may be benefits to recreational fishing.

	Question	Yes	No	Don't know
1	From what you know of the James Price Point LNG (JPP) proposal do you think it will reduce your recreational fishing effort during the construction phase?	5	5	5
2	Do you think the completed project will reduce your fishing effort over time?	6	7	2
3	Do you see benefits to recreational fishing as a result of the JPP development?	7	8	0

4.2.3 Recreational attitudes to the proposed JPP LNG Precinct

Roughly half of recreational fishers that were interviewed or were spoken to, saw potential positive advantages in the JPP LNG Precinct's development, or were relatively neutral about whether it would have a positive or negative effect on their fishing.

Positive attitude

Key among the potential for positives were the perceived opportunities the development might bring to improve the recreational fishing and boating scene in Broome. Most of these people lamented the very basic boating infrastructure at Broome. Some, including tackle shop owners, thought there would be a good opportunity to have a boat-launching facility, with a secure recreational car park and boat storage facility associated with the JPP development. This could have a benefit in extending the range of recreational fishing, alleviating some of the pressure

around Broome. They also hoped that the Precinct would provide an impetus for Government to provide more suitable boating facilities in Broome, such as a marina.

Several of those recreational fishers who see the JPP LNG Precinct as a positive, said they think the jettys, channel-markers and other features will act as fish aggregating devices (FAD)s. These people tend to be of the view that whatever happens at JPP, recreational fishing activities will continue and they expect to maintain their fishing activities and adapt to any new situation.

Negative attitude

The most prominent concern of those recreational fishers opposed to the JPP LNG Precinct was that the precinct would despoil a wonderful natural area. This was a concern for both the onshore and offshore aspects of the development, but the primary focus tended to be on the offshore elements. There was worry that the development would affect the sailfish aggregations and the special character of the waters west of the Quondong-JPP area. They were worried about the visual effect of being confronted with a large industrial structure next to their favoured fishing grounds, and they felt that this development would be the forerunner for further large-scale development in the Kimberley, which they opposed.

Those recreational fishers who see mainly negatives were concerned that the scale of the development would have significant negative environmental effects. Some were of the view, shared with charter operators, that the fisheries near Dampier were spoilt for a period of 10-12 years as a result of gas-related disturbances there. This view was unable to be substantiated within the constraints of this project.

The loss of the specific area near JPP that would be used for the Precinct was lamented, but several of these people could see that access to other areas may also be enhanced as a result. This generally positive outlook was tempered, however, because they were concerned about the increasing local populations near Broome and the fact that the wilderness aspect of the Kimberley, especially around the Broome area, was dwindling.

This group also tended to be less positive about the likelihood of better marine facilities in Broome. Their views about this included:

- Government or the Shire should have already provided more adequate facilities and they did not think it was appropriate for these to be offered as a "sweetener" to soften local attitudes towards the JPP LNG Precinct,

- Broome was a difficult place to plan marine infrastructure because of its unique geography, compounded by significant Aboriginal heritage issues.

- Any further development of marine facilities for recreational fishers needed to be balanced against the increasing commercial traffic that was inevitable as a result of the JPP LNG Precinct.

There was also concern that any restriction to the northerly flow of recreational fishing and camping activities would place increasing pressure on locations nearer to Broome such as Barred Creek.

4.3 Tackle shop owners

Two of three tackle-shop owners interviewed held positive attitudes towards the proposed JPP LNG Precinct. They thought there would be benefits, not only to their businesses from the increasing population, especially during the construction phase, but more broadly in terms of better infrastructure. Their key concerns were that road/track access to areas north of the proposed JPP LNG Precinct should not be restricted.

The tackle-shop owners noted that during the Dry season the Broome population swells from about 14,400 regular residents, when about 45,000 tourists per month visit the town between May and September.[5] Most visitors do at least some fishing. Those with the positive attitude did not think the proposed JPP LNG Precinct would affect the attitude of visitors towards Broome or result in decreased recreational fishing by visitors – "*so long as the [JPP LNG Precinct] is clean.*"

One tackle-shop owner was implacably opposed to the proposed JPP LNG Precinct development. He was concerned that the tourism business in Broome is "ticking along nicely" and that the JPP LNG Precinct will endanger this trade, in part because the aspect of Broome being the gateway to the Kimberley wilderness with its associated values, will be compromised. He noted that the "*ooohhh-ahhh*" factor described by his tourist customers about flying into Broome would be lost. The JPP-LNG Precinct would be easily visible from planes landing in Broome. He said that European visitors often commented to him about development proposals with remarks such as: "*how can you be so stupid [as to industrialise an area of such natural beauty]*."

[5] www.broomevisitorscentre.com.au/page/populationstatistics

His other key concern was that provision of access for industry in situations such as the JPP-LNG Precinct was increasingly being offset by the creation of marine conservation zoning that included sanctuary zones and other forms of marine protected areas (MPA). These environmental offsets restricted access for recreational fishers. This, he said, would have a wider effect of forcing people away from areas they know, and which they have fished for many years in a sustainable way – taking reasonable amounts of fish to eat on the beach or nearby.

Table 3. Key issues raised by recreational fishers

Issue raised	Potential Impact/ Benefit	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Local overfishing during construction phase	Local depletion of fish due to recreational overfishing by construction workers	Construction	Critical	A plan to protect the Quondong-JPP area from overfishing during the construction phase should be developed in consultation between DoF, Proponents, and recreational fishing groups including the Broome Fishing Club.	Proponent Department of Fisheries
Access to areas north of JPP LNG Precinct potentially hindered	The LNG plant could prevent normal coastal traffic north of the Precinct. Historically there has been access up the west coast of the Dampier Peninsula beyond JPP.	Construction & Operation	High	Maintain coastal vehicle access around the JPP LNG Precinct.	Proponents Department of State Development Department of Transport Department of Planning
Better boating facilities for Broome	Upgrade of boating facilities in Broome (currently inadequate)	Construction & Operation	Critical	Investigate options for JPP LNG Precinct development to contribute funds towards new recreational boating facilities.	Proponents Department of Transport Broome Port Authority

Possible marine facility at JPP LNG Precinct	Shift of some recreational fishing effort away from Broome	Operation	Medium	Establish a recreational boating facility near to the JPP LNG Precinct.	Proponent Department of Transport Department of Planning
Sailfish aggregations potentially disturbed.	Increased activity, dredging, and disturbance near areas of known aggregations of sailfish and other pelagic species could impact on existing marine environment. Lack of scientific data to assess potential impacts.	Construction & Operation	Critical	Fund research into potential effects of LNG precinct construction and on-going operations on pelagic fish stocks, including sailfish. Make the outcomes of this research publicly available – in accessible language.	Proponent in consultation with Department of Fisheries

4.4 Construction phase overfishing problem

During the interviews we told all fishers, based on discussion with DSD personnel, that the construction phase of the project would generate up to 3,500 temporary jobs for workers over a period of two-three years. Many of these people would reside near the site in a camp.

There was concern that many construction workers would be keen to do some fishing as part of their recreational activity. This would put unreasonable pressure on local fish stocks. It was considered necessary by most recreational fishers that the construction workers should be denied the right to fish in local waters in the Quondong-JPP area.

4.5 Access north of the JPP LNG Precinct

A significant number of recreational fishers were worried that exclusion zones surrounding the JPP facility would restrict access past the LNG plant to favoured recreational places further north such as Coloumb Point and Carnot Bay. Most complained that there was, as yet, insufficient understanding of how access arrangements to these places would be maintained.

4.6 Better boating facilities for Broome

The lack of good boating facilities was strongly felt by all sections of the fishing community. Most recreational fishers, and charter fishers were hopeful that the proposed JPP LNG Precinct project would result in the provision of better boating facilities in Broome.

4.6.1 Boat ramps

The recreational fishers interviewed were all very clear about their attitude towards the existing boat ramps in Broome. All three boat ramps are problematic in most weather and tide conditions. This forces many recreational fishers to launch their boats from the beach at Gantheume Point. This, they complained, was unfortunate because it required them to drive their vehicles into the salt water and then park them higher on the beach for the entire time the boat was being used. This was a security issue, but more importantly the saltwater corrosion and rusting to the vehicles made it very expensive.

Figure 4. Recreational boat launching Gantheume Point Beach

4.6.2 Hard-stand

The Broome hard stand area for boats is perhaps best described as "rudimentary." It is small, unpaved, and relies on apparently dilapidated jinkers for hauling out vessels. In the photo below a near-new charter vessel is just in front of the white ute. The owner said he was very nervous when he needed to remove it from the water for maintenance.

Figure 5. Broome hardstand area with recreational, charter and commercial boats

Figure 6. Boat ramp associated with Broome hard stand area

4.7 Sail fishing

The attractions of sailfish (*Istiophorus platypterus*) fishing are the excitement and spectacle of it. The fish are released after capture. There is skill involved in getting them to "hook-up" but the main thrill is in playing the fish, which jump and run and put on a remarkable show. The fish are brought to the boat – sometimes a picture is taken, and they are released to be caught again.

The sheer numbers of sailfish that are available for hooking up is impressive. The numbers were always mentioned during interviews with keen pelagic fishers. People spoke of good days when up to 40 fish could be hooked up, and exceptional days late in the season when 150 would be raised, but a typical day was about 10 fish.

The Peanut is about the right distance from Broome to make an extended but memorable fishing experience. It is approximately 30 nautical miles north of Broome, and can be reached in a couple of hours by a well-found boat in good weather. The typical fuel bill might be 120 litres. This makes it an achievable destination for a keen recreational fisher.

The fishers who enjoyed going to the Peanut and other areas off the Quondong-JPP coast were enthralled with the marine activity that they could engage with. They spoke of watching as the

sailfish would work the schools of pilchards to the surface by circling them and forcing them into columns. Then the dolphins would arrive, and "*four or five hundred dolphins*" were described as "*coming through*" and carving up the columns. Other marine animals like leatherback turtles and humpback whales would be seen. Killer whales, white pointer sharks, and whale sharks have been reported as visiting the area, as have leatherback turtles – though sightings of these species are more rare.

Several of the recreational fishers had interesting anecdotes to tell as part of their speculation about why the areas west of Quondong-JPP should be so prolific. There appeared to be a relatively common view that the bait headed north in two streams, one nearer the coast than the other. Both headed north on the current towards the Peanut. The inshore stream turned northwest when it reached the Barred Creek area, heading across the Puddle. Both streams then extended beyond the Peanut where they appear to disperse later in the season.

The south end of the Peanut, the recreational fishers say, is the strongest aggregation point for sailfish. There is speculation that the currents there are unusual. One fisher said that he had marked the location of a float near the south of the Peanut that appeared to be caught in an eddy and did not significantly change position for three-four days.

4.7.1 Are the sailfish local?

The recreational fishers are perplexed as to why the sailfish are so predictable around the Peanut. A visiting fisheries scientist, Dr Julian Pepperell, was asked in the 1990's to give a view about the population. He did a limited genetic study that showed there was some genetic connection with sailfish caught near Dampier. However, the extent of this connection is currently unknown.

> *It's thought that sails aggregate offshore where nutrient-rich coastal waters meet the open oceanic waters. These areas hold concentrations of plankton, and subsequently the baitfish that feed on them, which in turn is what the sailfish are looking for. DNA fingerprinting carried out on sailfish from the prolific waters around Broome a few years back showed that there was a degree of common gene material among both Dampier and Broome sailfish. The interpretation, given by Dr Julian Pepperell who carried out this work, was that at some point in time there was intermixing of both stocks. But where and when remains a mystery.*
>
> *(http://www.westernangler.com.au/default.asp?action=article&ID=150 accessed 7/09)*

Broome sail-fishers have developed a hypothesis that the sailfish aggregation represents a discrete local population. Although Dr Pepperell's study would seem to refute this proposition, by showing that there is a genetic connection between those populations near Broome and those

near Dampier, there is some evidence that sailfish in the Indian and Pacific oceans tend to generate population structures. The structured sailfish populations are not inconsistent with the sail-fishers' notion of a localised population, albeit over much larger areas than the Broome sail-fishers might be thinking.

The key science on this point is from work done by Dr Jan McDowell who conducted mitochondrial DNA tests on 600 sailfish as part of a PhD project. She found significant heterogeneity among sailfish from the Pacific and Indian oceans, that was lacking in Atlantic ocean populations (Graves and McDowell 2003:293). This "… suggests that sailfish exhibit significant population structuring both between and within oceans" (Graves and McDowell 2003:293). In Dr Pepperell's view this "…does mean that they are prone to form separate populations (although this really means over large distances)" (J. Pepperell pers. comm. 7/09).

Dr Pepperell also conducted an economic study of the annual Broome sailfish tournament in 1992. This may be part of the basis for the local estimation that this tournament brings an income of $1 million to Broome each year. Unfortunately we were unable to locate the report.

A tagging program for sailfish has been in place since 1986. The New South Wales Department of Primary Industries manages the data from this program. Between September 1986 and September 2008 there had been in excess of 5,500 sailfish and 150 black marlin were tagged and released. These figures include 22 sailfish that have been re-captured after being tagged (P. Bolton, NSW Fisheries Manager pers. comm. 7/09).

Although there has been much tagging of sailfish, there appears to be little analysis or scientific examination of data as a result. This is frustrating to some charter fishers who would like to know more about the stocks upon which their businesses depend. One of the charter businesses interviewed was considering funding its own tagging program in the hope of generating better information.

4.8 Shore based angling

Barred Creek, Quondong, and James Price Point (JPP) are favoured shore-fishing places for local Broome people and tourists. Barred Creek is the nearest significant coastal feature north of Willie Creek and is a scenic and sheltered embayment that provides a number of choice locations for beach camping and coastal fishing. Quondong, further up the coast, is somewhat more exposed but is also a favoured place for locals and provides an excellent reef for fishing. There appears to be somewhat less recreational shore-based fishing at JPP, which has some cliffs or steep hills to

be negotiated before gaining access to the beach and the inshore reefs, but it also provides excellent fishing reefs.

Recreational fishers said there were two main reefs at JPP that were good fishing. Popular local fish is green snapper, or maori perch, commonly called "gidit" by Indigenous people, but mangrove jack, threadfin, whiting, and other near-shore species are also caught, as well as painted crayfish.

The area to the north of JPP itself, sheltered from southerly and easterly winds by the point, and protected by the reefs, is the only safe anchorage on the coast south of Cape Leveque to Broome. It is used regularly by recreational and charter fishers.

4.9 Economic modeling – recreational fishing

Given the disparate range of recreational fishing in the Broome area it was not possible to provide realistic data relevant to the input-output analysis as provided by many of the commercial fisheries. The "mini-survey" that canvassed tournament attendees yielded some useful data. Some, more detailed, data was collected from a small number of committed recreational fishers, but there were insufficient numbers of participants in this part of the survey to make the results meaningful.

Nonetheless, data collected by the DoF on catch and effort of recreational fishers in the past, has shown that there has been a rapid increase in demand for recreational fishing, and the associated pressure on fish stock for target species in the Broome area in the past 20 years or so. An estimate of the value of recreational fishing in WA was prepared based on data from the National Survey of Recreational Fishing in 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 then made based on the recreational fishers "utility" derived from fishing activity. Travel cost, based on distance travelled to recreational fishing sites, was 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).

5 CHARTER FISHING

5.1 Overview

Currently there are about ten charter fishing operators that are based in Broome. Of these, some operate more than one vessel. Around 15 active vessels currently offer fishing tours from Broome.[6] There are also aquatic eco-tour operators (AETOL), land-based fishing tour operators, and land and boat based fishing tour operators. These tour operators are in much smaller numbers than the boat-based fishing tour (charter) operators.

There are many potential boat-based charter licensees that hold interests in fishing tour operator's licences (FTOL) with Kimberley endorsements. Only a portion of these licences is active. The Minister for Fisheries has committed to a review of charter licences on a region-by-region basis. The large numbers of inactive licences generate much "latent effort" in this fishery sector. This is a significant issue both for active fishers and management.

The Broome fishing tour operators range from small specialists offering tours such as kayak fishing and creek-based fishing for barramundi, threadfin and other near-coast species, to operators with large and expensive vessels that range up the Kimberley coast into and beyond the Buccaneer Archipelago.

We held interviews with six charter operators and one owner/investor. Of these, four were active and offered boat-based fishing tours, one was a fishing camp operator, and one was inactive because his boat was in disrepair. One of the operators was in partnership with the investor and worked several vessels for which he hired skippers.

The four boat-based active charter operators specialised in providing tours near, or offshore from the Quondong-JPP area. However, two of the operators had vessels that permitted them to fish a wider area; one was a kayak-based operator.

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[6] A much smaller number of charter fishing operators are based in Derby, but these operators were not interviewed as part of this study. It was thought they would be much less affected by the specific development of the JPP LNG Precinct, although there may be some impact from the general development of the Browse Basin gas.

The key concerns of the charter sector were that the construction and ongoing dredging needs associated with the JPP development would affect the sailfish and other local fish stocks. They pointed out that they had no information as to whether the access channel to the JPP LNG port would need continual maintenance dredging, and there was little or no information available to assess the potential impact on their businesses.

5.2 Importance of the Quondong-JPP area

Most of the charter operators fish between Broome and areas north. Interviews were concentrated among smaller operators who work the west coast of the Dampier Peninsula. The operator interviewed with the largest boat offered tours mainly between Broome and Pender Bay near the northern end of the Peninsula, though his boat was capable of more extended journeys and he would occasionally go to Scott Reef or the Rowley Shoals. The others mainly offered day-trips from Broome.

5.2.1 Billfish specialists

Three of the fishing tour operators we interviewed specialised in bill-fish charters. The operator who works north to Pender Bay also said that he spends about 15-20% of his fishing time in the areas around the Peanut fishing for billfish and other pelagics. Some of the billfish specialists cater to the top end of the market; others offer more affordable tours.

"People come from all over the world to catch sailfish here."

One of the bill-fish fishing tour operators specialises almost completely in bill-fish and has a near new boat built specifically for this purpose. He noted that almost all his clientele were from the 'top end of the market;' people who came from all over the world and stayed in five-star accommodation when in Broome. They came specifically to catch sailfish and marlin and he estimated that they would spend more than $500-600 per night for accommodation in Broome for a family for a week of fishing, and their other expenses would match this high-end expenditure.

This operator follows the bait that moves up the coast through the dry season until the season reaches its climax around the Peanut. He said he has a steady customer base that is attracted primarily by the reliability of the sailfish resource.

A second bill-fish specialist has four vessels and is in a partnership arrangement with the investor. He has a jet boat of more than 12 metres (40 feet) with a top speed of 30 knots, a 10 metres (33

feet) centre cabin boat, and two six metre (20 feet) dinghies, for which he hires skippers. About 65% of the customers of this business are from overseas or interstate, with 30% from Perth and southern WA, and about 5% are locals.

The operator's two smaller vessels work the coastline generally north of Barred Creek, and the area near JPP is a favourite place because it provides relatively sheltered waters and a nearby safe anchorage if it is necessary. Although the larger vessels specialise in bill-fish the two smaller boats are also used for angling for species such as threadfin, and coastal reef fish.

He fishes the area between Broome and Tallboys Rock, about 13 nautical miles northwest of JPP. He also follows the bait up the coast during the season, working the larger boats further out. He has a self-imposed conservation rule that the larger boats should fish at least 15 nautical miles from Broome and no closer than 10 miles from shore. The operator said that he and the other charter fishers were always careful avoid driving through the "bait balls," but sometimes they would drive around the balls to try to herd them together. He told an anecdote that once he was herding a ball from one side and noticed that he was helping a humpback whale by herding the bait into its mouth.

This operator has been charter fishing in Broome for 11 years and historically has fished the Puddle and Peanut as key features. He currently catches and releases an average of about 30 fish per day from the Peanut later in the season. He noted that much of the bait appears to hug the coast on its way north early in the season, travelling on 'blue water fingers', but then disperses later in the season and scatters out towards the Peanut.

The investor that is partner in this business expressed some frustration that he has been unable to raise any serious scientific interest in the sailfish and marlin resource in Western Australia. Although his vessels have enthusiastically participated in tagging programs and have conscientiously provided log-book returns, he complained that little scientific research on the resources upon which his business depends seems to have eventuated.

The third bill-fish specialist operator's boat was in disrepair and he was unable to fish the current season. He noted that he had caught 400 sailfish and tagged 100 the previous year. When his relatively small boat (nine metres) was working well, his business depended on taking small parties on day trips for sailfishing and viewing the spectacular marine life off the Quondong – JPP area. He said that he liked to give his customers 'a good view of the marine life in the area' and that this included many big turtles, sea snakes, humpback whales and big sharks.

5.2.2 Attitude of billfish specialists

The billfish specialists were pessimistic about the JPP LNG Precinct. They thought it would negatively impact their businesses. Two of the four said that their previous experiences at Dampier led them to believe that the dredging and construction associated with the construction of the LNG harbour and ongoing dredging requirements would have a very significant effect on the capacity to catch fish in the area. In their experience Dampier had had excellent sailfishing prior to 1989 but that it was "*ruined*" as a result of laying pipelines associated with LNG development there. They said that that fishery was "*just coming back now*."

One of the billfish specialists is intending to build a new boat and said that he is including the fact of the JPP LNG Precinct's development in his plans. He said he was of the view that the precinct would affect his capacity to fish relatively near the shore, and said that if the precinct was to go ahead he would consider building a 40 foot long gamefish vessel rather than his preferred 33 foot vessel because he anticipated needing to "go wide" i.e. further out to sea than the Peanut.

5.2.3 Demersal charter specialist

A number of charter companies specialise in offering reef-fishing tours. One interviewee operates a 60 foot (18 metre) vessel, plus whale-watching tours from a high-powered open speedboat. This operator is less reliant on the pelagic aggregations opposite the Quondong-JPP area because of his concentration on reef fishing and whale-watching. The reef fish are caught in various places offshore from Broome. The humpback whales follow the coastline, appear to come in quite close following bait and, arguably, may be affected by the JPP development, which was of concern to him. He also had experience of the Dampier installations and was of the view that in the areas where seismic testing had been done, the fishery had been severely affected for more than a decade.

5.2.4 Kayak charters

One fishing tour licensee offers fishing tours by kayak. His clients are set up with trolling gear, and he leads them by kayak to catch mainly the two available species of threadfin salmon. He has won three tourism awards and thinks that he is the only kayak fishing business in Australia.

In spite of being a set of very small boats in a large space, he is very restricted in where he is able to operate. Most of his business is done near the Broome Port (c.90%) but JPP is his only realistic away-from-Broome alternative. This is because Willy Creek is not available due to the

danger of crocodiles, and Barred Creek is unsuitable for other reasons. JPP is a good place for him because it is protected from both easterly and southerly winds and there are good fish there.

The Broome Port is becoming much less viable to this charter fisher because the threadfin on which he depends are getting harder to catch. He considers that his catch is down about 80% in the Port area over the past few years. He ascribes this downturn to the increase in Port traffic, and believes that the traffic will only increase as a result of the JPP LNG Precinct's development. He thinks that any further restrictions on boating in the Port area are likely to affect him greatly and make the Port tours untenable.

He pointed out that threadfin are a relatively short-lived species, living about six years, and that their life-cycles and habits are easily disrupted. He noted that despite the good efforts of individuals the science on the threadfin salmon continued to be in "bits and pieces" primarily due to lack of funding.

5.2.5 Fishing camp charter concerns

The fishing camp charter operator's principle operation is a considerable distance from Broome and JPP, in the coastal Kimberley. Although his business is unlikely to be as directly affected by the JPP development as the others, he had strong views.

In this operator's view, the JPP LNG Precinct is likely to set a precedent for other major industrial developments in the Kimberley, including the mining of bauxite on the Mitchell Plateau, and the eventual damming of the Fitzroy River for industrial-level agriculture, which will in turn attract chemical and fertilizer plants, and hydro-carbon refinery operations.

Table 4. Key issues raised by charter fishers

Issue raised	Potential Impact/ Benefit	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Fear that seismic and other disturbance will damage fishery.	Lack of clarity about actual effects of construction/dredging etc. is fuelling concern about potential effects.	Construction & Operation	Critical	Promote public understanding of engineering and construction processes, and strategies to minimise potential environmental impacts when the final design and location have been determined. Relevant science should be summarised and made available to public.	Proponent Department of State Development
Dredging will be disruptive.	Charter fishers think that dredging will not be limited to the immediate port areas and will need to be extended to nearer to the main pelagic fishing grounds, and may impact on pelagic fish stocks including sailfish.	Construction	Critical	Prepare a dredge management plan, which includes details of spoil disposal, timing, disposal of spoil and on-going maintenance dredging requirements in consultation with potentially affected stakeholders including charter fishers, prior to construction.	Proponent Department of Fisheries Department of State Development Department of Transport

Dredged channels will need to be maintained.	Fishers are concerned about benthic disturbance associated with maintenance dredging for vessel access.	Operation	Critical	See above	See above
Better science on sailfish aggregations.	Charter fishers rely on pelagic fish aggregations, which may be disturbed, with unknown consequences.	Construction & Operation	Critical	Fund substantial publicly available research into the potential effects of LNG precinct construction and on-going operations on pelagic fish stocks, including sailfish and marlin.	Proponent, in consultation with Department of Fisheries.

5.3 Discussion of charter fishing issues

The key issues that relate to charter fishing are primarily about the potential physical impacts on the sailfish and pelagic resources, and the "specialness" of the areas of sea located immediately west of the Quondong-JPP coastline. All the charter fishers were of the strong belief that this is an area of sea that, for reasons unknown to science, creates a spectacular concentration of pelagic fish, marine mammals, and other predators. This is what attracts their customers.

It is unfortunate that more scientific work has not occurred on the bait movement, the concentrations of predators, and the sailfish and marlin aggregations. Although substantial effort has been put in by recreational and charter fishers, especially in respect of the tagging program, it is claimed that little adequately funded science has been done.

It should be expected that the scientific exploration of the waters off the Quondong-JPP area would be part of the agenda associated with the environmental approvals process for the proposed JPP LNG Precinct. A result may be that more information about the apparently unique aggregations of billfish and other species is established.

The concerns raised by charter fishers, that the construction of the Dampier LNG facility had negative effects on sailfish populations there, and that there is potential for this to also occur near JPP, should further explored.

The other range of issues raised by the charter operators related to the increase in traffic and congestion in Broome Port. Virtually all segments of the fishing community have these concerns. The charter fishers have a particular range of issues associated with the need to use the beach and Gantheume Point as a main access point for their charters. One operator invested in an expensive dinghy that has retractable wheels so he can drive his passengers from the beach to the charter vessel anchored offshore. Another complained that it cost him about $3,000 per year in rusted brakes and structural corrosion on his vehicles because of the need to use the beach regularly.

5.4 Input-output rationale

For the input-output rationale it has been assumed that the charter industry is likely to have a boost in activity associated with the construction of the proposed JPP LNG Precinct, due to an increase in construction workers fishing for recreation. These people may be restricted from fishing near the proposed JPP LNG Precinct they will be building, but some may wish to take

fishing charters and in this respect they would be no different than other members of the public. The construction phase is likely to increase Broome's population and this will naturally flow on to an increase in charter fishing. However, limiting the increases in charter activity are the port issues. These may currently be limiting the participation of charter fishers who are licensed to work the Kimberley area and would be entitled to operate out of Broome, but do not. Based on the comments received, the increase might be at least 10%.

Following the development of the JPP LNG Precinct it is also estimated that there may be a decline in charter fishing in the vicinity of up to about 10% from its current level of activity. This decline could be the result of people being "turned off" by the notion of a large industrial site adjacent the Broome coast. There was opinion that European visitors in particular would be put off by the nearby industry. However, there may also be environmental consequences, as several of the charter fishers think there will be. In the unfortunate event that these predictions come true some of the pelagic elements of the charter fishing could be reduced considerably, although it would seem there will always be a call for chartering that includes reef fishing and fishing for demersal species.

6 PEARLING

6.1 Overview

Pearl Oysters (*Pinctada maxima*) are found in nearshore areas throughout the Pilbara and West Kimberley. The pearling industry began in the late 1860s in the Western Pilbara where Cossack (near Roebourne) became a major pearling centre. In the later years of the 19th century the focus of Western Australian pearling moved to Broome and pearl shelling for "mother of pearl" was the town's major industry until the Second World War. Following the war, plastic was a readily available replacement and the demand for pearl shell declined.

The modern pearling industry developed from the 1950s and is based on cultured pearls. Pearl shell is collected from a range of known pearl shell "beds", principally at 80 Mile Beach and near the Lacepede Islands. The DoF regulates the collection of shell as a closed entry quota allocated fishery. Hatchery based pearl shells are cultivated in private aquaculture facilities owned by pearling companies. The DoF also regulates the growing out of hatchery oysters and the total seeding levels across the industry.

To cultivate a pearl, the pearl oyster is implanted with a specialised shell nucleus made from mussel shell and suspended in the water in pearling panels on "longlines." As the pearl oysters grow, they coat the nucleus with nacre, which will hopefully develop into a round pearl over a long period of time (usually two years). A single pearl shell can be seeded three separate times over its productive life. Ideally, pearl oysters are individually cleaned of fouling material every 21 days. Each pearl farm operation (the majority of which are sea-based) consists of collection infrastructure for the wild oysters, and sometimes aquaculture facilities, seeding facilities, cleaning vessels, accommodation facilities and the longline systems, which house the seeded and non-seeded pearl oysters during grow-out. The DoF issues pearling leases to pearling licence holders, which define the area within which pearl oyster aquaculture activities may occur.

The pearl oysters filter-feed from the ocean. The surrounding seawater provides all their nutritional needs. Although they are suspended on the longlines in the farms, rather than being on the sea floor, the pearl farmers try to mimic the natural condition and feeding state as much as possible.

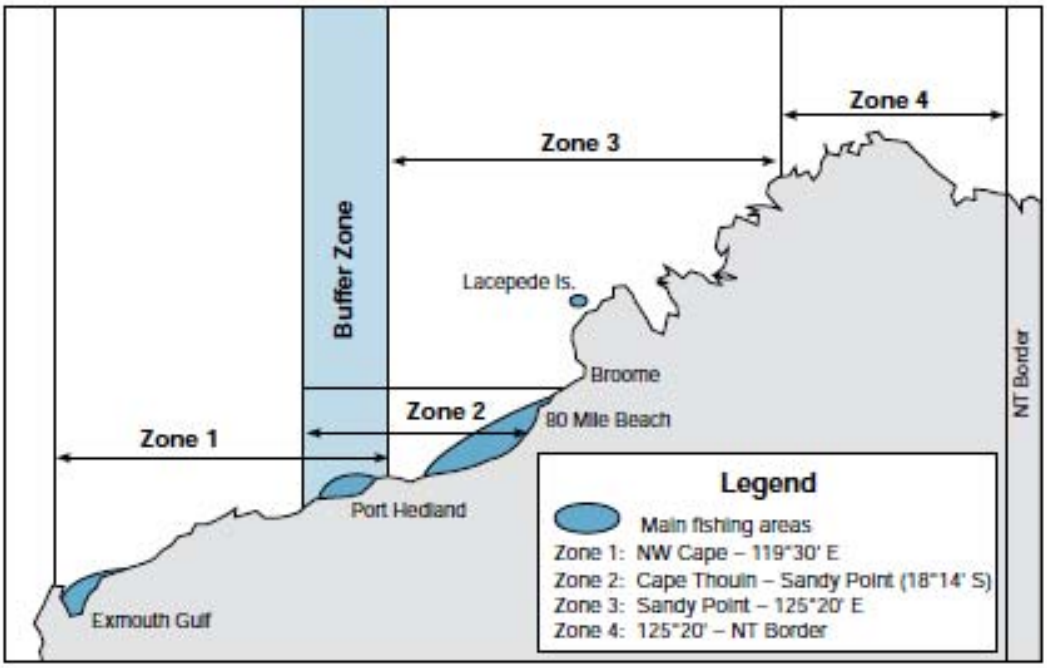


Figure 7: Location of main pearl oyster fishing areas (Source SFR:186).

6.1.1 Physical and biological requirements

Pearl oysters are filter-feeding bivalves. Pearl producers use the oysters' ability to access food in the water column and convert the food into growth. The pearl oyster shells experience optimum growth rates when located in areas of high phytoplankton density, strong current flow and a low background level of siltation.

According to Clipper Pearl's submission to this study:

> *"The energy required by [pearl oysters] to first ingest, then digest, available food, needs to be at such a level that allows scope for growth. Changes to that energy budget that result in significant decrease in the efficiency of that feeding process will adversely affect growth and subsequent development and enhancement of the final pearl product."*

One of the main ongoing tasks for pearl farmers is the maintenance of the pearl shell. Shells become encrusted with marine growth that needs to be cleaned at regular intervals. Without this cleaning, the shell uses too much of its available energy to maintain its ability to open and close while feeding, and it is less likely to grow and produce good nacre to its maximum potential.

6.1.2 Production cycle

Each hatchery oyster takes from two to four years to develop from hatchery juveniles until they can be implanted with the nucleus. Each pearl then takes at least two years to develop after the nucleus is implanted. During this time the oysters are held in panels suspended on the longlines, completely dependent upon the surrounding ocean environment for nutrition and general health. The longlines are maintained and the oyster shell is cleaned on a rotational basis.

Each oyster is capable of being used more than once to produce a pearl. Most can be used twice; some can be used three or (rarely) four times. This production cycle is relevant to the impacts of the proposed JPP LNG Precinct on the pearling leases. If a year's cohort of shell is missed because of aquatic impacts during construction, from pollution or disease, the cycle of replenishment of shell will be disrupted, multiplying the effect of the initial disruption. This could produce considerable financial difficulty in an industry that is currently facing challenges.

6.2 Current state of industry

The current market for Australian pearls is not as healthy as it has been. The global economic downturn is severely limiting discretionary spending worldwide, dampening demand and it is difficult to maintain prices. The wild stock fishery is in a very healthy condition with prolific quantities of pearl oysters, some of which was un-fished in 2009 due to the difficult economic conditions.

Nonetheless, there appears to be discipline within the industry and pearl prices have not collapsed. A recent newspaper report (*West Australian* 12 Jan. 2009) quotes co-owner of exclusive jeweller, Linneys, a pearl producer for more than 50 years. He said that the pearl market has been around for 5,000 years and is certain to improve in time. However, operators are finding current market circumstances very trying in the short term.

6.2.1 Industry trends

The pearling industry is currently suffering from the global economic downturn. Pearling companies are finding it difficult to maintain viability and there appears to be a general trend of consolidation of pearling interests. The JPP LNG Precinct development is likely to exacerbate the trend towards consolidation. This is mainly because increasing local pressures such as access to good farm lease sites, access to wharfage in Broome and elsewhere, access to suitable labour, and the capacity to retain human resources, will be negatively affected.

The main pearl farm of the second largest pearling company is likely to be affected by the proposed JPP LNG Precinct because it is immediately adjacent the proposed precinct location. The outcome of the arrangements that will be required to accommodate the rights of this company cannot be known at this time. However, it seems likely that any reduction in pearl farming capacity generally will tend to exacerbate the trend towards industry consolidation. This could result in the negative effect of further reduced competition, dampening the entrepreneurial spirit that has been such a notable positive aspect of Kimberley pearling throughout its history.

6.3 Oceanic pearls

Until recently, most pearl farming took place in relatively sheltered waters. King Sound on the eastern side of the Dampier Peninsula was used extensively for pearl farming in the 1980s and 90s, and earlier pearl farms were established in locations such as Kuri Bay, further north in the Kimberley. There remain several farms in King Sound. However, Clipper Pearls pioneered the farming of pearls in open waters off the west coast of the Dampier Peninsula. It remains the largest pearl producer in this area, and its pearl farm is directly adjacent to the Quondong-JPP area.

Based on advice from an aged "hard-hat" pearl diver who had had considerable experience of collecting pearl shell in the earlier years of the 20th century, Clipper Pearls experimented with growing out cultured pearls in oceanic conditions. The hard-hat diver recommended the seas immediately west of the area between Quondong Point and JPP as the best place to develop quality cultured pearls.

The experiment was successful and Clipper Pearls is now recognised as producing a high-end product. Other pearling companies are now developing farms in oceanic conditions on the west coast, albeit at a somewhat smaller scale than Clipper.

In the area between Gourdon Bay south of Broome, and Pender Bay near the north end of the Dampier Peninsula, the following companies have pearl farm leases:

- Arafura Pearls Holding Ltd
- SJ and JD Arrow
- Australian South Sea Pearl Company Pty Ltd
- Clipper Holding Pty Ltd
- Maxima Pearling Company Pty Ltd

- Natural Pearls Pty Ltd
- Paspaley Pearling Company Pty Ltd
- Pearls Pty Ltd
- Roebuck Pearl Producers Pty Ltd

Clipper Pearls estimates that its site based at the Quondong-James Price Point coastal area accounts for approximately 17% of the total value of pearls produced in Western Australia (A. Ogg pers. comm.).[7] Clipper says it is the largest single producer of Australian South Sea pearls after the Paspaley Pearling Company.

The Clipper Pearl lease sites are located in close proximity to the proposed LNG Gas Precinct at JPP. The northern boundary of the Clipper Pearl farm site is approximately two nautical miles west of James Price Point and extends 8.5 nautical miles to the south, extending past Quondong Point. Due to its proximity and current level of activity, the Clipper Pearl site is the pearling site most likely to be directly affected by construction of the JPP LNG Precinct.

6.4 Consultations with pearl producers

Consultations with the pearling sector began with discussion with the Pearl Producers Association (PPA), in Perth. The PPA assisted by providing an outline of the main concerns of the pearling industry and making contact with appropriate pearl producers.

Senior officers in six pearling companies were interviewed. Two of these companies have their main pearl farms in King Sound, on the eastern coast of the Dampier Peninsula. The other four have significant interests on the west coast of the peninsula. Each of the companies was asked to provide a brief overview of the company and its operations. The basic facts of the proposed JPP LNG Precinct, including the size, shape, potential dredging requirements and other relevant facts were explained to the pearl producers. They were then asked to comment on how they thought the proposed JPP LNG Precinct, as described, would affect their company's pearling operations. Five of the six pearling companies discussed issues at length in face-to-face interviews. One was somewhat reluctant to discuss specific details of his company's concerns by telephone, and said

[7] This is an estimated figure based on production value, not volume, because the overall price returned is greater than the industry average (A. Ogg pers. comm.)

that he would be happy to contribute at a later stage when more specific information about the potential impacts of the proposed JPP LNG Precinct were available.

The most significant consultation was with Clipper Pearls because their pearl farm is so close to the proposed JPP LNG Precinct.[8] Clipper provided substantial written detail about their business and this has helped inform the discussion reported below.

The key concerns of the pearl producers are summarised in the table below and are elaborated upon in the discussion following.

[8] Clipper provided the study with detailed economic information for inclusion in the EconSearch input-output analysis. However, because the other pearling companies declined to participate in this aspect of the study it would be inappropriate, and relatively meaningless, to provide economic indicators based on a sample of only one company.

Table 5. Key issues raised by Pearling Industry

Issue	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies	Responsibility/Key Drivers
Suspension of solids in water column, sedimentation and changes to water quality and flow	Reduces feeding efficiency of oysters and reduces pearl growth and lustre.	Construction & operation	High – critical for Clipper	Prepare a dredge management plan, which includes details of spoil disposal, in consultation with potentially affected stakeholders including pearling companies, prior to construction	Proponent Department of Fisheries
Possible introduction of marine pests	Introduction of black striped mussel , Asian green lipped mussel, and similar pests that could make it difficult or impossible to maintain oyster health and cleanliness.	Operation	Critical	Biofoul inspections (Quarantine Pre-arrival Report) to be conducted by Australian inspectors as a condition of entry to Australian waters. Specific relevant regulations relating to biofoul inspections should be reviewed and enhanced, if possible, to achieve highest possible levels of protection.	Proponent Australian Quarantine Inspection Service (AQIS) Department of Agriculture Fisheries and Forestry (DAFF) Department of Fisheries
Possible introduction of oyster disease.	Increased incidence of disease affecting *P. maxima* due to transfer of pathogens on LNG	Operation	High	Promote research and assess possible effects of pearl oyster disease.	Australian Quarantine Inspection Service (AQIS) Department of

	carriers.			Implement aquatic animal health surveillance requirements.	Agriculture Fisheries and Forestry (DAFF)
Risk of collision with pearl farms.	Pearl farms damaged by collision with LNG related marine traffic	Construction & operation	Medium	Increase visibility of Pearl lease site through use of markers and lights	Project proponents in consultation with pearling industry
Increased competition for wharfage in Broome	Pearling vessels forced from existing wharf because of limited space and priority given to LNG related traffic.	Construction & operation	Critical	Investigate and promote alternative berthing facilities to service pearling and other marine interests in Broome.	Broome Port Authority Departments of Transport and Planning
Increased competition for marine oriented staff.	Pearling staff will be attracted to higher wages associated with LNG Precinct employment at JPP and elsewhere.	Construction & operation	Critical	Use 457 visa exemption to permit pearling companies to engage overseas workers as they have in the past.	Dept. of State Development Dept. Immigration and Citizenship (C'th)
General living costs increased.	Increasing costs of living in Broome will generate inflationary pressure on pearling wages.	Construction & operation	Medium	Contribute to the SIA management plan to attract and retain lower paid workers.	Department of State Development

Environmental offsets limit options for pearl farms.	Gradual reduction of pearling lease areas as a result of increasing marine environmental management arrangements.	Construction & Operation	High	Establish integrated coastal and marine planning mechanisms on regional scales, to address concerns arising from potentially conflicting coastal and marine user groups.	WA Government plus relevant agencies

6.5 Pearling issues

6.5.1 Suspension of solids

Two of the pearling interest holders in our sample of six had their main base of operations in King Sound and did not think sediment plumes or other physical disturbance from dredging and other undersea earthworks would directly affect them. Two others were of the view that sediment issues could be a problem but that they did not expect to be directly affected by them.

Clipper Pearls did expect to be directly affected by sediment issues because of their proximity and considered that significant change to the existing physical conditions were "*likely*" and of "*high impact*" on the business.

Although acknowledging that it does not have the capacity or the background information to fully comprehend the physical effects of the JPP LNG Precinct development, Clipper Pearls said that it considers it reasonably likely that impacts would include, but not be limited to:

- *Sedimentation, siltation, turbidity, and reduced water quality as a result of dredging the shipping channel,*
- *Changes to local water chemistry from the building of the breakwater,*
- *Changes to bottom topography, composition and nutrient flow due to tidal scouring,*
- *Explosive excavation during the construction phase, with unknown consequences,*
- *Alteration of the alongshore current flow, with changes to the available food regimes.*

These impacts could bring long-term changes to the local ecosystem, which will affect water purity and nutrient levels. Any increase in the levels of suspended particles in the water column may interfere with photosynthetic processes that support the production of phytoplankton and zooplankton that are critical for the pearl oysters survival, growth and health.

Another experienced local pearl farmer owns significant pearl farm licences on the west coast of the Dampier Peninsula. He expressed strong concerns about the potential for the dredging associated with the JPP LNG Precinct to disturb nearby pearling beds including in the Lacepede Channel. He said the Lacepede Channel bed has at times accounted for about 10% of the wild catch pinctada maxima fishery, and that it was especially important for the local pearl farms

because it provided oysters that did not need to be moved far from their original location. In this pearl farmer's opinion the shipping channel associated with the proposed JPP LNG Precinct was likely to require more or less continuous dredging due to the strong tidal flows and regular cyclone activity.

Detailed consideration of the geotechnical aspects of the proposed JPP LNG Precinct site will need to be conducted as part of the planning for construction. The outcomes of these studies will determine the magnitude and the character of the physical changes to the water column and ocean floor as a result of the construction of the harbour, breakwater, and shipping channel. Detailed planning of ways to mitigate the necessary disruption will need to be done following the geotechnical study. Of particular interest to the pearling industry generally will be the capacity to deal with fine particulate matter that has the potential to create sediment plumes that extend over a wide area.

6.5.2 Marine pests

All pearling interests are concerned about the introduction of marine pests. The issue raised is that the increased marine traffic as a result of development of the proposed JPP LNG Precinct will inevitably expose the Kimberley pearling industry to greater risk of marine pests.

Figure 8. Black Striped Mussel (source DoF)

The black striped mussel (*Mytilopsis sallei*) could create a serious threat. This species, which originates in central South America, has infested various Pacific and Asian ports and already been discovered in Darwin (see DoF website). The primary concern of pearl farmers is that the mussel proliferates rapidly and would quickly foul pearling longlines. The mussels attach themselves to the pearling infrastructure and pearl shell, compete with the oyster for nutrients, and make shell cleaning and maintenance difficult or impossible. Such species can reproduce at alarming rates, resulting in fouling and loss of both equipment and biological assets. In the worst case, the inability to clean the shell would make pearl production unviable.

A recent paper on the introduction of marine pest species by hull fouling and ballast water in tropical areas summarises the state of science on the matter. It concludes, in essence, that the evidence points to fewer problems with introduced species and pests in tropical waters. Part of this, the authors acknowledge, may be:

> *[b]ecause most marine non-indigenous species have been reported from temperate rather than tropical areas, [and] it is unclear if the apparently lower numbers of marine species introductions (including 'pest invasions') in tropical Australia are purely a function of the smaller number of studies. Lines of evidence have started to emerge, however, that tropical ports may be more resistant to marine introductions, at least in the central Indo-West Pacific. Reasons include their high biodiversity and apparent homogeneity (i.e., containing many estuarine, coastal and reef species with widespread distributions compared with the more restricted biota in the equivalent habitats of temperate areas) (Huchings et al. 2002: 226).*

Thus, there appears to be somewhat less concern for the introduction of marine pests in tropical waters than in temperate waters – but this hypothesis is yet to be strongly tested. The potential for the introduction of pests remains a serious worry for the pearling industry. This worry will be exacerbated by the development of the JPP LNG Precinct.

6.5.3 Oyster disease

The pearling interest holders raised the possibility of increased traffic introducing disease to pearl oysters. There are diseases associated with *P. maxima* and other *Pinctada* oysters that could be transported to Western Australia as a result of increased vessel traffic. There is a rickettsia-like organism that has caused significant mortality of *P. maxima* in Hainan Province in China (Wu and Pan 1999). In the 1990s a disease in western Japanese *Pinctada fucata mertensii* pearl oysters was found to be caused by a "filterable agent" although whether this was an infectious disease such as a virus or the result of local environmental conditions such as toxic algal blooms was unclear (Minoru 2000).

It seems obvious that international traffic of ships between areas that host natural populations of *Pinctada* species will increase, to some extent, the possibility that diseases affecting these species may be transferred. Presumably, increased vigilance of marine aquatic animal health is the appropriate antidote.

The Aquatic Animal Health Committee (AAHC) – is the primary industry/government interface for policy, communication and awareness related to aquatic animal health issues. AAHC members represent the Australian, state and Northern Territory government departments with responsibility for aquatic animal health; the CSIRO Australian Animal Health Laboratory; the capture and recreational fishing industries; the finfish, mollusc, and crustacean aquaculture industries; and the ornamental fish industry. The committee's primary function is to provide

high-level policy and strategic advice … on national aquatic animal health issues. (Source: http://www.daff.gov.au/animal-plant-health/aquatic/committees, 7/09).

6.5.4 Navigation

Currently pearl farms are marked with standard "navigation aids" on relevant corners and marking channels. The lease areas are also marked on paper and electronic hydrographic charts. Despite the marking and lighting standards and ready availability of lease location information, accidents happen, and vessel interactions with pearl farm leases have been reported.

Figure 9: Corner mark at Clipper lease, with JPP in background.

The JPP LNG Precinct will increase the risk of marine traffic interfering with pearl farms because the area will be much busier. The risks of collision with pearling infrastructure will be correspondingly higher. Simple mitigation measures would include the JPP LNG project proponents upgrading the markers for the infrastructure associated with pearling so that it is more visible, both to direct sight and to radar. Electronic charts can also be updated at regular intervals. It may be appropriate to limit the movement of LNG tankers and other large vessels to daylight hours. (This suggestion would also be helpful in alleviating some of the navigation concerns of the Broome Prawn Trawl fleet.)

Pearling interests also complained that some international ships are not able to communicate sufficiently well in English to ensure that nearby vessels understand the ship's movements and that difficult incidents had occurred in the past because of this. It may be possible to use AIS electronic ship identification more effectively. Pilots will presumably be needed to bring ships into the JPP LNG Precinct's harbour. Consideration may need to be given to the distance from which the Australian pilots control incoming and outgoing vessel movements.

6.5.5 Wharfage in Broome

All pearling interests interviewed commented on the difficult situation at the Broome Wharf. In their view, the increased use of the wharf by the oil and gas industries has created a situation where it is becoming increasingly difficult to use, and where oil and gas vessels are given priority. The difficulties are considered to result from physical constraints and administrative inconsistency.

Figure 10. Pearling vessel, Broome Wharf

The Broome Wharf is a challenging facility for anyone who needs to use it to load or unload a small or medium sized vessel. The tidal range is enormous and material must be craned to and from vessels, sometimes up to many metres. The Wharf is protected from most weather, but it can become very difficult for smaller vessels.

The administrative concerns that the pearling industry has raised relate to ease of access. They noted that before the oil and gas industries became prominent, access to the wharf was much easier. Currently, visitors are required to undergo safety inductions, or to be escorted on the wharf. Strict rules apply, hardhats are required in many situations and there is not the easy on-and-off movement associated with other wharfs. Alternative wharfing is not available in Broome.

One of the pearling interests suggested that an option to improve the port could be construction of new floating jetties adjacent the Broome jetty. Floating arrangements are used in many marinas and yacht clubs and could provide some relief to smaller vessels that require wharf space in Broome.

6.5.6 Staffing issues

A major concern for the pearling industry, according to the people we interviewed, is the capacity to retain trained staff. The industry reported that it had a very difficult time with the recent mining boom because good workers would be attracted to the greater earnings available elsewhere. The provision of substantial opportunities for workers interested in pursuing maritime work and careers nearby in the Kimberley increases the likelihood that good people will be lured away from pearling into more lucrative oil and gas employment. The result, the pearling industry says, is that the quality of the workers left in pearling declines while the wages bills increase due to the need to compete with other industries for a share of the labour pool. Although several of the pearling companies are substantial businesses they say they cannot compete with the oil and gas industries and will inevitably lose their best and most highly trained employees to bigger employers. The need to train staff for specialist pearling work is especially frustrating when the trained recruits use their newly acquired maritime skills to leverage better opportunities in offshore oil and gas.

A suggestion from one of the pearling interests was that the Commonwealth Government could assist by supporting access to Temporary Business (Long Stay) 457 visas for international workers in the pearling industry. This company said their previous experience with Philippine and other Southeast Asian workers was very positive and they would welcome the opportunity to re-engage such workers.

The owner of the oldest pearl farm in the area noted, for comparison, that although the LNG industry was expected to have a lifespan of about 50 years, his father started pearling and had been employing local people, including Aboriginal people, since 1946; his pearl farm had been established in 1960 and had operated continuously in the 49 years since. He said that it employed about 80 people.

6.5.7 General living costs

The development of the JPP LNG Precinct is likely to further increase living costs and demands for housing. This will inevitably have a flow-on inflationary effect to many local industries. The

pearling industry indicated that is was worried that in addition to the challenges of keeping good staff, there would be underlying pressure to increase wages in order to keep up with the increased local cost-of-living.

6.5.8 Environmental offsets

Pearling company representatives raised the issue of the potential for environmental offsets. The Specimen Shell and Marine Aquarium fishery participants also raised this issue. Their issues are similar. They need continued access to significant sections of coastline.

"Environmental offsets" occur when, as a result of industrial approvals, Government supports the establishment of extended conservation estates in areas that are not likely to be required for future industrial development. Currently a marine planning exercise is being conducted by the Department of Environment and Conservation at nearby 80 Mile Beach due to such a process connected to the Gorgon gas project. While there are benefits in terms of better conservation of Western Australia's many unique environments, some relatively benign industries that require access to these environments find themselves restricted, especially in "sanctuary zones" where no extractive activity is permitted.

The Pearl Producers Association provided a draft report entitled "Demonstrating Environmental Credentials: *Pinctada maxima* Pearling Industry (Australia)". Among other things the report states that: "Several commissioned reports have been completed confirming the general view that pearling is environmentally benign." It also points out that the *Pinctada maxima* pearling industry "has adopted an Environmental Code of Practice and is currently establishing an Environmental Management System template."

The establishment of integrated marine planning processes in which all stakeholders in marine and coastal issues take part in regional planning exercises may be the best way to ensure sophisticated and workable planning in complex areas such as the Kimberley.

6.6 Issues specific to Clipper Pearls

The Clipper Pearls pearl farm is located immediately adjacent the proposed JPP LNG Precinct. Although the final location of the precinct is yet to be determined, it is certain that the Clipper Pearls lease will be very close. Therefore it is likely that Clipper will be more greatly affected than any of the other pearling companies.

Clipper Pearls has approximately 25 years of experience in the pearling industry, of which 10 years is at the current site between Quondong and JPP. According to Clipper's technicians, much of the experience gained from the current site is unlikely to be transferable to other available oceanic sites within reasonable proximity of Clipper's existing base. If the pearl farm needs to be moved because of the JPP LNG project, the move will come at substantial cost to the detailed environmental and other knowledge that has been built up over this time. In interviews, Clipper Pearls personnel emphasised that it takes at least two and a half years at any new location to establish basic results in terms of the location's capacity to produce high quality pearls. From this basic starting place, the specific site knowledge needs to be built and compounded over time. This intimate understanding of the site is not transferable or easily replicable.

Clipper's written submission to the FIS stated:

> *"The qualities of the pearls produced at this site are yet to be rivaled by any other producer. The fact that the clean, untouched pristine ocean waters, fed by the upwelling of phytoplankton rich current of the East-Indo Trench, appear to flow directly from the edge of the continental shelf through this offshore region of the Dampier Peninsula."*

In Clipper's view:

> *"… any changes to the turbidity (water clarity), flow direction and velocity, and come of suspended particles (non-food) in the waters around Quondong Point will likely impact on the general health and survival rates of pearl oyster being farmed, as well as the quality of product produced by these oysters (including the endemic wild-stock).*
>
> *Further impacts to the biodiversity and abundance of the phyto and zooplankton populations through reduced photosynthetic processes from changed turbidity area also expected to impact on the pearl oysters adaptation and survival in proximity to and down current of the proposed gas hub infrastructure.*
>
> *[Construction of] a … seawall and initial and ongoing dredging will also alter the physio-chemical attributes of the area, previously unaffected by any significant commercial activity.*

This project could have negative effects to one of the core competencies of our company; a business critical factor which provides our competitive advantage."

6.6.1 Genome project

Clipper is currently three years into a collaborative research and development project that seeks to identify some of the genetic attributes that are specifically triggered at the current lease area. In 2009 Clipper was also embarking on a further five-year program aimed at unlocking further genome information applicable to bio-mineralisation characteristics of pearl oysters. According to Clipper, the current site is essential to achieving the expected milestones and outcomes from this project.

6.6.2 Employment at Clipper

In a typical year (e.g. 2007/08), Clipper Pearls engages the equivalent of 94 full-time employees. This includes 32 ongoing full-time positions, plus casual workers making up 62 full-time equivalents. In addition Clipper engages specialist seeding technicians under seasonal contract. The work roles within Clipper range from land based administrators, logistics teams and managers, to expert marine scientists and marine workers such as vessel masters, engineers, catering crew, divers deckhands, and pearl-shell scrubbers.

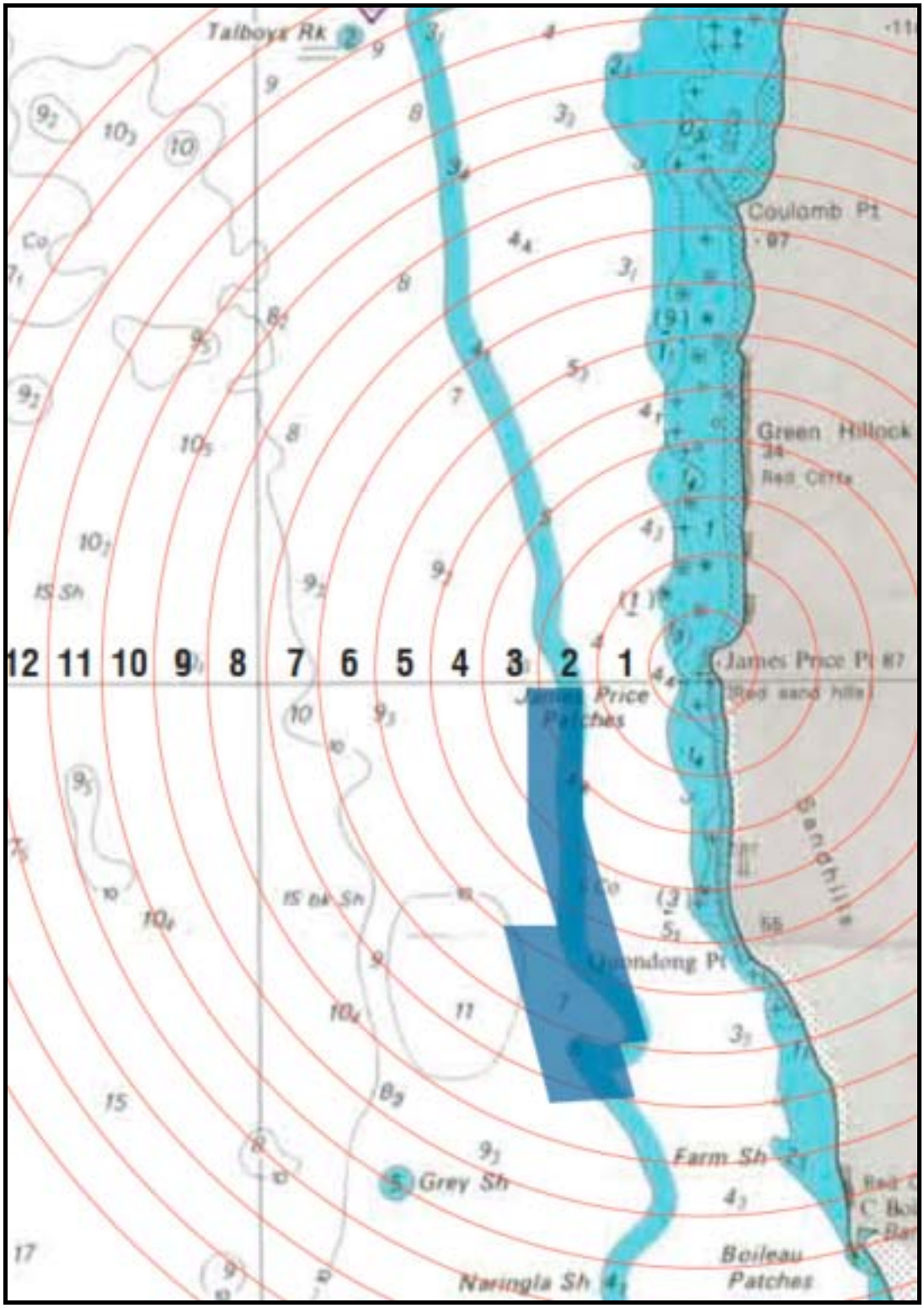


Figure 11. Map showing location of Clipper lease areas. Rings are at one nautical mile each.

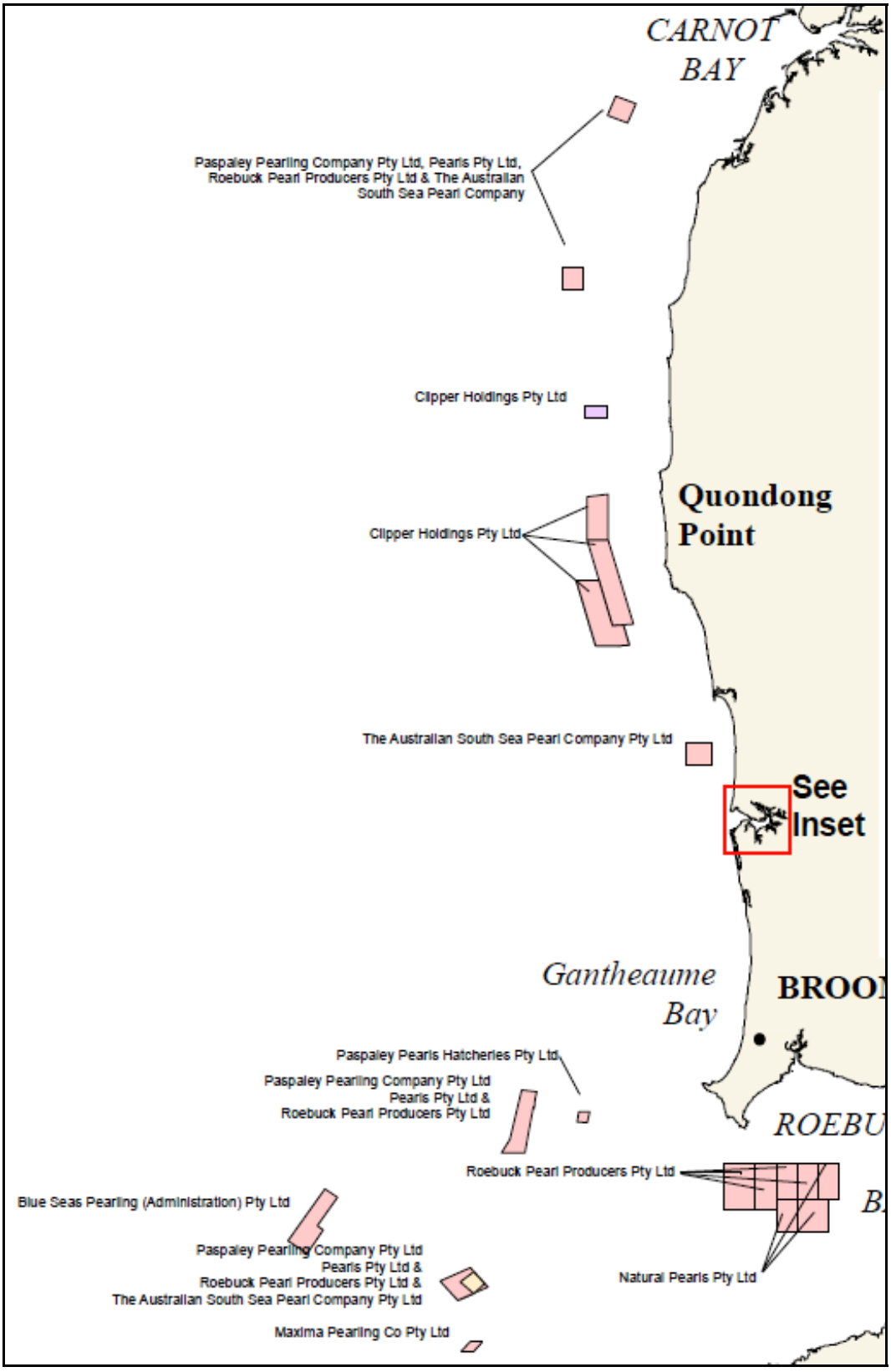


Figure 12. Pearling leases southern west coast of Dampierland Peninsula (Department of Fisheries)

6.7 Discussion

6.7.1 Input-output model not used

It is uncertain yet whether the proposed JPP LNG Precinct may have the effect of ruining the Clipper Pearls site because it is so close. Although re-location of the leases is possible, the specific position of these particular leases appears to be relevant to their capacity to generate a top quality product. Re-learning the fine-grained knowledge that permits a pearling operator to get the most out of a given site appears to be part art and part science, and takes some years to master. For these reasons we think that the proposed development of the JPP LNG Precinct will have a very significant effect on the pearling industry in the West Kimberley.

The DoF State of the Fisheries Report of 2007/08 states that while a "[p]recise estimate of the value of product is difficult to achieve … based on information provided by the industry … the value of cultured pearls and by-products was considered to be approximately $113 million in 2007" (SFR:185). The WA pearling industry provides employment for approximately 500 people (SFR:185).

Although Clipper Pearls generously provided detailed information on its operation, we were unable to get the same level of economic information from the other companies. In these circumstances it would be inappropriate, and ineffective, to run an input-output analysis.

7 SPECIMEN SHELL AND MARINE AQUARIUM FISHERIES

7.1 Overview

Specimen Shell fishers collect rare and interesting shell specimens primarily for private collections. Marine Aquarium fishers collect small fish and other marine fauna for use in aquariums. We interviewed two active specimen shell collectors and two marine aquarium fishers. One fisher said he would have his business directly affected by the JPP LNG Precinct's development. For the others, the impact of the precinct is expected to be less direct, but real nonetheless.

Specimen Shell, and Marine Aquarium fishers said that the west coast of the Dampier Peninsula is an important place for their fisheries. James Price Point is a regular place for these fisheries to operate. It was described as "*not major but important*." It was noted by a marine aquarium collector that the areas from James Price Point to Sunday Island, effectively the west and north coasts of the Dampier Peninsula, was a "*unique area*" that contains *"… lots of unique shell that doesn't live anywhere else.*"

One marine aquarium fisher collects hermit crabs. He claims JPP is an excellent place for finding hermit crabs because there is a good reef structure near shore and there are mangroves nearby. This fisher gets "*a lot of hermit crabs in the Price's Point area.*" Although he said there were some other places he could go to, these were becoming harder and harder to locate because of the specific requirements for hermit crabs, and for other species that are collected.

The fisher said that he always "farms" areas, especially for hermit crabs. This meant that he collects specimens from an area, then leaves it "fallow" to regenerate before coming back to it. In order to rotate the "crop," he needed other sites that he could use in a similar way. The loss of the JPP site would therefore be a significant burden to him.

Table 6. Key issues raised by Specimen Shell and Marine Aquarium Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Loss of productive area at JPP.	Direct loss of productive area with reduced options for replacing it.	Construction & Operation	Critical	Investigate opportunities to collect hermit crabs and other species from the JPP site prior to construction, and keep them alive for subsequent replacing when construction is finished. Maintain highest level environmental practices so that loss of productive marine habitat is minimised.	Proponent Department of Fisheries WAFIC
Loss of areas for collection due to environmental offsets	"Death by a thousand cuts" as productive areas are taken by environmental offsets resulting from coastal development approvals.	Construction & Operation	Critical	Promote integrated coastal and marine planning initiatives on a regional scale, which provide opportunities for all potentially affected stakeholders to input into long term coastal zone management strategies	Department of Fisheries WA Department of Environment and Conservation
Dredging may result in loss of habitat	Direct loss of benthic habitat, and pollution of JPP and surrounding area	Construction & Operation	High	Prepare a dredge management plan, which includes details of extent of dredging and spoil disposal, in consultation with potentially affected stakeholders including the MAF, prior to	Proponent Department of Fisheries

	construction	Department of Transport

7.2 Discussion of issues

The main impact on the Specimen Shell and Marine Aquarium Fisheries (SS&MA) is a general one. These fishers are rapidly losing access to productive beaches, littoral, and adjacent shallow seas.

> *"Our shell collecting areas are continually shrinking due to more and more marine parks and projects …"*

Proposals such as the Department of Environment and Conservation's plan to establish marine conservation reserves on the Eighty Mile Beach and other places in the Pilbara, have stemmed from "offsets" of increased conservation estate as a form of compensation for industrial access. SS&MA fishers fear that the JPP LNG Precinct proposal will result in further such additions to the conservation estate and further reduce the areas in which they may find specimens. They note that it is the cumulative effects of increasing coastal industrialisation, increasing restrictions as a result of native title, and the increasing conservation estate, that limits their access.

Direct pollution from increasing development is also an issue for these fisheries. A fisher with experience in Port Hedland provided a written submission that said, among other things, that:

> *"Around Port Hedland significant areas of coral reef systems are being deprived of marine life, especially marine shells, due to constant dredging and settlement of airborne iron ore dust."*

Although iron ore dust is unlikely to be a problem at JPP, the cumulative effects of channel dredging are as yet unknown.

8 BROOME PRAWN MANAGED FISHERY

8.1 Overview

The Broome Prawn Managed Fishery operates in a designated trawl zone due west of the Quondong-JPP area, labelled "the Box" by the prawn fishers. Its inshore boundary is about 11 nautical miles from the coast adjacent to the Quondong-JPP area. Fishers target western king prawns (*Penaeus latisulcatus*) and coral prawns (*Penaeus spp.*) over hard sandy and muddy substrate, with prawn trawlers.

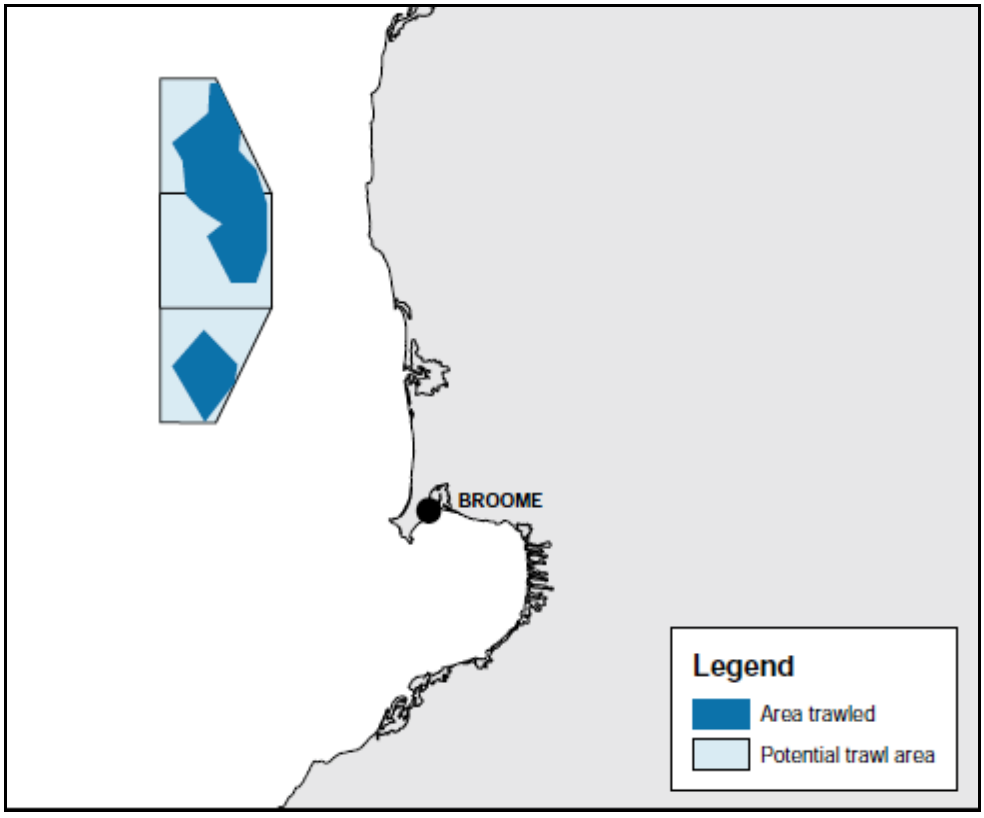


Figure 13. Location of Broome Prawn Managed Fishery (SFR:140)

The season for the fishery is typically June, July, August, and is set in a unique configuration each year to take advantage of lunar phases. Generally, the opening of the fishery coincides with seasonal closures in the Northern Prawn Fishery and the Kimberley Prawn Managed Fishery.

The Broome Prawn Managed Fishery appears to offer an important and convenient niche to its limited number of licensees. It is small in total value, and in the past two years has not been fished at all, but when the prawns are available it fills a space between other seasons and helps to promote a steadier stream of product to prawn market.

The fishery is managed via a system of input controls including limited entry, seasonal closures and equipment controls. Fish escape devices, specially designed steel grids, are used to reduce the by-catch of large animals.

There are five licensees in the Broome Prawn Managed Fishery, four of whom were interviewed. Three of these operators were interviewed together in the offices of one of the prawn licensees in Fremantle. The fourth was interviewed separately. The proposal for the JPP LNG Precinct was outlined and explained to the fishers. They were then asked to comment on how they thought the development and operation of the Precinct was likely to affect their interests in the Broome Prawn Managed Fishery. They were also invited to take part in the EconSearch economic study but all declined.

8.2 Description of fishing method

Fishing takes place at night, and is normally finished by 6:30 am. Yield is influenced by the lunar cycle, and in the right conditions the fishery can produce 600 – 700 kilograms of prawns per night. Trawl fishers said that excellent individual catches would be around 3-400 kilograms per night. The SFR 07/08 states that the average catch rate in the fishery is 25.2 kilograms per hour for western king prawn and 23.2 kilograms per hour for coral prawn.

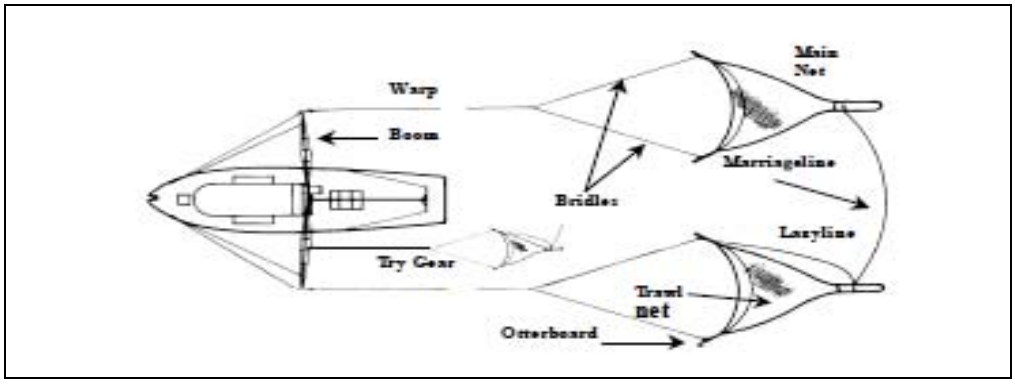


Figure 14. Prawn Fishery Vessel and Nets. Source: Alex Lynch,Northern Prawn Fishery Data Summary,Statistics for the first half of the 2004 season (15 April - 27 May), August 2004, AFMA Logbook Program

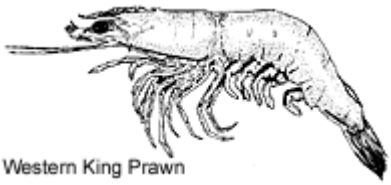
The vessels used in the Broome Prawn Managed Fishery are typically about 24 metres (80 feet) in length. They trawl large nets (a maximum of two nets) on either side from wide-spread booms. Samples are taken during the prawning operation by the "Try" net, which is much smaller. Information about the catch from the Try net determines the length of set of the main trawl nets.

8.3 Current state of Broome Prawn Managed Fishery

The main target species, western king prawn (*Penaeus latisulcatus*), is a premium prawn. The coral prawn (*Solenocera australiana*) catch is also significant but does not command the high price of the king prawns.

Average prices attained for prawns from the Broome Prawn Managed Fishery for the 2007 season were:

- King Prawns $10.05/kg
- Coral Prawns $3.50/kg


Western King Prawn

The fishery is divided into three zones from north to south. One of the fishers commented that smaller prawns are caught in the northern part of the fishery and larger prawns are caught in the middle and southern zones. He suggested that a significant amount of recruitment to the fishery takes place from the north, where he believed the breeding grounds were located.[9]

In the 1990s prawn fishing seasons were shorter than currently permitted – about 45-50 days. Close to 100% of these permitted fishing days were fished. Catches fluctuated but a high combined catch of 239 tonnes was taken in 1998. Over the past decade the permitted days for the fishery have increased to about 75-80. Initially, fishers extended their efforts to match the longer season but this level of effort has dropped in the past five years or so (Kangas *et al.* 2009).

In 2007 only 39 of a possible 72 days were fished, resulting in a total catch of 72 tonnes (Kangas *et al.* 2009). Thirty-three tonnes were western king prawns and 39 tonnes were the less valuable coral prawns.

Although the fishery was open for a total of 74 days in 2008 only one vessel participated. Its purpose was to find out if catch rates would be high enough to justify other boats joining the

9. This perception does not necessarily concur with data collected by the Department of Fisheries.

fishery, but it caught a negligible amount of prawn (Kangas *et al.* 2009). No boats have used the fishery in 2009 (E. Sporer pers. comm. 8/09). The reasons for this appear to be a combination of unsatisfactory economic conditions and a recent lack of availability of king prawns.

Reduced economic returns to fishers in recent years are blamed on increased fuel costs and poor market conditions (globally) for prawns. An increase in the value of the Australian dollar has led to a considerable reduction in prawn exports from Australia resulting in a domestic over-supply. It has also led to an increased presence of imported prawn (L. Slade – seafood trader, pers. comm. 8/09). These conditions are expected to abate with reductions in the value of the Australian dollar.

Those prawn fishers with vertically integrated businesses noted that the Broome Prawn Fishery is, in more normal conditions, a relatively small but highly important part of their annual operations. They commented that the Broome prawn fishery enables them to achieve continuity of supply to their seafood plants. The Broome Prawn Managed Fishery is open during periods that the Northern Prawn Fishery and the Kimberley Prawn Managed Fishery (Kimberley Prawn) are closed, or in shoulder season. Access to the Broome Prawn Fishery permits vessels, crews, and land-based staff and equipment to be employed on a more steady basis. They reported that access to the Broome fishery has historically been an integral part of overall prawn fishing operations in the region.

8.3.1 Industry trends

It seems likely that this fishery will continue to exist as a small niche fishery that will be used by licence holders during times when economic conditions and abundance, especially of king prawns, coincide to make it profitable and/or economically useful to the licence holders.

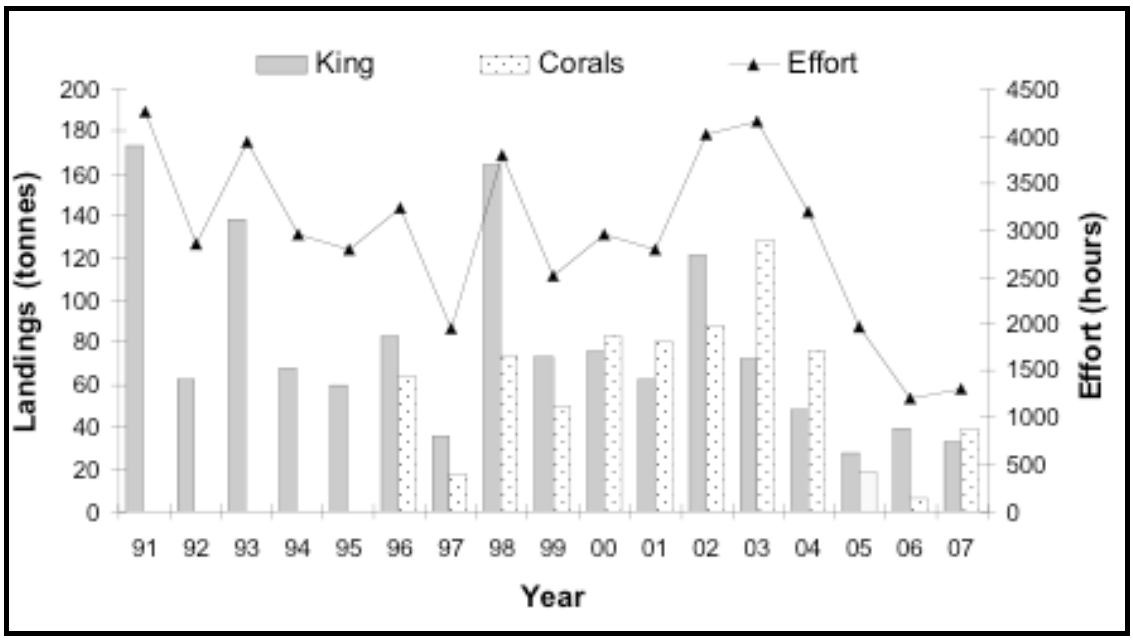


Figure 15. Historical prawn catches 1991-2007 Source: Kangas/Sporer et al. 2008

8.3.2 Physical and biological requirements

The Broome prawn fishers said they believed that the prawn nursery grounds were located to the north of the permitted fishing area (which they call "The Box") because it tended to produce smaller prawns earlier in the season. This is significant because the activities associated with the proposed JPP LNG Precinct would have a direct impact on this area. The DoF believe, however, that Roebuck Bay, to the south, is the main nursery area for prawns in "The Box".

A DoF survey showed the distribution of the king prawn species to be widespread at low abundance, with the only viable Catch Per Unit of Effort (CPUE) located in the relatively small "Box ". For this reason they are quite confident that the local stock is at low risk of overfishing (Penn and Dybdahl 1988) despite low yields in recent years. The *State of the Fisheries Report (2007-2008)* states that "[t]here is a low risk of overfishing this stock, due to its low catchability and the relatively small fishing area compared to its widespread distribution" (SFR:150).

8.3.3 Are Broome Prawns superior?

The fishers said that the king prawns caught in the Broome Prawn Managed Fishery are superior to other king prawns because of their aesthetic qualities. They said the prawns had a white or translucent intestinal string, and that they could fetch a price of up to $1.50 more per kilogram than other king prawns of similar size. This claim was checked with an experienced prawn dealer

who was not aware of the Broome prawns being more expensive than other prawns. However, specific sales are often based on individual and subjective judgments and there is no particular reason to discount or disbelieve the fishers' claims. DoF staff confirm that in their view the Broome prawns could command a similar price to Shark Bay king prawns, which are also a visually appealing premium product (E. Sporer pers. comm. 08/09).

Table 7: Key issues raised by Broome Prawn Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/ Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Increased traffic.	Increased risk of collision	Construction & operation	Low	Restrict LNG tankers movement in vicinity of LNG Precinct to daylight hours only.	Department of Transport
Pipelines may disturb local area.	Possible direct disturbance to prawns Possible shift in species mix near pipelines.	Construction & operation	Medium	Promote public understanding of engineering and construction processes, and strategies to minimise potential impacts on fish populations, when the final design and location has been determined. Develop a plan to minimise and manage the potential for disturbance to prawns.	Proponent in consultation with Department of Fisheries
Sediment plumes may be extensive	Suspended sediments may disturb prawns – especially juveniles	Construction & operation	Low	Prepare a dredge management plan, which includes details of on-going maintenance dredging requirements, in consultation with potentially affected stakeholders including the WA Fishing Industry Council, prior to construction	Proponent Department of Fisheries Department of Transport
Infrastructure problems, including	Existing problems with marine infrastructure in	Construction & operation	High	Investigate and promote alternative berthing facilities to service commercial fishing and other marine interests in	Broome Port Authority

wharfage in Broome	Broome exacerbated.	Broome.	Department of Transport

8.4 Broome prawn fishers' issues

The table above summarises the issues raised by the Broome prawn fishers. They are elaborated in greater detail in the sections below. The risk factors, potential mitigation strategies/opportunities, and responsibility/key drivers columns are our assessment of the level of threat represented, and our suggestions of potential strategies to mitigate the threats or to develop opportunities from them.

8.4.1 Traffic concerns

Broome prawn fishers said their ability to manoeuvre their vessels when they are trawling is limited. They said they had very limited capacity to turn out of the way of other vessels because their maximum turning capability is in the range of seven to ten degrees when trawling at night at about 3.5 knots. They were worried that the proximity of the proposed JPP LNG Precinct to the trawl grounds and the need for large LNG tankers and smaller support vessels to be active in the area had the capacity to generate difficult traffic issues and potential danger to them.

The fishers noted that navigation rules require that vessels in passage must alter course and give way and to vessels with restricted ability to manoeuvre. However, the fishers said that this rule would be difficult to comply with by large tankers that would also be restricted in their capacity to turn and/or slow down.

The fishers pointed out that they have only ten hours of dark to generate their catch. If a trawl shot is interrupted for reasons such as vessel or pipeline avoidance – their capacity to catch will be significantly impacted. The opportunities for these time-consuming interruptions to prawn trawling will be significantly greater as a result of proposed development of the proposed JPP LNG Precinct, in their view.

According to the Broome prawn fishers, the passage of large vessels has potential to impact the behaviour prawns. The impact of vessel noise and large propeller turbulence on prawn distribution is unknown but it may impact on the prawns and have a negative impact on catch.

8.4.2 Possible biological impacts

The Broome prawn fishers said it was hard to determine biological impacts without engineering and construction details. They noted that the "Peanut" area that is important to the recreational and charter sector fishers is also important for the prawn fishery. The feature is called the "Kidney" by the prawn fishers and they said that the waters on either side of it are among the

most productive portions of the permitted fishing area. The prawn fishers noted that the bottom around the Kidney comprised hard sand - good for western king prawn habitat.

The fishers said that they need to retain access to the whole of "The Box" in order to keep the fishery viable to them. Certain portions of "The Box", however are more difficult to fish than others. There are areas that contain large numbers of stingrays that get caught in the trawl and are a nuisance. There are reefs in the eastern portions of "The Box" that also need to be avoided.

8.4.3 Pipelines

In the opinion of Broome Prawn Managed Fishery licensees, the construction of gas pipelines would typically involve digging a trench, laying the pipe, and filling the trench with stone. This would cause immediate disturbance during the construction, with the dredging and suspension of sediment that may be unsuitable to the prawn species in the area. It may also effectively alter the species mix of the local area.

The pipeline would generate a significant feature on this relatively featureless bottom, creating a lengthy artificial reef. This may attract demersal predator species such as coral trout and snappers. These could impact on the abundance and survival success of the prawn species that are currently fished.

A pipeline construction that involves filling a trench with stone that stands above the sea floor could also make the area un-trawlable. The Broome prawn fishers were concerned that, depending on its location, the pipeline could dissect productive trawl areas and have a serious impact on the viability and success of prawn fishing. Extensive trawl exclusion areas around the pipeline would exacerbate this impact.

8.4.4 Sediment plumes

The plume of suspended sediments that may occur as a result of dredging during construction, and the possible need for ongoing dredging, may negatively affect prawn nursery grounds that feed the fishery. This was particularly worrying for the fishers because they consider it likely that the juvenile prawns are recruited to the fishery from the north, and it seems likely that pipelines would come from the north down to the proposed JPP LNG Precinct. All licence holders agreed that if juvenile recruitment were impacted the fishery would either yield less marketable prawns, or cease to exist.

8.4.5 Marine infrastructure needs

In common with most of the commercial and recreational fishers interviewed, the Broome prawn fishers commented on the shortage of infrastructure in the Port of Broome. They were concerned that the JPP LNG Precinct development would create extra pressure on the Port. The current limited facilities at the Broome Wharf would be further stretched, making it harder to unload product and take on fuel and stores.

8.4.6 Possible mitigation strategies

It may be possible to require the LNG tanker vessels to sail during daylight hours, at least during the three month prawning season. This would limit the potential for interrupting nearby prawn trawling. Additionally, local LNG Precinct traffic could be restricted from using " The Box" at night during the prawning season. Additional clarification about the direction likely to be taken by most of this traffic maybe also help to alleviate these concerns.

Detailed study of the possible local impacts of undersea structures on benthic populations may help clarify the potential for localised shifts in species mix hypothesised by some of the Broome Prawn fishers.

8.5 Discussion

8.5.1 Possible economic impact and input-output rationale

According to the DoF SFR (p. 141) the Broome Prawn Managed Fishery (BPMF) produced an annual value to fishers of about $500,000 in 2007. It has not produced a significant return to fishers in the two years since 2007. Although the fishery, in normal conditions, contributes significant income and fills a useful niche for the fishers, other fisheries are bigger and more important to the regional economy.

Several of the fishers felt quite strongly that the fishery was unlikely to be viable if the JPP LNG Precinct were to be constructed, largely due to perceptions that there would be general disturbances and disruptions that might result in less prawn recruitment, and the safety issues of dealing with a fishery on a major tanker route.

The DoF has advised that the prawn resource is spread much more widely than the small "Box" within which fishing is permitted. If recruitment of new prawns is taking place over a wide area, in part from the south as well as the north (as some of the prawn fishers have suggested), the

construction and presence of pipelines and other infrastructure associated with the proposed JPP LNG Precinct may have significant impact on the prawn population than imagined by the prawn fishers.

It is estimated that there could be up to a 25% reduction from current levels in this sporadic fishery as a result of the proposed JPP LNG Precinct development. This is mainly because the fishery could become less attractive to some operators due to the increased amount of shipping and other traffic, congestion at the Broome Wharf, and similar issues. However, much is likely to depend also on the economics of prawn fishing generally. The BPMF is a "niche fishery" and it is likely to continue to be used when it is convenient for the fishers to use it. Although the prawn populations may be temporarily disturbed by construction and dredging nearby, prawns are highly fecund, short lived animals and can be expected to adapt to altered circumstances. However, the situation could be much different if there are long-term or sustained negative environmental effects over a wide area.

9 MACKEREL (INTERIM) MANAGED FISHERY

9.1 Overview

The Mackerel (Interim) Managed fishery extends between Cape Leeuwin and the Western Australian / Northern Territory border, with the largest catches taken off the Kimberley and Pilbara coasts. The Kimberley reporting area is between longitude 121E and the Northern Territory border. The fishery includes all species of three related genera, *Scomberomorus, Grammatorcynus*, and *Acanthocybium*, but the main target species is Spanish mackerel (*Scomberomorus commerson*) which accounts for more than 90% of the catch. Grey mackerel (*Scomberomorus semifasiatus*) is the second most caught species in this fishery (SFR: 173) The annual catch, and catch rates for Spanish mackerel are gradually increasing over time which indicates that this is a healthy fishery (SFR:177).

Spanish mackerel and the other mackerel species caught by this fishery are moderately long-lived, fast growing species that exhibit annual variations in recruitment strength and adult movement due to environmental fluctuations (SFR:175).

The key management tool for the fishery is an Individual Transferable Quota (ITQ) system. The Total Allowable Commercial Catch (TACC) for Area 1 (the Kimberley) is 205 tonnes of Spanish and other mackerel and 60 tonnes of Grey mackerel (Broad Barred Mackerel). The TACC in the Kimberley region is significantly higher than for the Pilbara and Gascoyne, and West Coast zones (SFR).

There are currently three active vessels in the Kimberley zone. All three active mackerel fishers were interviewed, although only one provided detailed economic data for inclusion in the EconSearch report (Appendix 1). The basic outline of the proposed JPP LNG Precinct was explained, and the fishers were asked to comment on and discuss their views about the potential for the development of the precinct, as outlined, to impact on their fishery.

9.2 Description of fishing method

Spanish mackerel fishing in the Kimberley region typically consists of a mother-ship and three dories (dinghies). The dories are manned by a single crewmember. They leave the mother-ship to troll three individual lines that are baited with a ganged garfish, or other bait, on a wire trace.

The dory fishers return to the mother-ship to unload their catch and the crew then process and freeze the catch for market.

Typically, a Mackerel mother vessel will have four crewmembers. During the season it will fish two fortnightly trips per month with short breaks for reprovisioning. The fishers operate from the coastline out to about 100 nautical miles. The crew is employed for about six months of the year.

The main factors influencing choice of place to fish include the abundance of baitfish, weather, tide/currents, and bottom type.

One Mackerel fisher advised that his vessel takes about 75% of its total catch from the waters around the Lacepede Islands, roughly within a 100 nautical radius. Within this wider area, about 15-20% of his total catch is taken from south of the Lacepedes, with areas to the west of Cape Bertholet (17 degrees 15 minutes south latitude) being particularly productive, as is the area around Tallboys Rock, which is about 13 nautical miles northwest of JPP. He explained that the area around Tallboys was especially useful in strong easterly winds because of the shelter provided by the Dampier Peninsula coast.

Between May and September during the mackerel season the southeast winds dominate the weather. They limit the mackerel fisheries capacity to fish "out wide" to the west of the Dampier Peninsula. Although good fishing grounds are located between 40 and 50 nautical miles west of Cape Bertholet, they can be accessed only during periods when the weather permits. Areas closer to shore are in the lee of the mainland and permit fishing during higher winds.

9.3 Potential impacts – Lacepedes area

One mackerel fisher felt that the scale of the development proposed for the JPP LNG Precinct could "*turn the fish off*". He was concerned that pollution associated with large scale dredging and benthic sediment being suspended in the water column could have a serious impact on the distribution and availability of all pelagic species, but especially of the Spanish mackerel that he relies upon. He commented that the high tidal range and large-scale movement of water would, in his opinion result in a pollution plume that would affect a wide area.

Another mackerel fisher commented similarly. This licence holder said he had invested a considerable sum of money on the basis that the mackerel fishery was well managed, isolated and unlikely to be influenced by external factors. He was concerned that the proposed development may interfere with the natural movement and migration of mackerel species up and down the

coast, and that mackerel are a species that "spook easily," affecting their catchability. He was concerned that the large scale of the JPP LNG Precinct's construction would generate physical impacts that could disrupt the fishery over a large area.

The Mackerel fishers were very interested to know if explosives would be required for dredging the port and shipping channel required for the JPP LNG Precinct. This concern stemmed from their perception that little is known about the location and habits of larval and juvenile fish, and that they consider that seismic or explosive activity could have a significant impact on recruitment of juveniles to the fishery, which would come in addition to the negative impact on the catchability of the adult population (see Appendix 6 for further discussion of seismic impacts on fisheries).

Table 8. Key issues raised by Mackerel Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Loss of access to inshore passage	Inconvenience, potential loss of towed dinghies	Construction & operation	Medium	Develop an accord between industry and commercial fishers to allow access to waters in proximity to port and rig related infrastructure.	Proponent Department of Transport WAFIC
Fish – "turned off" by noise, spillages and sediment plume from dredging	Reduced catch near areas of disturbance	Construction & operation	High	Establish baseline data, and undertake on-going monitoring to determine effects of construction and operation of LNG facility (including noise, spillages, dredging and sonic activity) on fish stocks Compensation should be considered where direct impacts are demonstrated.	Proponent Department of Fisheries Department of Transport

9.4 Mackerel Fisher's issues

9.4.1 Loss of access to inshore passage

Some of the mackerel fishers tow their dories behind the mother-ship. They have up to four dinghies in tow and they travel close to the coast to avoid the impact of the prevailing easterly winds. Occasionally a dinghy will roll over, causing damage to the outboards and electrical equipment (sounders). In the worst case a dinghy can be lost. Dinghies are integral to the fishing operation and, in addition to the cost of the accident, damage or loss results in downtime while repairs and maintenance are conducted or a new dinghy is purchased.

One of the mackerel fishers pointed out that the safest route between Broome and the fishing grounds is to travel between the shore and the Clipper Pearling leases. He identified the northern and southern inshore corners of the Clipper Pearl lease site on his chart plotter. He was concerned that the JPP LNG Precinct and associated wharf and breakwater would interfere with this navigation route, and force mackerel vessels to pass to the west of the pearl lease making the passage more difficult.

9.4.2 Physical disruption and noise

The three active mackerel fishers interviewed were concerned about physical disruption as a result of the proposed JPP LNG Precinct construction and ongoing operation. They said they feared that the movements of large ships, dredging, pipe laying, ship anchoring and similar impacts would have a negative affect on the catchability of the mackerel stocks around the Lacepede Islands.

Noise pollution was noted as having a significant effect on mackerel populations. It was feared that noise will contribute to cumulative negative effects of physical pollutants in the form of spillages and possibly introduced harmful species. The fishers were concerned that overall the JPP LNG Precinct development would cause an inevitable decline in the mackerel fishery.

Whether the noise associated with the proposed JPP LNG Precinct's construction and operation, including the use of seismic testing in the Browse Basin and elsewhere, will have a significant impact on fisheries is apt to remain a controversial issue for some time. For convenience a summary of a portion of the available science on the affects of noise pollution was created, and can be found in Appendix 6.

9.4.3 Possible mitigation strategy

One of the mackerel fishers noted that the use of seismic surveying and explosives associated with oil and gas exploration had had a negative impact on the fishery in the "Timor Box." An arrangement was apparently reached between the fishers and the oil and gas explorers to provide compensation based on the historical catch levels.

Historical levels of catch per vessel were established and decreases in catch during and after the exploration phase were compensated for. The fisher felt this was an equitable arrangement.

9.5.1 Input-output rationale

For the input-output analysis we have assumed up to potential 20% decline in the mackerel fishery in the Kimberley zone. This is primarily due to the fisher's estimations that the mackerel resource associated with the area around the Lacepedes will be reduced or become less catchable due to the impacts of noise and physical disturbances associated with construction of the sub-sea pipe. It is also conceivable that plumes of fine sediment will reach as far north as the Lacepedes Channel (this was likely in the opinion of one of the local pearl farm operators interviewed) and could affect the Spanish mackerel fishery there. The effect of the plumes may or may not occur, or may cause only a temporary problem during the initial dredging, if there is any problem at all. However, the extent of the dredging that will be needed is currently unknown and it remains speculative as to how much maintenance dredging will be required and its long term and cumulative effects.

Any reduction in the fishery around the Lacepedes could be compensated by moving the fishery further north to the northern Kimberley areas, which some of the mackerel fishers currently use in the latter parts of the season. However, the result of this shift could be that Darwin is used as the main port servicing the fishery, because it would then be nearly as close as Broome and would provide more and better services. Such a shift would also be a considerable inconvenience to the fishers.

10 KIMBERLEY GILLNET AND BARRAMUNDI MANAGED FISHERY

10.1 Overview

The Kimberly Gillnet and Barramundi Fishery (KGBF) extends from the WA / NT border to the top of 80 Mile Beach. Seven licences are available to access this fishery, although only six were active in 2007 (SFR:146). Historically, the fishers in this fishery have tended to specialise and remain in a particular geographic area – especially in the western half of the fishery. Currently there is only one operator who specialises in the "Broome Coast" portion of this fishery, although there is no administrative reason that other licence holders could not also fish this area. The Broome Coast fisher holds two of the seven available licences and concentrates his fishing effort in Roebuck Bay.

The sole Roebuck Bay fisher was interviewed, and a telephone discussion with another operator who fishes in the King Sound Area east of Cape Leveque was held. The basic outline of the JPP LNG Precinct was explained, and the fishers were asked to comment on and discuss their views about the potential for the development of the precinct to impact on their fishery.

The primary catch is giant threadfin (*Polydacylus macrochir*) with lesser catches of blue threadfin (*Eleutheronema tetradactylum*) and barramundi (*Lates calcarifer*).

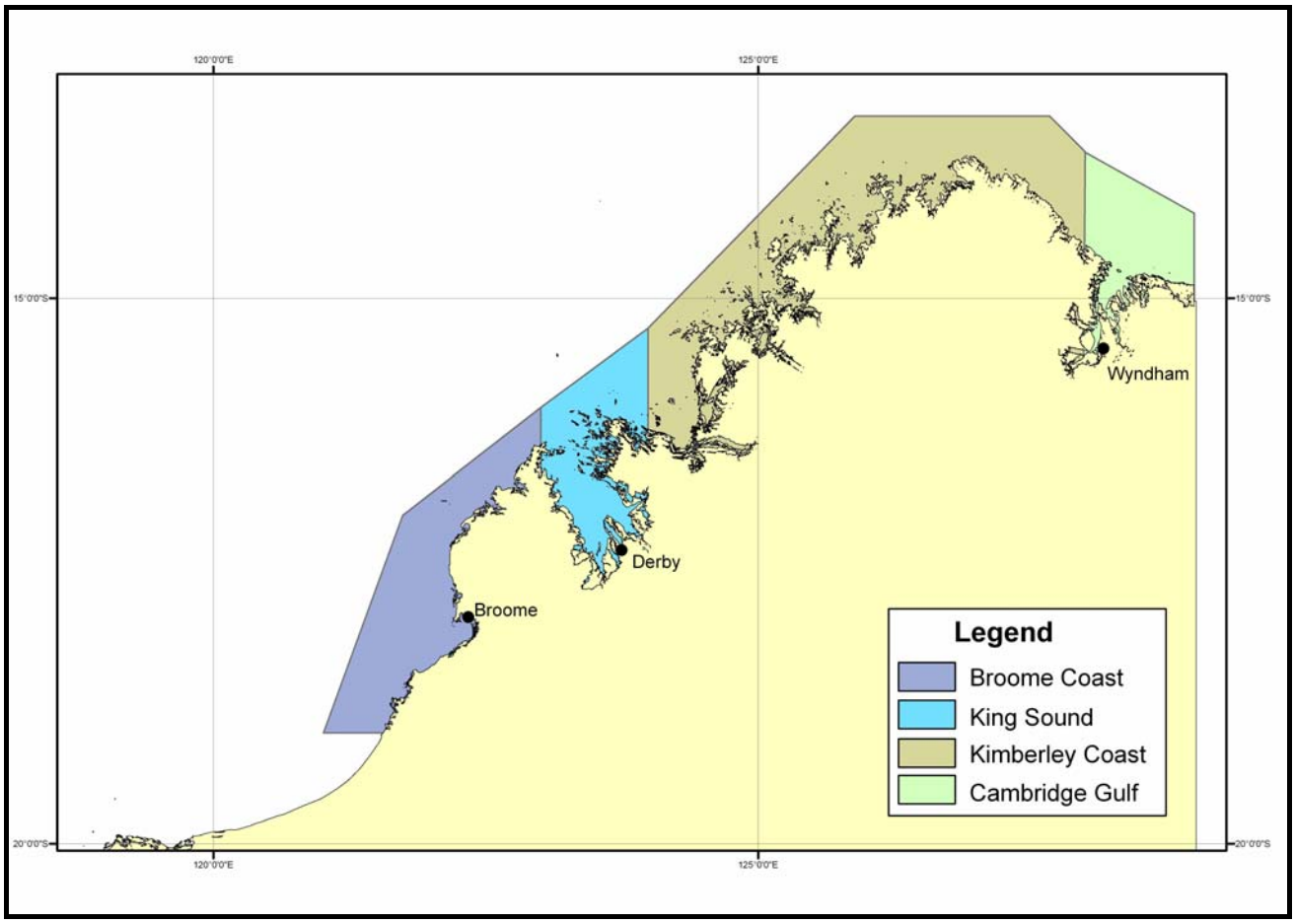


Figure 16. Kimberley Gillnet and Barramundi fishery areas

Threadfin tend to live in areas where the substrate contains significant amounts of organic material. The fact that newly recruited threadfin are found almost exclusively in such habitats, for example at Roebuck Bay, provides some evidence that this type of habitat may constitute important nursery areas for these species. Roebuck Bay is known to have high levels of intertidal invertebrate fauna, which produces ample food for threadfin.

The reported catch (t) of the major commercial species from each of the principal fishing areas in the north coast bioregion in 2007.

Catch Category	Principal Fishing Area				
	Cambridge Gulf	Kimberley Coast	King Sound	Broome Coast	Pilbara Coast
Barramundi	0.3	13.5	5.2	6.7	0.0
Threadfin salmon	0.0	4.0	1.1	72.6	25.4
TOTAL	**0.3**	**19.6**	**6.5**	**82.4**	**25.4**

Table 9. Principal Fishing Areas for Barramundi and Threadfin Salmon. Source: SFR:149

As the table above, taken from the State of the Fisheries Report of 2007/08, clearly shows, the Broome area produces the bulk of threadfin salmon.

Threadfin salmon is the signature dish of many Broome restaurants and the Broome coastal fishery is the main supplier of fresh threadfin. Most of the threadfin supplied to this local market comes fresh from the Roebuck Bay operations of the sole Broome Coast fisher, who employs seven people.

10.1.1 Industry trends

Many of the licensees in the Kimberley Gillnet and Barramundi Managed Fishery operate to the east of Cape Leveque. The Broome Coast fishery, however, accounts for the bulk of the total catch, and most of this comes from Roebuck Bay.

The catch per unit of effort trend in this fishery overall appears to be quite positive. Nonetheless much of the fishery is localised around Broome where there are interactions with recreational fishers.

An accord currently exists which deals with a range of specific resource sharing issues. This document, "Accord for the Future Management of Barramundi and Threadfin 2007-2012," is a voluntary agreement between representatives from the charter, recreational and commercial fishing sectors. It includes a number of agreements for improved conservation and management of barramundi and threadfin stocks in the north. However, increasing development of Broome, partly associated with the JPP LNG Precinct, will likely see an increase the recreational catch levels.

Further population growth in Broome as a result of the JPP LNG Precinct may generate further public concern about the gillnetting of threadfin and barramundi in Roebuck Bay. It may be useful to consider ways of broadening the geographic base of the main portion of the catch.

10.1.2 Threadfin biology

The basic biology of the threadfin species has been studied and published (Pember *et al.* 2005), but formal stock assessments are yet to be conducted and so there is not a target catch. However, in general terms, the catch and catch rates for threadfin appear to be quite positive. The SFR authors have concluded that part of the reason for the positive catch rates may be

increasing levels of fisher efficiency (SFR: 147). However, they also note that insufficient funding has prevented more detailed work on these important commercial and recreational species.

If the reasons for the positive catch rates are, as the SFR authors suggest, an indication of increased efficiency and not a reflection of a positive biological picture, then this fishery may be susceptible to significant local disruption. Advice from DoF research staff suggests that the scale of the development at JPP is likely to have some effect on the local oceanography (S. Newman pers. comm. 6/09). The movement patterns and population dynamics of the two threadfin species do not yet appear to be completely understood. It is known that they are shallow water species that do not venture deeper than about 15 metres and are usually seen in depths of 10 metres or less.

10.2 Description of fishing methods

Threadfin are a popular species for charter, recreational, and customary fishing sectors, as well as for the commercial sector. They can be caught from shore and from small inshore boats which makes them a sought after species for a wide range of fishing interests. This makes them a sought-after species for shore-based anglers as well as for the small number of commercial fishers.

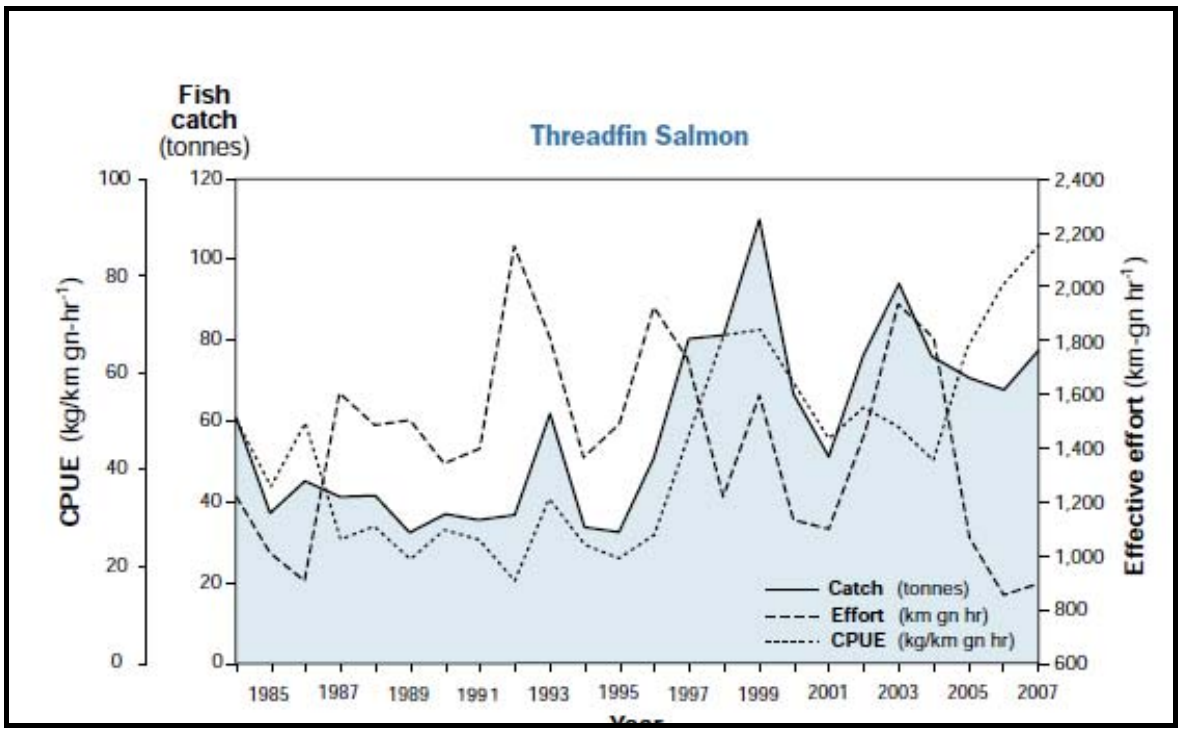


Figure 17. Threadfin salmon catch rates (Source: SFR)

Table 10. Key issues that may affect Barramundi and Gillnet Managed Fishery

Issue raised	Potential Impact	Project Phase	Risk /Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
JPP Precinct infrastructure causes changes to local habitat	Temporary local depletion of threadfin species	Construction & operation	Medium	Provide funding to build on the existing scientific database for near-shore finfish stocks. Provide funding to increase understanding of role of environmental factors in movement and distribution of near shore finfish stocks.	Proponent Department of Fisheries
Increased recreational fishing due to increased population may exacerbate resource sharing issues	Controversy about netting in Roebuck Bay	Construction	Medium	Conduct formal stock assessment of threadfin species. If necessary conduct mediation between recreational and commercial sectors.	Department of Fisheries

10.3 Threadfin fishers' issues

The extensive jetty system, the breakwater, and the dredged channel to accommodate the LNG vessels at the JPP facility may be found to significantly disturb patterns of threadfin behaviour. The drafts of the LNG tankers are understood to be approximately 16 metres, which means that the channels will be dredged to depths beyond which threadfin species are thought to tolerate.

Disturbance from sediment plumes and other effects also seem possible. If the patterns of coastal threadfin movement are disturbed in the Quondong-JPP area there may be unintended consequences to the populations in Roebuck Bay.

10.4 Input-output rationale

For the input-output analysis we have assumed up to a 20% reduction in the commercial catch of threadfin salmon in the Broome region may be possible. The reasons for this include the increased recreational fishing pressure brought by an increased Broome population, which will inevitably presage increased resource sharing concerns about netting in Roebuck Bay. Although it seems unlikely that building the JPP LNG Precinct will have a direct physical effect on threadfin stocks in Roebuck Bay, where the main commercial fishing interests are concentrated, there may be physical consequences closer to JPP, which may affect local regional catches. Although some basic biological science has been done on threadfin, much further work is required in terms of understanding the fisheries science of these species, including formal stock assessments.

A consequence of any reduction in commercial catch may be that fresh threadfin becomes less able to be produced locally, and its prominence in the Broome restaurant trade will be reduced.

11 NORTHERN DEMERSAL SCALEFISH MANAGED FISHERY

11.1 Overview

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the north-west coast of Western Australia in waters east of longitude 120'E. Tropical snappers (*Pristimoides* spp.), emperors (*Lutjanus* spp.) and groupers (*Serranidae* spp.) are the main target species in the fishery. The dominant catch is goldband snapper, which accounts for more than one-third of the total catch. Although the direct impacts of the proposed JPP LNG Precinct are not as obvious as for some other fisheries, the indirect and cumulative impacts of oil and gas exploration and production in the Browse Basin may be significant. Those issues that relate to the increasing strain on marine infrastructure in Broome will directly impact this fishery.

Species	NDSF annual catch (tonnes)					
	2002	2003	2004	2005	2006	2007
Goldband snapper (*Pristipomoides* spp.)	152	226	283	429	336	393
Red emperor (*Lutjanus sebae*)	101	118	144	192	166	176
Scarlet perch (*Lutjanus malabaricus*)	61	48	68	92	79	96
Spangled emperor (*Lethrinus nebulosus*)	35	39	33	21	28	14
Cod/grouper (Serranidae)	49	74	103	110	129	121
Other species	36	47	59	78	63	108
Total demersal scalefish catch	**434**	**552**	**690**	**922**	**801**	**908**

Table 11: NDSF Annual Catch. (Source: SFR: 155).

The fishery extends from the shoreline to the 200 nautical mile territorial limit and is divided into an inshore zone (Area 1) and an offshore zone (Area 2). A voluntary arrangement divides the offshore zone into three management zones, Areas A, B & C.

Historically, Zone B of Area 2 has the highest recorded level of access and catch. Zones A & C are considered developmental areas with potential to yield sustainable commercial quantities of key target species.

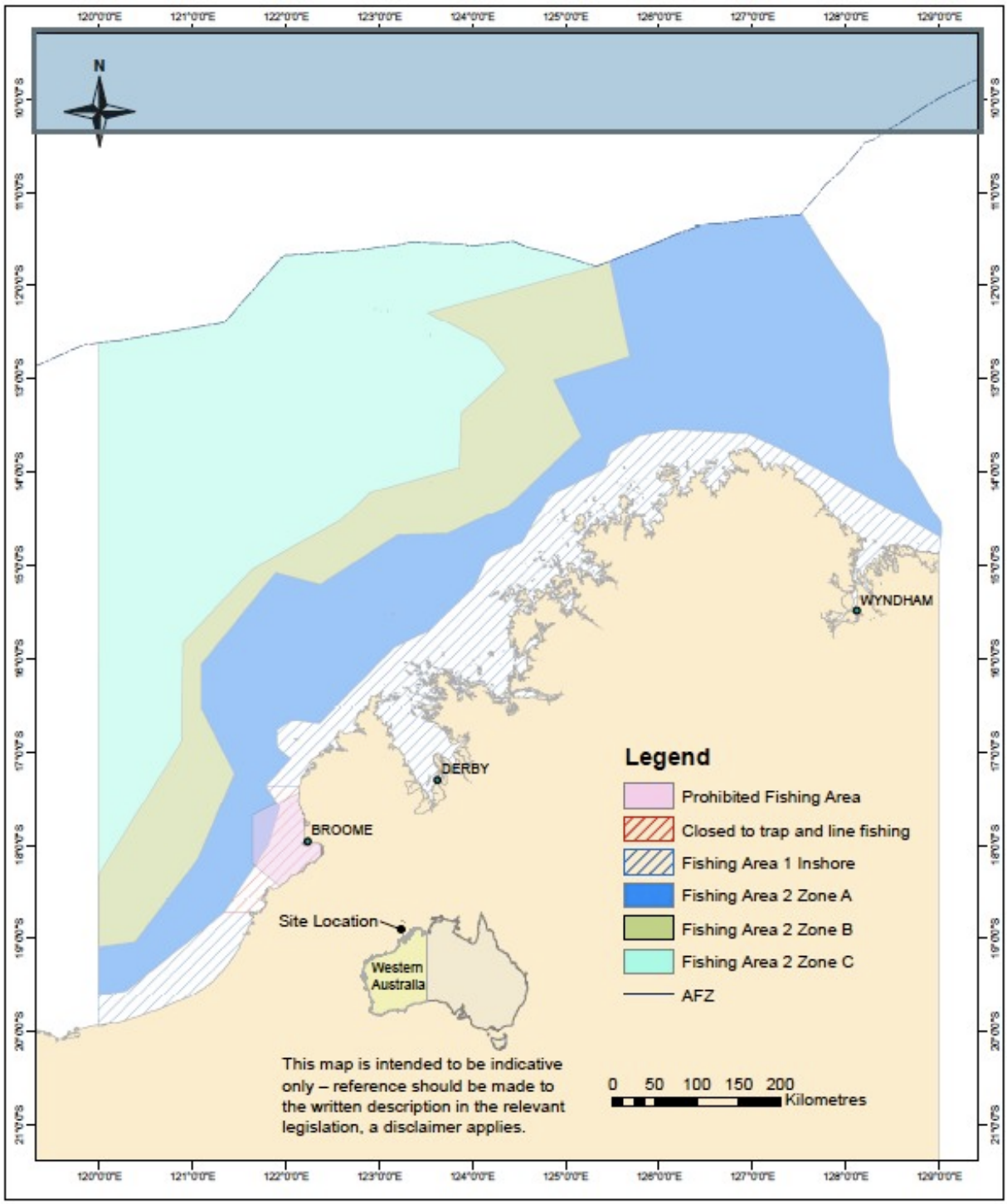


Figure 18: Fishing areas Northern Demersal Scalefish Managed Fishery

To minimise conflict between commercial and recreational fishers, the inshore waters in the vicinity of Broome (including the Quondong-JPP area) are closed to NDSF fishing.

The NDSF uses a blend of input controls to manage harvest levels in the fishery, with transferable fishing effort quotas being the primary management tool. Effort levels in Area 2 are set for each of the zones based on annual research advice and discussions with licensees. The effort quota is then allocated across the licences equally. Additional effort days have been allocated to licence holders in Zone C of the fishery to assist in the development of this lesser fished area of the fishery.

The transferable effort system has enabled rationalisation in the fishery with seven vessels using the effort assigned across the 11 licences that govern access to the trap sector operating in Area 2 of the NDSF. A "standard" fishing day in the NDSF comprises the use of 20 traps. Vessels can operate more than 20 traps per day and the allowable fishing days are adjusted accordingly. For example, if a vessel fishes 30 traps in a 24-hour period, 1.5 days will be deducted from their allowable fishing days.

The seven trap vessels that fished in the NDSF in 2007 used between 20 and 48 fish traps per day. In Zone B (Area 2) of the fishery a total of 1,144 standard fishing days were allocated across the 11 licences. The number of "standard" fishing days actually used by the trap fleet in Zone B was 1077.

The effort allocated in Zone A (Area 2) in 2007 was 616 standard fishing days, with 158 of those days utilised. No fishing was recorded in Zone C (Area 2) in 2007 (SFR:162). Although line fishing is permitted, no line fishing was recorded in Area 2 of the NDSF in 2007.

Of the seven vessels operating in the fishery, four use the Port of Broome for vessel unloading, berthing, refuelling and restocking and maintenance

The catch from this fishery is high-quality fresh finfish. The product needs to be handled quickly and efficiently and transported to Perth and interstate markets.

11.2 Description of fishing method

A typical NDSF vessel is an 18-21 metre (60 to 70 feet) fibreglass or aluminium boat with a fast planing hull and a forward cabin, much like a large rock-lobster vessel. The vessels use about 9000 litres of fuel per 10-14 day trip.

The permitted fishing devices in the fishery include handline, dropline and fish traps, but in recent years only wire traps are used. Each trap in the fishery must have an internal volume equal to, or less than, 2.25m^3.

Typically, the traps are baited with oily fish such as sardines/pilchards. The traps are all individually buoyed and are fished in various configurations. They are left in the water for various periods of time depending on sea conditions, the species targeted, and the depth of water being fished.

11.3 Current state of Northern Demersal Scalefish Managed Fishery

Demand for the key target species is high due to the high quality of trap-caught fresh, chilled product, and the attributes of reef species as premium table fish.

In the most heavily fished part of Zone B (Area 2) the catch per unit of effort (CPUE) in 2007 was 770.8 kilograms per "standard" fishing day (20 traps x 38.54 kg per trap per day). In 2007 the CPUE for the key target species in Zone B were as follows;

- goldband snapper – 339 kg / std day
- red emperor – 153 kg / std day
- cod spp. – 104 kg / std day

The total landed catch for the NDSF in 2007 was 908 tonnes (SFR:153).

11.3.1 Industry trends

The last full assessment of breeding stock levels in this fishery was undertaken in 2002. It found that the population of goldband snapper was at about 41% of the estimated biomass level of the virgin stock. The red emperor population was found to be at about 54% of the virgin biomass. The recommended limit of reduction from fishing pressure from the virgin biomass is 40%. Although a range of other species are taken by this fishery in smaller amounts (especially cod), goldband snapper and red emperor are the key indicator species. Since these were both above the 40% limit the fishery was assessed as "adequate" (SFR: 154).

Increasing catches in this fishery are being monitored by the Department of Fisheries. In 2007, the catch of goldband snapper exceeded the performance indicator of a 20% increase in catch above the average catch of the preceding four years. Additionally, the catch of red emperor and cod/grouper complex were close to their performance indicators. An updated stock assessment review is currently in progress (SFR: 154).

Increased oil and gas exploration in the Browse Basin and Timor Sea appears to be the main factor that could affect this fishery.

Resource sharing with recreational fishers would ordinarily not be an issue for this fishery – especially as the area around Broome has been designated a no-fishing zone. However, the oil and gas industries are moving more and more people into the areas where the NDSF operates, leading to increased concern over competition from recreational fishers.

Pollution of various sorts, including noise from seismic surveys or oil spills, such as the recent West Atlas spill, may have effects on this fishery. However, the level of these effects is currently unknown.

11.3.2 Employment

There are four to five people employed on each of the seven vessels. In addition to the approximately 35 people directly employed on the boats, each operation has a shore-based component. This often includes the skipper or owner's partner, who does a considerable amount of logistical and other work.

It was clear from the interviews that four of the vessels and their crews were Broome based and spent a considerable amount of time in Broome when not fishing.

Downstream employment associated with this fishery is mainly due to the need to transport the fresh product to major domestic centres.

11.4 Potential impacts

The construction and operation of the JPP LNG Precinct will have less direct effects on the capacity of this fishery than on other more locally based fisheries near Broome. The specific impacts associated with the facility's construction and ongoing operations are limited because NDSF is already prohibited from fishing in the Quondong-JPP area. Nonetheless, there are sections of Fishing Areas 1 and 2 in Zone A that are relatively close to the proposed JPP LNG site. There could be some direct impacts to the northeast of these areas, arising from the laying down of sub-sea pipes, for example.

The key potential impacts for this fishery are associated with the cumulative effects of increasing levels of maritime activity associated with the development of the gas reserves.

The map below, is taken from the Santos Limited website and shows the locations of known gas and oil fields in the Browse Basin area. These fields are in Area 2 of Zone B and are relatively close to the main locations in which the NDSF fishers set their traps.

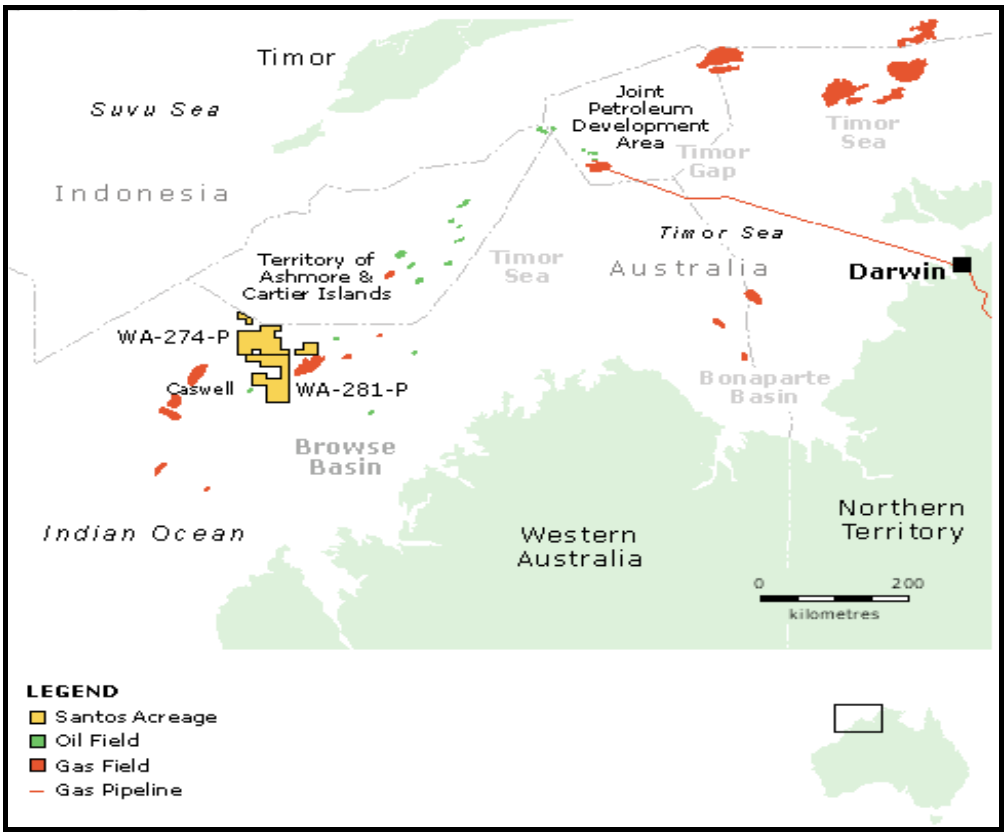


Figure 18: Browse Basin gas fields. Source: www.santos.com

Table 12. Key issues raised by Northern Demersal Scalefish Managed Fishery fishers

Issue raised	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Increased vessel traffic.	Increased risk of collision. Risk of gear being damaged	Construction & operation	Medium	Prepare a Port Management Plan, in consultation with all marine users, to address port related issues including vessel movement. Ensure AIS technology fitted on all oil and gas related vessels. Investigate options for visible markers for NDSF trap lines in congested areas.	Department of Transport Proponent WAFIC
Exclusion areas around rigs and infrastructure.	Loss of available fishing space Currently productive fishing places may become off-limits.	Operation	High	Develop an accord between industry and commercial fishers to allow access to waters in proximity to port and rig related infrastructure.	Proponent. WAFIC Department of Fisheries Department of Transport.
Creation of new undersea structures	Possible change to local habitats Possible shift in species mix near pipelines.	Construction & operation	Medium	Promote public understanding of engineering and construction processes, and strategies to minimise potential impacts on fish populations, when the final design anlocation has been determined.	Proponent Department of Fisheries

Seismic activity	Risk of damage to fishery uncertain to fishers at present.	Construction & operation	High	Establish data base, and undertake on-going monitoring to determine effects of construction and operation of LNG facility (including noise, spillages, dredging and sonic activity) on fish stocks	Proponent in consult with Department of Fisheries
Resource sharing with rig tenders.	Recreational fishing by rig tenders could raise total catch above TAC.	Operation	Critical	Develop an accord between industry and commercial and recreational fishers regarding recreational access by oil and gas employees and contractors.	Proponent WAFIC Recfishwest APPEA Department of Fisheries
Infrastructure, including wharfage in Broome.	Existing problems with marine infrastucture in Broome exacerbated.	Construction & operation	High	Investigate and promote alternative berthing facilities to service commercial fishing and other marine interests in Broome	Proponent Broome Port Authority Department of Transport WAFIC

11.5 Northern Dermersal Scale Fishery issues

11.5.1 Rig tender traffic

All license holders interviewed commented that rig-tender traffic has noticeably increased in the past few years due to oil and gas activities in the region. This, they said, has already caused increased loss of fishing equipment on the fishing grounds due to interactions with large vessels.

The NDSF fishers believed that more traffic on offshore fishing grounds will inevitably increase the interaction of large vessels with fishing boats and fishing equipment. Each fishing trap, including rope and floats, costs about $1,500 to build. An operator fishing 40 traps can have $60,000 worth of equipment in the water at any one time.

The NDSF fishers expressed considerable annoyance at the apparent attitude of rig tender skippers. They indicated that in past there had been difficult situations and confusion over rules of right-of-way. They were worried that the bigger and more powerful oil and gas vessels would pay insufficient attention to the needs of smaller fishing vessels.

NDSF fishers proposed that all oil and gas vessels, and NDSF vessels, should use Automatic Identification System (AIS) technology, so that electronic vessel information regarding presence and location is readily available.

The International Maritime Organisation (IMO) requires the AIS transponder system on vessels of more than 300 tonnes. Many recreational vessels use it to avoid collision with large vessels.

The NDSF fishers also pointed out that communicating clearly with the crew of ships and tenders from non-English speaking countries already creates some navigational problems for them that are likely to be exacerbated with increased international traffic associated with the proposed JPP LNG development. They also noted that their fibreglass-hulled vessels were less visible to radar than steel and aluminium hulled vessels.

The NDSF fishers suggested that a Port Management Plan should be negotiated with all users of the port when the rate of vessel movements per day associated with the JPP LNG Precinct is known. They proposed that such a plan should monitor traffic coming in and out of the port and manage wharf access so that all user-groups can utilise the port in a safe and efficient manner.

11.5.2 Exclusion areas around rigs and offshore installations

All NDSF fishers were concerned that access to valuable fishing grounds could be lost should exclusion zones be designated around rigs and sub-sea piping. Fishers pointed out that they were already feeling effects from exclusions around the Chalice, Jabiru, and Puffin installations. They asked that any future exclusion zones around rigs and pipelines be negotiated with NDSF stakeholders.

11.5.3 Undersea structures

Two licence holders indicated that a positive outcome of the gas development, for them, could be that underwater structures associated with sub-sea piping might act as fish aggregating devices (FAD)s, drawing species such as goldband snapper. This situation could be of advantage if the NDSF fishers were permitted to lay traps near the pipe locations. However, if the precise locations of sub-sea piping are not made public (e.g. for security reasons), this potential advantage would be dependent on the fishers ability to locate the pipes for themselves.

These structures may also play a role in altering the species mix in the areas where they are located. Fish may move from their previous habitats and predator-prey relationships may change in the new habitat. This was also a concern for the Broome Prawn fishers who raised the possibility that pipelines located in their fishing grounds near JPP would act as FADs for demersal predatory species that would feed on the prawns that they were harvesting.

11.5.4 Seismic activity

Seismic activity associated with oil and gas development is thought by many fishers to be detrimental to larval, juvenile and adult fish populations. This issue was raised in a number of contexts, both by NDSF fishers and knowledgeable recreational fishers with experience of the development of the LNG facilities at Dampier. They were of the view that the pipelines associated with the Dampier project were:

> *"… put in with seismic tests and it took 12 years for the fishery to come back. Everything within 500 metres of the seismic is dead and the fishing slowed right up over a wide area."*

A brief survey of the scientific literature indicates that there is conflicting evidence on the impacts of seismic surveying on fisheries. Some of this research is considered here in order to contextualise the concerns of the fishers interviewed. Appendix 6 addresses the impacts of noise pollution of fisheries in more detail.

Prior to conducting seismic work at Scott Reef in the Timor Sea, Woodside Energy Ltd. (Woodside) produced a desktop study to identify relatively safe parameters for permitting airgun array type seismic activity in the area. In summary, the Woodside desktop study found:

- levels above 180 decibels "may cause onset of a mild TTS[10] in the most sensitive of fishes."
- values higher than 187 decibels "may produce clear-cut TTS that might linger for several weeks (or more)…".
- values higher than 200 decibels "might cause an injury to adult fishes." (p.C.78)

Environmental approval for the Scott Reef development was conditional on Woodside's commitment to undertake a peer reviewed fish monitoring program (Woodside 2007b). The compliance report associated with this program states:

> *Woodside has shown through experimental field testing during "Phase I" of the Maxima Survey that no auditory impacts to marine fish, in the form of Temporary or Permanent Threshold Shift (TTS and PTS, respectively), occurred through sound exposure levels generated by the air gun array proposed for the Maxima "Phase II" survey (see Final Adaptive Management Program). This was further supported by onsite examinations which demonstrated that no physiological impacts had occurred, as well as post-line marine faunal observations which documented no exposure mortality. As no impacts to site-attached reef fish occurred through exposure to a single sail line, cumulative impacts through repeated exposure would not be expected to occur (Woodside 2008:24).*

Other studies of seismic activity show that it can have significant impacts on local fish populations. The following is taken from a document entitled "A review of Woodside's Draft Environmental Impact Statement of the Chinguetti Offshore Oil Development Project in Mauritania".[11]

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10 Temporary and Permanent Threshold Shifts TTS/PTS are measures of the temporary or permanent loss of hearing from loud noise.

11 This report was prepared for the Mineral Policy Institute, an "Australian-based non-government organisation specialising in advocacy, campaigning and research to prevent environmentally and socially destructive mining, minerals and energy projects in Australia, Asia and the Pacific". Available online at http://www.foe.org.au/groups/affiliates/australian-affiliate-members-of-foe-international/the-mineral-policy-institute-mpi/. Accessed 25/08/09.

Results of research conducted by Norwegian scientists indicate that school pelagic fish change their behaviour in response to a seismic signal at a distance up to 100 km from the signal source (Dalen *et al.,* 1996). Another study showed that intensive seismic exploration caused a decline in fish populations and resulted in a 70% decline of commercial catch near the Norwegian shore (Patin, 1999). Engas *et al.* showed in 1996 that seismic surveys in deep water ecosystems can cause a temporary decline in commercial fish catches of more than 40% (Kloff and van Spanje 2004).

A more recent review paper on this issue concludes that seismic activity may have temporary effects on the catchability of demersal fish such as north Atlantic cod (*Gadus morhua)* and haddock (*Melanogrammus aeglefinus)* (Hirst and Rodhouse 2000:117). Hirst and Rodhouse note that fish with swimbladders seem to be more affected than those without. It should also be noted that the decibel levels in the tests reported in Hirst and Rodhouse appear to be considerably higher than in the Woodside Maxima survey discussed above (see Appendix 6 for additional discussion).

In light of these conflicting research findings and the concerns expressed by local fishers, we believe that it would be useful to create a plain language summary of existing research relevant to the proposed physical impacts associated with the further development of Browse Basin gas, and the construction and operation of the JPP LNG Precinct. Such a resource could promote informed and constructive public discussion.

11.5.5 Increased pressure on fish stocks

NDSF fishing grounds are several hundred kilometres offshore. These operators were, therefore, less concerned than other fishers about the increase in recreational fishing around Broome due to the expanding population. However, they were very concerned about the recreational fishing activities of workers stationed off-shore on platforms and rig tenders. One operator described in detail the potential magnitude of the impact. He submitted the statement below as part of a longer discussion. The full text of his submission contained in Appendix 2.

Portion of statement of NDSF fisher regarding potential for rig and tender based recreational fishing to affect NDSF

"Recreational fishing is widely undertaken by many vessels from oil rig tenders, to standby to survey vessels. It is an activity that is seen to be useful to alleviate boredom among crews and can have tacit acceptance from the bigger companies for this purpose. Critically it may not always involve the retention of all fish caught, but will involve the catching and release of fish as a means of whiling away time. The target species are almost exclusively the top end Emperors, Cods and Mackerels while the depths involved, invariably involve death from barotrauma for released fish.

Our modelling makes the following assumptions:

Spread over oil and gas exploration, drilling, seismic, construction and survey. The Kimberley currently hosts conservatively 60 vessels operating offshore.

Average crew size is nine persons. Rig tenders operate with 12-15 while smaller vessels may operate with as low as four.

Australian crewed vessels are operating on four weeks on/off rosters; this gives a crew change every 28 days or 13 times a year.

If four crew take home a recreational possession limit of 20kg of frozen fillet each every 28 days, fillet recovery rate for a non professional filletter is around 30% so 66.6kg of whole fish is required

66.6[whole fish equivalent] x 4 [persons fishing] x 60 [vessels] x 13 [crew changes] = 207,792 kg

Our assumptions make no provision for mortality from baro-trauma in released fish or fish consumed onboard by crews, it would be fair to assume that both of these should have a value for the purpose of estimating mortality.

To put this in perspective, the "state of the fisheries" most recent catch range for the Pilbara wetline fishery is 90-110 tonnes of fish, yet one subgroup of the recreational fishing community is exceeding that by nearly 100%.

Neither the recreational or commercial users of the Kimberley fish stocks can afford to lose this much fish to one small group should we wish to manage stocks sustainably into the future. Left unchecked it will ultimately affect the fishing experience of all parties at some point in the future."

Information from the DoF suggests that 60 vessels may be an over-estimation for the Kimberley region alone. However, the key point is that recreational catch from vessels servicing the oil and gas industries offshore can be substantial. It is likely that fishing from oil and gas vessels will increase as the Browse Basin and other areas are developed. The JPP Precinct development may well contribute to this phenomenon. The DoF have confirmed that this issue has been raised and is being further investigated with the Western Australian Fishing Industry Council (WAFIC) and the Australian Petroleum Production and Exploration Association (APPEA).

The recreational fishing capacity of the gas and oil rig tenders needs to be seen in context with the targeted catch of the NDSF. The target catch of combined species in the NDSF is between 600 – 1000 tonnes, according to the most recent State of the Fisheries Report 2007/08 (SFR). In 2007 the fishery harvested 908 tonnes. This leaves less than a 100 tonne buffer between the actual catch of the NDSF and the upper limit of the target catch. If the nominal recreational take by tenders were less than half of what the NDSF fisher cited above suggests, the total allowable catch for the fishery would be surpassed. Even if the figures provided by the NDSF fisher are somewhat inflated, this situation raises a potentially serious resource sharing issue.

There may be simple mechanisms available to mitigate this problem. For example, vessels associated with the oil and gas industries could be prohibited from recreational fishing. Alternatively, recreational fishing could be permitted on the condition that the fish caught is consumed aboard. One NDSF fisher suggested that the Western Australian Fishing Industry Council (WAFIC) and Recfishwest might collaborate with The Australian Petroleum Production & Exploration Association (APPEA) to design a regulatory mechanism to address these issues. Such a process might involve some form of mediated negotiation between the three parties, an approach that has worked well for disputes between recreational and commercial fishers in the past.[12]

11.5.6 Port of Broome

The Port of Broome is already a challenging place to unload fish. This is due in part to the easterly wind that predominates from May to September, the high tidal range (8 – 10 metres plus) and the competition for space between the oil & gas industry, charter operators, pearling operators and commercial fishers. There are no alternative unloading points in the area so operators have no choice but to use the facility, or seek alternative ports. [13]

These challenges are exacerbated by the requirement that operators use the Broome Port Authority's cranes on the main wharf. This means, among other things, that they must comply with stringent Occupational Health and Safety regulations. In order to meet the various rules relating to use of the wharf the fishers need to book their position well in advance to unload their catch and to take on supplies such as fuel and water. The NDSF fishers resent the fact that the easy come-and-go access that applies to most ports in Australia is not available at Broome. They lament the loss of past informal arrangements and the increasing bureaucratisation of the Broome facilities because of the additional pressures that these conditions impose upon their industry.

It is important for this fishery to have an efficient unloading process because its operators are providing quality fresh fish. Delays reduce the quality and the value of the catch, some of which has already been stored in ice slurry for some days by the time it arrives in Broome.

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12 For examples, see Wright et al., 2000.

13 Darwin is the only feasible alternative port for the NDSF.

All the NDSF fishers interviewed were concerned that, without effective mitigation, the proposed JPP LNG Precinct will further exacerbate the difficult situation at Broome Port, requiring more of them to transfer their base of operations to Darwin.

11.6 Input-output rationale

There are a range of issues associated with the development of the Browse Basin oil and gas that could significantly affect this fishery, and are discussed above. However, most of these issues relate to the fact that this fishery needs to share its fishing space with the oil and gas industries, and these issues will continue, independently of the specific issues relating to the JPP LNG Precinct.

The key issues relating to the JPP LNG Precinct for this fishery are the marine traffic and Broome Port situation. In common with other sectors of the marine industries that need to use Broome Port, there is concern that the JPP LNG Precinct will cause the Port to be dominated by the gas industry. Conditions at the port are already reported as difficult. This fishery needs to transfer its fish quickly to refrigerated transport. There could be significant inconvenience caused by the Broome Wharf being "swamped" by JPP LNG Precinct related traffic. This is likely to be most acute during the construction phase when porting facilities at JPP are yet to be developed, and when there is a lot of active small to medium sized vessel use as a result of the construction. Once the construction is completed there will continue to be increased traffic associated with the JPP LNG Precinct, but it is likely to be at a lesser extent.

The obvious mitigation measure is that Broome Port is significantly improved, with better facilities for small and medium sized vessels. This is important to all people who use boats in the Broome area. However, it is unknown whether there will be significantly improved porting facilities in Broome as a result of the JPP LNG Precinct's development, and whether these would be provided prior to the start of construction. Significant planning is likely to be required. There are significant constraints in terms of the geographical situation of the port; construction options may be limited by important Aboriginal heritage considerations thought to exist in the area.

A reduction in the portion of the economic activity of the NDSF that is associated with the Broome Port seems likely, at least during the construction period. Based on the levels of frustration expressed with the port situation we think this could be as high as up to 20%. Almost half the vessels in this fishery (three out of seven) currently operate from Darwin. Thus, we think that an overall reduction in the fishery of about 10% is possible. The negative flow-on effects of

this reduction would be strongly weighted towards the Broome/West Kimberley region. It would comprise mainly loss of fueling, re-provisioning, re-fitting, and similar work that may need to shift to other centres due to the inconvenience of using Broome. Of course, this figure would escalate quickly if more vessels decide to shift their main focus of operations to Darwin due to the frustrations experienced in Broome.

12 AQUACULTURE

12.1 Overview

The Kimberley has significant potential for the aquaculture development of species in addition to pearl oysters. There are numerous Kimberley sites suitable for the culture of finfish and shellfish species in marine, brackish water and fresh water environments. In particular, the vast fresh water resources of Lakes Argyle and Kununurra have enormous potential for aquaculture development. Although development opportunities in the coastal area are limited by remoteness, the coastal zone is ideally suited to many forms of aquaculture. The offshore islands, with their exposure to high-quality sea water also present significant future potential.

12.2 Potential aquaculture species

The Kimberley Aquaculture Development Plan, published by WA Fisheries in the late 1990s lists a number of species that are suitable for commercial aquaculture. The species are listed for their marketability, suitability to aquaculture rearing methods and compatibility with the environmental conditions that influence the Kimberly region.

Potential aquaculture species for the Kimberly region are listed below;

Table 13. Kimberley species with aquaculture potential (WA Fisheries website)

Species with potential for commercial aquaculture in the Kimberley		
• *native aquarium fish*	• *barramundi*	• *redclaw crayfish*
• *pearl oysters*	• *edible oysters*	• *tropical abalone*
• *cherabin*	• *grouper*	• *coral trout*
• *red emperor*	• *mangrove jack*	• *mud crab*
• *trochus*	• *clams*	• *trepang*
• *marine prawns*	• *brine shrimp*	• *catfish*
• *Argyle bream*		

Several of the abovementioned species have existing, well developed culture technology. These species, which are considered suitable for commercial development, include some native aquarium fish, barramundi, trochus, clams. and pearl oysters (species other than *P. maxima).*

12.3 The Dampier Peninsula Aquaculture Management Zone

The Kimberley Aquaculture Development Plan also provides a description of Aquaculture Management Zones in the region. These include: the Dampier Peninsula, Lake Argyle, Irrigation, Pastoral, Coastal and Offshore Zones. The DoF advise there are three existing aquaculture licences on the west coast of the Dampier Peninsula, which are currently inactive.

Dampier Peninsula Zone includes the Dampier Peninsula, King Sound and the Canning Coast. The zone includes the Tropical Aquaculture Park located in Broome and a special development zone with Derby at its centre. A dominant feature of the zone is King Sound, which is characterised by a macro-tidal regime that would be suitable for a range of aquaculture developments. The Dampier Peninsula Zone is considered to have high aquaculture potential.

The Tropical Aquaculture Park in Broome consists of seven land-based sites which have been made available for lease to aquaculture and pearling companies. Currently three of the seven sites are leased and used for a pearl oyster hatchery and aquaculture training facilities. The Tropical Aquaculture Park was built to facilitate and encourage the development of aquaculture technology for a wide variety of marine, brackish water, and fresh water species. It is hoped that in the future the Tropical Aquaculture Park will provide a base for hatcheries producing commercial quantities of seed stock, such as juvenile trochus and barramundi, destined for growing out elsewhere in the Dampier Peninsula Zone. The Dampier Peninsula's coastal strip is a high-energy coast with sandy beaches, rocky headlands, and embayments such as at JPP. The low-profile coast provides marine and brackish water sites that may be suitable for trochus, marine finfish species, prawns, mud crab and clams. The Kimberley Aquaculture Development plan states that the area is primarily suited to land-based production systems as marine-based systems are likely to be limited to low energy embayments with small tidal streams.

As evidenced by the oceanic pearling system developed by Clipper Pearls, adjacent to the Quondong – JPP area, marine-based aquaculture in the region exists in an extreme environment of massive tidal movement and regular cyclones. However if adequate anchoring systems could facilitate sea cage farming in the region, the large tidal flow may efficiently dilute any associated

waste outputs, and oxygen depletion would be unlikely, making the area potentially suitable for oceanic aquaculture.

12.4 Aquaculture development in the vicinity of proposed JPP LNG Precinct

The main aquaculture development in the vicinity of the proposed JPP LNG Gas Precinct is the pearl farm owned and operated by Clipper Pearls adjacent to the JPP / Quondong site. The description of this activity is explained in the pearling section of this report, see above.

Identifying impacts for aquaculture operations, other than pearl farming, proved difficult due to the lack of aquaculture development for species such as prawns, trochus, clams and fi-fish in the Dampier Peninsula Aquaculture Zone. The three licences that exist appear to be inactive.

The potential for aquaculture development in the region is obvious and investment by the WA Government in the Kimberley Aquaculture Development Plan and the Tropical Aquaculture Park in Broome is evidence of this. However, uptake of aquaculture in the region by commercial proponents is slow. This is probably due to the isolation of many of the sites and the lack of infrastructure and resources needed to run complex operations (Lee. C *et al* 2004).

The most notable finfish aquaculture operation in the region is the salt-water barramundi hatchery and farming operation located in Cone Bay on the Buccaneer Archipelago. This operation provides an example of what is achievable in the region. It includes a hatchery and marine-based rearing facilities located at the site. The manager was contacted by the study team but decided not to participate in this FIS. It was thought that the distance between the farm-site in Cone Bay and the proposed JPP LNG Gas development would result in a negligible impact on this operation.

Another notable aquaculture development in the region is the community based aquaculture hatchery located at One Arm Point on the Dampier Peninsula. The operation is land-based but relies on access to fresh and saltwater resources to grow shell fish species such as trochus and tropical abalone. While the geographical area between the proposed JPP site and One Arm point make direct impacts on the operation unlikely, the operation is an example of a successful aquaculture operation in the region and what the region is capable of producing given time and the maintenance of environmental systems in the region.

The One Arm Point hatchery is also a success story for socio-economic reasons. The Bardi Aboriginal Community operates the One Arm Point hatchery. This aquaculture facility is considered a success due to the capacity building outcomes it has provided for the local people. See Lee et al. (2004) for more information on this.

12.4.1 Aquaculturalists interviewed

Aquaculture licence holders from the Pender Bay / Kelk Creek area were interviewed as part of the Fishing Industry Impact Study investigation. Although they were not currently utilising their aquaculture entitlement, they commented there was potential for land based red claw and black bream farming in the region due to the fresh water aquifers that occurred in the region.

They were concerned about the volume of fresh water that may be needed for the proposed development and were concerned that important aquifers may be contaminated if the proposed JPP LNG Gas development accessed groundwater during the construction phase. It is hard to quantify the level of potential use and or impact to groundwater resources in the region by the proposed development as this information is not available at this stage.

The licence holders were also concerned about introduced marine pests that may be associated with increased shipping as part of the development. They noted from their experience in Port Hedland that the dredging necessary for maintenance of the shipping channel caused a reduction in the health of the local marine environment.

The Kimberley Aquaculture Development Plan recognises the coastal zone of the Dampier Peninsula Aquaculture Zone as best suited to land-based aquaculture development. Any impact to ground water in the region could limit future development.

The Aquaculture Council of Western Australia believes that displacement of fisheries should result in both compensation, and offsets towards aquaculture in order to maintain seafood supply. The Aquaculture Council noted that in a world of changing climate conditions there is a strategic food security need to offset reductions in wild catch with aquaculture.

Table 14. Key Issues raised by Aquaculturalists and ACWA

Issue raised	Potential Impact	Project Phase	Risk/Need Factor	Potential Mitigation Strategies/ Opportunities	Responsibility/Key Drivers
Loss of fresh water and potential contamination from use of aquifers by JPP LNG Precinct.	Less fresh water available for aquaculture on the Dampier Peninsula.	Construction & Operation	unknown	Minimise potential impacts, including water use and management strategies when the final design and location has been determined	Proponent Department of State Development Department of Water
Dredging may result in loss of habitat	Direct pollution of JPP and surrounding area	Construction & Operation	High	Prepare a dredge management plan, which includes details of on-going maintenance dredging requirements.	Proponent Department of State Development
Marine pests possibly introduced	Introduction of black striped mussel and similar pests that could cause marine aquaculture to be made more difficult in this area.	Construction & Operation	High	Ballast water to be discharged well away from aquaculture operations. Biofoul inspections (Quarantine Pre-arrival Report) to be conducted by Australian inspectors as a condition of entry to Australian waters. Specific relevant regulations relating to biofoul inspections	Australian Quarantine Inspection Service (AQIS) Department of Agriculture Fisheries and Forestry (DAFF) Department of Fisheries

				should be reviewed and enhanced, if possible, to achieve highest possible levels of protection.	
Displacement of commercial fisheries should be offset with encouragements for aquaculture to maintain continuity of seafood supply (Aquaculture Council).	Loss of local seafood as result of diminution of fishing industry.	Construction & Operation	HIgh	Promote integrated coastal and marine planning initiatives on a regional scale, which provide opportunities for all potentially affected stakeholders to input into long term coastal zone management	Departments of Fisheries, Environment and Conservation, Planning, WAFIC, ACWA,PPA, KLC, and others

12.5 Discussion of issues

Apart from intensive pearl production, which is the key aquaculture component of the Kimberley region, aquaculture development of other species such as prawn, barramundi, mud crab and trochus is a relatively small part of the regional economy at present. However, there appear to be significant opportunities for future substantial growth. This growth may be necessary in order to offset reductions in wild catch fisheries that may occur as a result of developments such as the exploitation of the oil and gas reserves of the Browse Basin, and the expansion of the marine conservation estate.

The aquaculture operations located at One Arm Point and Cone Bay are examples of the potential that aquaculture has in the region and how it has the potential to become increasingly viable as infrastructure in the region improves. The development of the JPP LNG Precinct may provide increased services in the region, like sealed roads and access to power, that may assist aquaculture development.

The coastal zone of the Dampier Peninsula seems best suited to land-based aquaculture development due to the extreme oceanographic conditions experienced in the region, although, as discussed above robust anchoring systems may make some oceanic aquaculture attractive.

The value of the groundwater is potentially significant for future land-based aquaculture in the region. The potential use of groundwater by the proposed JPP LNG Gas Development should be quantified and any negative impacts that may be a result of the use of groundwater by the development mitigated.

REFERENCES

Collins, J.H. 2008. Marine Tourism in the Kimberley Region of Western Australia. *Geographical Research*, 46(1):111-123.

Dalen, J., Ona, E., Soldal, F.V., Saetre, R., 1996. Seismiske undersokelser til havs. *Fisken og havet.* 9: 26.

Engas, A., Loîkkeborg, S., Ona E., Soldal, F.V., 1996. Effects of seismic shooting on local abundance and catch rates of cod *Gadus morhua* and haddock *Melanogrammus aeglefinus.* Can. J. Fish. Aquat. Sci

Fisheries, Department of, 2008. *The State of the Fisheries 2007/2008*. Department of Fisheries, Western Australia.

Griener, R., Stoeckl, N. and Schweigert, R. 2004. Estimating community benefits from tourism: the case of Carpenteria Shire. Paper presented to the 48th Annual Conference of the Australian Agricultural and Resource Economics Society, Melbourne.

Hutchings, P.A., R.W. Hilliard, and S.L. Coles 2002. "Species Introductions and Potential for Marine Pest Invasions into Tropical Marine Communities with Special Reference to the Indo-Pacific, *Pacific Science* Vol. 56 No.2 pp. 223-233

Kangas, Mervi, Errol Sporer, and Sharon Brown 2009. " Broome Prawn Managed Fishery 2008 Research Report (Preliminary) Department of Fisheries, Perth WA.

KPP Business Development 2009. Tourism Impact Assessment – Kimberley Liquefies Natural Gas (LNG) Project. TWA 39/2009. Commissioned by Tourism Western Australia, in partnership with The Western Australian Department of State Development.

Lee C., Fong J., B. Sharpe, and C. Clements, Community Based aquaculture hatchery, One Arm Point, Dampier Peninsula, the Kimberley, Western Australia – A community success story, *SPC Trochus Information Bulletin* No.11, 2004.

Mineral Policy Institute website http://www.foe.org.au/groups/affiliates/australian-affiliate-members-of-foe-international/the-mineral-policy-institute-mpi/

Minoru, Soimachi, 2000. "Mass mortalities of Japanese pearl oyster Pinctada fucata martensi", *Aquabiology* Vol. 22 No. 1 pp. 39-44

Onyx, J. and R. Leonard 2005. Australian Grey Nomads and Amercian Snowbirds: similiarities and differences. *The Journal of Tourism Studies*, 16(1): 61-8.

Patin, Stanislav, 1999 Environmental impact of the offshore oil and gas industry, 425 pp. available on www.offshore-environment.com

Pember, M.B., S.J. Newman, S.A. Hesp, G.C. Young, C.L. Skepper, N.G. Hall, and I.C. Potter, 2005. Biological parameters for managing the fisheries for Blue and King Threadfin Salmons, Estuary Rockcod, Malabar Grouper and Mangrove Jack in northwestern Australia, Fisheries Research and Development Corporation Report FRDC project 2002/003

Penn, J.W. & Dybdahl, R. 1988. A research vessel survey of pearl oyster and prawn resources north-west of Broome, Western Australia. Fisheries Report no. 81. Fisheries Department of WA, Perth.

Stoeckl, N., Griener, R. and Mayocchi, C. 2006. The community impacts of different types of visitors: an empirical investigation of tourism in North-west Queensland. *Tourism Management* 27: 97-112.

Taylor, C.N., Bryan, C.H., and Goodrich, C.G. 1990. *Social Assessment: theory, process and techniques.* Studies in Resource Management #7. Centre for Resource Management: Canterbury, NZ

Williamson, P.C., N.R. Sumner and B.E. Malseed 2006 *A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000,* Fisheries Research Report No. 153, Department of Fisheries, Perth

Wright, Guy, Rebecca Metzner and Hugh Chevis, 2000. Using Mediation to Solve Fisheries Disputes in the Guidelines for Voluntary Resource Sharing Process, Fisheries Western Australia Western Australian Department of Fisheries. www.wa.gov.au/westfish/corp/broc/mediation/mediation.pdf

Wu, Xinzhong, and Jinpei Pan 1999. "Studies in Reckettsia-like Organism Disease of the Tropical Marine Pearl Oyster 1: The Fine Structure and Morphogenesis of *Pinctada maxima*Pathogen Rickettsia-like Organism"*Journal of Invertebrate Pathology* Vol. 73 Issue 2 pp. 162-172

Woodside Energy Ltd 2007a. "Environmental Protection Statement: Maxima 3D Marine Seismic Survey, Scott Reef"

Woodside Energy Ltd 2007b. "Fish Monitoring Program: Maxima 3D Marine Seismic Survey, Scott Reef"

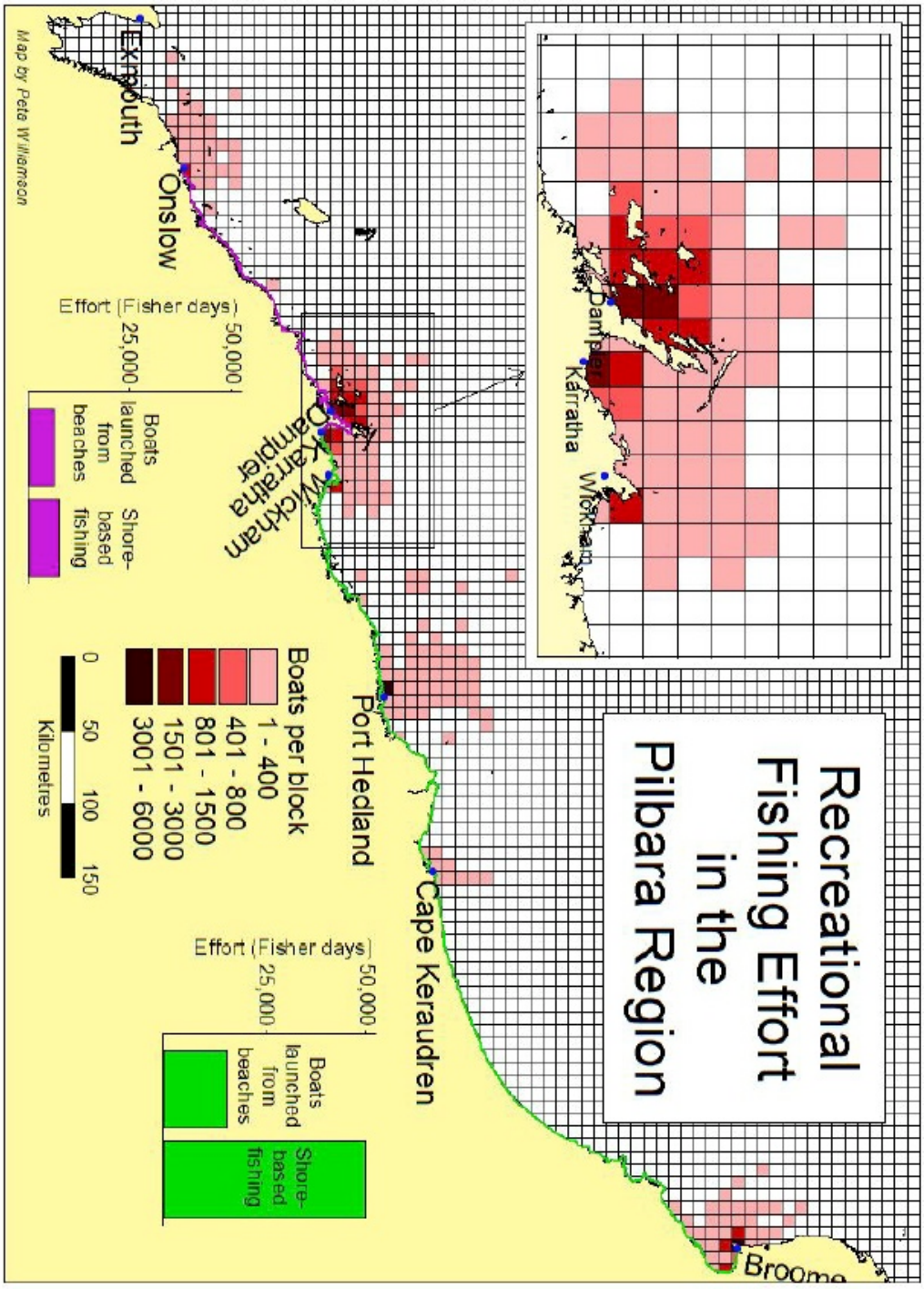
Woodside Energy Ltd 2008. "Environmental Compliance Report: Maxima 3D Marine Seismic Survey, Scott Reef"

Zhang, J., Hertzler, G. and Burton, M. 2003, *Valuing Western Australia's Recreational Fisheries,* prepared for the 47th Annual Conference of the Australian Agricultural and Resource Economics Society, Fremantle.

APPENDIX 1

"Heat map" of recreational fishing effort – Pilbara and Broome areas

Source: Williamson, P.C., N.R. Sumner and B.E. Malseed 2006 *A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000,* Fisheries Research Report No. 153, Department of Fisheries, Perth



APPENDIX 2

Statement of Northern Demersal Scalefish Fisher regarding potential for recreational fishing from rig tenders to impact NDSF available catch.

"As a license holder that has borne effort reductions in the past to ensure sustainability of Pilbara fish stocks and an active fisher in the NDSF, we are watching the proliferation of offshore oil and gas development along with the soon to commence onshore development of a number of projects.

All of these developments propose to bring increased pressures on the regional fish stocks, both through increasing recreational pressure from a regional population and through increased fishing from crews of vessels engaged in construction and service operations to this development

It is our view that fish stocks of both regions will eventually suffer the same resource allocation debate that has befallen the west coast and other bioregions. Although stocks are currently robust, it is necessary for planning to commence now as to how to manage these regions bearing in mind that fish from these 2 bioregions are the core of state wetfish supply.

Of particular concern to us and which should also be of concern to regional recreational fishing communities. Is the sheer amount of fishing mortality attributable to fishing by crews of commercial work vessels in both regions, Our modeling shows that the annual catch from work vessels is currently over 200 000 kg per annum and will increase in line with development activities now proposed for that sector.

Recreational fishing is widely undertaken by many vessels from oil rig tenders, to standby to survey vessels. It is an activity that is seen to be useful to alleviate boredom among crews and can have tacit acceptance from the bigger companies for this purpose. Critically it may not always involve the retention of all fish caught, but will involve the catching and release of fish as a means of whiling away time. The target species are almost exclusively the top end Emperors, Cods and Mackerels while the depths involved, invariably involve death from barotrauma for released fish.

Our modeling makes the following assumptions:

- Spead over oil and gas exploration, drilling, seismic, construction and survey. The Kimberley and Pilbara currently hosts conservatively 60 vessels operating offshore.

- Average crew size is 9 persons Rig tenders operate with 12-15 while smaller vessels may operate with as low as 4

- Australian crewed vessels are operating on 4 weeks on/off rosters this gives a crew change every 28 days or 13 times a year.

- If four crew take home a recreational possession limit of 20kg of frozen fillet each every 28 days,

- fillet recovery rate for a non professional filleter is around 30% so 66.6kg of whole fish is required

- 66.6 x 4 x 60 x 13 = 207792 kg

Our assumptions make no provision for mortality from barotrauma in released fish or fish consumed onboard by crews, it would be fair to assume that both of these should have a value for the purpose of estimating mortality.

To put this in perspective, the "state of the fisheries" most recent catch range for the Pilbara wetline fishery is 90-110 tonnes of fish, yet one subgroup of the recreational fishing community is exceeding that by nearly 100%.

Neither the recreational or commercial users of the Kimberley and Pilbara fish stocks can afford to lose this much fish to one small group should we wish to manage stocks sustainably into the future. Left unchecked it will ultimately affect the fishing experience of all parties at some point in the future."

APPENDIX 3

Example of economics study questionnaire

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Economic Impact of the Kimberley LNG Project – Charter Operators

Please read this first:

- Please only include the amounts that can be attributed to your charter business for the 2007/08 financial year
- If exact figures are not available, please provide careful estimates.

PART A CAPITAL

1. In the following table, please include a list of all gear and equipment that you use for commercial charter operations in the Broome region, including electronic equipment, sheds, trailers and motor vehicles (please give values *exclusive* of GST).

Item	Age (yrs)	Current value $	Replacement cost $
Boat engine			
Boat (without engine)			
Electronic Equipment			
Fishing Gear (specify)			
Sheds/buildings			
Motor vehicles			
Trailers			
Other equipment (specify)			

2. If this capital is not solely used for your charter business, what is the percentage of your capital used for the commercial fishing?_____%

3. If your capital has other uses, what are these uses?

_____

4. What is your estimation of the current market value of your charter boat licence(s)? _____

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PART E IMPACT OF PROPOSED GAS PROCESSING PRECINCT

1. Please indicate what the likely effect of the construction and ongoing operation of the proposed gas processing precinct and related activities on your business. Please consider all potential social and economic impacts (e.g. number of visitors, changes to fishing locations, employment, operating costs, etc.)

Nature of the Impact	Timing of Impact	Magnitude of the Impact		
		Low	Expected	High
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			
	☐ Construction phase ☐ Ongoing impact			

PART F FURTHER COMMENTS

Please provide any additional comments that could assist in preparing the report.

Thank you for completing this survey

APPENDIX 4

Letter to Stakeholders

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Fishery Impact Study – James Price Point – LNG Gas Hub

You may be aware that James Price Point (JPP), approximately 60 kilometres north of Broome has been chosen by the Government of Western Australia as a preferred site for a liquefied natural gas (LNG) precinct to provide onshore processing facilities for liquefied natural gas LNG sourced from the Browse Basin north of Western Australia.

JPP was chosen following extensive assessment of a number of possible locations for an LNG precinct undertaken by the Northern Development Taskforce.

The purpose of this letter is to let you know, as a licensed fishing interest holder, that Big Island Research Pty Ltd has been contracted by the WA Department of Fisheries to conduct a "fishing impact study" (FIS). This FIS will form part of a Social Impact Assessment that will in turn be part of a comprehensive strategic assessment of the JPP site by the Western Australian Government under the *Environmental Protection Act 1986* (EP Act) and the Commonwealth Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

We are interested in collecting information – in confidence – that will help build a picture of the social and economic importance of those fisheries that might be affected by the proposed JPP development. EconSearch, an Adelaide based economics consulting group with fisheries experience, will process economic data. From this they will generate models of potential changes as a result of the construction and operation of the LNG precinct at JPP.

Christian Pyke, Executive Officer of the South Australian Sardine Industry Association, and myself will be interviewing recreational and commercial fishers. We will be in Broome to interview people the week of 11 May and into the following week. We want to collect economic and other relevant information, including your opinions, and we want to get an idea of where your fishing or related interests are, so that this information can be used to build a realistic picture of the potential of the LNG precinct development to affect your interests. Confidences will be strictly kept.

If you wish to participate please call me on 08 9335 3733, or Christian Pyke on 0428 233 200, or e-mail me at guy@bigislandresearch.com.

Guy Wright
4 May 2009

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APPENDIX 5

Short recreational questionnaire given to Broome Fishing Club members

Fishing Impact Study – Kimberley LNG Project – James Price Point.

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The purpose of this survey is to document recreational fishing expenditure to gain a rough estimate of its value to the local economy. This will help gauge the possible economic impacts of any change in fishing from the James Price Point LNG project if it goes ahead.

We encourage you also to use the back of the sheet to make any comments you think relevant.

Total value of boat and engine	$1,000 – 5,000
	$5,000 – 20,000
	$20,000 – 40,000
	$40,000 – 70,000
	$70, 000 +
Current value of all fishing gear	$100 – 500
	$500 – 1,500
	$1,500 – 5,000
	$5,000 – 20,0000

Average fuel use per day of fishing	0-50 litres
	50-100 litres
	100 – 150 litres
Estimate number of days fished per year between Willie Creek and	0-10
	10-20
	20-30
	30-50
	50+
Please estimate percentage of each fish type caught	pelagics – including sailfish
	reef fish
	"Salmon" – barramundi and other

Circle One:

From what you know of the James Price Point LNG (JPP) proposal do you think it will reduce your recreational fishing effort during its construction phase? YES / NO / DON'T KNOW

Do you think the completed project will reduce your fishing effort over time? YES / NO DON'T KNOW

Do you see benefits to recreational fishing as a result of the JPP development? YES / NO / DON'T KNOW

Please list any benefits that you think might come from the proposed JPP development

Please add any further comments you wish

APPENDIX 6

Brief review of literature on impacts of seismic noise on fisheries

Please note that this material is provided for convenience only. It was compiled by anthropologists with no levels of relevant expertise and is drawn from a limited sample of material that was easily available at the time of writing.

Marine noise pollution is an emotive issue that has attracted considerable debate in the context of marine wildlife conservation. McCarthy (2004, p.10) suggests that much of this controversy is associated with 'misuse of the term "decibel" (dB)'. This is a measure that can only be calculated relative to pressure, meaning that it is not possible to make direct comparisons between sounds in water and sounds in air. She also explains that the 'multidimensional' nature of sounds requires that factors such as 'intensity, duration, frequency, bandwidth, duty cycle, rise time, temporal structure, and similarity' to naturally occurring sounds (p.11) must all be taken into account when assessing the impact of anthropogenically generated noise on marine animals. As Hirst and Rodhouse (2000, p.117) explain, 'the transmission of sound in water is variable and site-specific, and will influence the distance to which organisms are influenced'. Species sensitivity to sound combined with particular environmental conditions — such as water depth, geographic features of the ocean bed, and water temperature —contribute significantly to the extent to which sounds can be detected by marine animals at specific distances from their source. The presence of multiple noise sources is also significant (McCarthy 2004, p11).

The impact of noise pollution on marine mammals (especially cetaceans) has been of particular concern to conservationists, researchers, and marine resource developers. Lang (2000) notes that this is at least partly due to legislation associated with the conservation of endangered species. A range of short-term physiological and behavioural effects resulting from underwater noise caused by 'boating, shipping, oil exploration, dredging, ice-breaking, and scientific and defense activities ' have been documented in a variety of species (McCarthy 2004, p. 15). However, very little data has been collected on long term effects (p.15). Impacts on other marine species have been less extensively examined, however a specific body of research does exist on the impact of seismic noise on fisheries.

In a review article on the effects of seismic surveying on fisheries, Hirst & Rodhouse (2000) report that airguns typically produce sound levels between 241dB and 265dB re1μPa

in short pulses, emitted at frequencies of 20 – 150 Hertz (but sometimes as high as 1,000Hz). [14] A survey can be in operation for 24 hours a day and may discharge 14,000 shots whilst travelling over a 178 kilometre trackline (96 nautical miles). Individual tracklines are separated by 50-100 metres (p.113). They note that marine wildlife directly exposed at close range (approximately 30 metres or less) to airgun detonations may be killed instantly or fatally injured (p. 113-114). The research cited by Hirst and Rodhouse (2000) suggests that fish with swim bladders are likely to be killed or severely effected at a further distance to the explosions than those that without swim bladders. They also report that crustaceans and molluscs living on the seafloor may be unharmed at much closer proximity to the airgun discharges (p.114). Hirst and Rodhouse (2000, p114) cite research conducted by Turnpenny and Nedwell in 1994 that reports 'physiological damage and mortality' of adult, juvenile and larval fish at, or above, 180dB re1μPa.

Longer term behavioral changes of fish that have been exposed to seismic surveys have been documented to impact upon fishing catch. Hirst and Rodhouse (2000, p.117) report that, in some circumstances, '[f]ishing success has been shown to be reduced for at least 5 days after airgun shooting has finished, and to a distance of 33km.' They note that, at the time of writing, there had been no research done on the long-term consequences of seismic surveying for fish catches, pointing out that behavioral disruptions 'during critical periods such as mating, spawning and migration' could be especially significant (p.117).

Wardle *et al* (2001, p. 1025) also report that '… open-sea experiments [on the effects of seismic surveys] have found indications of large-scale influences resulting in apparent movements of commercial fish species, for example, making them more or less accessible to fisheries.' They contrast this to their own research conducted in shallow water which shows that reef species remain within the vicinity even after airgun surveys.

Impacts of noise pollution on pelagic species, especially spanish mackerel, marlin and sailfish, are of particular concern for the fishers in the Broome area. The fisherman

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14 Gausland (2000, p.903) points out that 62dB should be added to sound measurements of airborne sound in order to compare them with measurements of waterborne sound in order to account for 'higher acoustic impedance' in the aquatic environment. She claims that the human pain threshold for airborne sound is 140dB while the underwater equivalent would be 202dB (p.903). She also explains that the 'frequency range of seismic surveys coincides' with the sound frequencies used by many marine species 'and may therefore interfere with their normal behaviour' (p. 904).

interviewed suggested that the long lateral lines of these large species might increase their sensitivity to noise pollution. Although Australian-based researchers, Dempster and Kingsford (2003) point out that '(k)nowledge of the hearing capabilities of large pelagic fish is poor' (p.216), Hawkins (1993. P.166) states that teleost fish in general 'are acutely sensitive to sounds, though their hearing abilities are confined to low frequencies'.

Bleckmann (1993, p.235) describes that the lateral lines of teleosts as 'distant touch receptors' that detect movement and inanimate objects by sensing sound waves in the aquatic environment. Given that these sensory organs are important for spatial orientation, specifically for identifying and locating prey, avoiding predators and obstacles and communicating within species (p. 236), concerns about the impact of noise pollution on fish populations in the area may be justified. However, we have not located evidence to suggest that large pelagic species are any more vulnerable than smaller species.

Slotte *et.al* (2004) have collected data on changes in the behaviour of several other pelagic species (herring, blue whiting and mesopelagic species) off the western coast of Norway following the use of seismic airguns. They found that blue whiting and mesopelagic species appeared to move to deeper water when airguns were being used in the area, suggesting that vertical, rather than horizontal, movement could be a short-term effect of seismic shooting. They note that overall density of herring and blue whiting seemed to increase with distance from the shooting area, which they argue could be a long-term effect of seismic activity, a finding that appears to replicates the results of two similar earlier studies. Slotte *et.al* (2004) also recorded evidence of herring and blue whiting moving back into the target area 3-4 days after the seismic shooting stopped. Nonetheless, they state clearly that 'seismic shooting on and close to spawning grounds and over well-established migration routes to spawning grounds' should be minimized or avoided (p.150) to prevent damage to fish populations at more vulnerable points in their lifecycles.

References:

Bleckmann, H. 1993 Role of the lateral line in fish behaviour. In T.J. Pitcher (ed) *Behaviour of Teleost Fishes*. Fish and Fisheries Series 7. Chapman and Hall: London, UK. Pp.201-246.

Dempster, T. and Kingsford, M.J. 2003. Homing of pelagic fish to fish aggregation devices (FADs): the role of sensory cues. *Marine Ecology Progress Series*. 258: 213-222.

Gausland, I. 2000. Impact of seismic surveys on marine life. *The Leading Edge.* August. Pp. 903-905.

Hawkins, A.D. 1993 Underwater sound and fish behaviour. In T.J. Pitcher (ed) *Behaviour of Teleost Fishes*. Fish and Fisheries Series 7. Chapman and Hall: London, UK. Pp. 129-169.

Hirst, A. & Rodhouse, P.G. 2000. Impacts of geophysical seismic surveying on fishing success. *Reviews in Fish Biology and Fisheries*. 10: 113-118.

Lang, W. 2000. MMS acoustic studies in the Gulf of Mexcico, FY 2000. *The Leading Edge*, August, Pp. 907-909.

McCarthy, E. 2004. *International Regulation of Underwater Sound: Establishing rules and standards to address ocean noise pollution*. Kluwer Academic Publishers, The Netherlands.

Slotte, A., Hansen, K., Dalen, J. and Ona, E. 2004 Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* 67 (2): 143–150.

Wardle, C.S., Carter, T.J., Urquhart, C.G., Johnstone,A.D.F., Ziolkowshi, A.M., Hampson, G., MacKie, D. 2001. Effects of seismic airguns on marine fish. *Contimential Shelf Research* 21: 1005-102