

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast bioregion includes waters of Pacific origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian Throughflow and Holloway Current which flow seasonally and interact with Indian Ocean waters. The Integrated Marine and Coastal Regionalisation for Australia (IMCRA V 4.0) scheme divides this bioregion into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters, particularly along the Pilbara coastline. Fish stocks in the North Coast bioregion are entirely tropical, with most having an Indo-Pacific distribution extending eastward through Indonesia to the Indian subcontinent and Arabian Gulf regions.

Coastal waters are generally low-energy in terms of wave action, but are seasonally influenced by infrequent but intense tropical cyclones, storm surges and associated rainfall run-off. These cyclone events generate the bulk of the rainfall, although the Kimberley section of the coastline does receive limited monsoonal thunderstorm rainfall over summer.

Significant river run-off and associated coastal productivity can be associated with cyclone events, with run-off ceasing during winter. The entire north coastal region is subject to very high evaporation rates (3 metres per year), although the Pilbara coastline is more arid than the Kimberley, due to its lower cyclone frequency.

The second significant influence on coastal waters is the extreme tidal regime, related to the wide continental shelf. Spring tides range from up to 11 metres along the Kimberley section of the coast down to around 2 metres in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters can, in the few locations with rivers, be significantly influenced by rainfall run-off and tidal mixing to generate varying water quality in different sections of the North Coast Bioregion. Along the Kimberley coastline, waters are turbid and relatively productive, while the Pilbara coast with its lower run-off and lesser tidal influence has the clear waters more typical of the tropics.

The coastal geography of the various sections of the coastline also differs. The Kimberley coast is highly indented, with bays and estuaries backed by a hinterland of high relief. Broad tidal mudflats and soft sediments with fringing mangroves are typical of this area. The eastern Pilbara coast is more exposed than the Kimberley, with few islands and extensive inter-tidal sand flats. Softer sediments and mangroves occur around the river entrances. The western Pilbara coastline is characterised by a series of significant but low-relief islands including the Dampier Archipelago, Barrow Island and the Montebello Islands. Near-shore coastal waters include rocky and coral reef systems, creating significant areas of protected waters. West Pilbara shorelines also include areas of soft sediment and mangrove communities.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

One of the principal commercial fisheries in the North Coast bioregion focuses on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by the Pilbara Fish Trawl Fishery and the Pilbara and Northern Demersal trap fisheries. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of around \$12 million, the most valuable finfish sector in the state.

Another significant commercial fishery in this bioregion is based on the collection of pearl oysters (*Pinctada maxima*) for use in the aquaculture production of pearls (see below). These are collected from the fishing grounds primarily off the Eighty Mile Beach, with smaller catches being taken around the Lacepede Islands (north of Broome).

The North Coast Bioregion also has a number of small, limited-entry trawl fisheries for prawns, producing about 700 t annually, valued at around \$10 million.

A number of other finfish fisheries operated in the region including surface trolling for Spanish mackerel, demersal line fishing, near-shore beach seining and gillnetting for barramundi/threadfin salmon and shark.

Recreational fishing is experiencing significant growth in the North Coast Bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers of metropolitan and inter-state tourists travelling through the area and visiting, in particular, the Onslow, Dampier Archipelago and Broome sections of the coastline. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based, with beach fishing limited to periods of flood tides and high water.

The numerous creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Aquaculture development in the north coast bioregion is dominated by the production of pearls from the species *P. maxima*. A large number of pearl oysters for seeding is obtained from wild stocks and supplemented by hatchery-produced oysters, with major hatcheries operating at Broome and King Sound. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands.

Developing marine aquaculture initiatives in this region include growing trochus and barramundi. A focus of

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aquaculture development is provided by the Department of Fisheries' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery, an indigenous-owned multi-species hatchery and the Kimberley Training Institute aquaculture training facility.

ECOSYSTEM MANAGEMENT

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Ecosystem Management Figure 1). However, trawling is still permitted in a number of locations (see specific commercial trawl fishery reports elsewhere in this volume). This activity is carefully managed to ensure that impacts are acceptable. The trawling is subject to Ecologically Sustainable Development (ESD) requirements in accordance with Commonwealth Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the Environment Protection and Biodiversity Conservation Act 1999. The extent of these areas means that 41% of the entire shelf region of the North Coast Bioregion could be classified as a marine protected area with an IUCN category of IV (as per Dudley, 2008¹; North Coast Ecosystem Management Table 1).

In addition to these habitat related marine protected area closures, the bioregion has a number of other marine protected areas including the Montebello and Barrow Islands and the Rowley Shoals proclaimed under the *Conservation and Land Management Act 1984*, and closures to fishing under section 43 of the Fish Resources Management Act 1994 at Point Samson, Peron Peninsula and the wreck of the Kunmunya Samson II (Delambre Reef) (see North Coast Ecosystem Management Figure 2). The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries has also participated in the marine conservation reserve planning process in this region. This has resulted in the recent establishment of the Camden Sound Marine Park. The Department has recently received funding to establish baseline and ongoing monitoring and research to underpin ecosystem management of this area. There is considerable interest in developing further marine protected areas within the Kimberley region, and the State Government has announced funding of a further marine protected area at Eighty Mile Beach. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimize environmental effects in the marine environment including the Kimberley Science and Conservation Strategy with DEC.

The Commonwealth Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has also undertaken a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. The federal minister for the environment has recently announced

the final reserve network proposed for the north-west which spans the North Coast and Gascoyne bioregions.

Marine habitats within the North Coast Bioregion of Western Australia are experiencing increasing pressure through a range of activities but most notably as a result of increased resource development activity that is occurring in the area.

The Department continues to engage with the Environmental Protection Authority through the environmental impact assessment process by providing advice on individual development proposals, which if implemented, have the potential to have an adverse impact on the marine environment. These include new (and upgraded) port developments in the Pilbara region, as well as offshore and nearshore oil and gas extraction projects in the Kimberley and Pilbara region. Major developments recently assessed for which the Department has played a key role include the Gorgon Gas Development at Barrow Island, and the proposed Kimberley LNG processing site.

The increase in international shipping movement and dredging activity associated with resource development in the Northern region is considered to present a high risk to the marine environment because of the potential for the introduction of non-indigenous marine organisms (including animals, plants, pathogens and diseases) into WA's coastal environment.

The recent Montara oil spill that occurred in this region highlights the potential risks to this area from oil and gas production. The outcome of this incident on fishery resources and assets may not be known for some time.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

Under the Integrated Marine and Coastal Regionalisation for Australia scheme, the bioregion has been divided into the bioregion has been divided into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley Gulf (IMCRA, V 4.0, 2006). While this sub-regional scale of management has been adopted by the Department through the implementation of an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details), in the North Coast these meso-scales have been combined into two marine based ecosystems Pilbara (Pilbara and NW Shelf, eighty Mile Beach), Kimberley (Canning, Kimberley) and a Nearshore/estuarine ecosystem.

In terms of ecological assets, the Department has recognised the following ecological values for the IMCRA regions within the North Coast Bioregion:

- Ecosystem structure and biodiversity;
- Captured fish species
- Protected species (direct impact – capture or interaction);
- Benthic habitats; and
- External impacts.

¹ Dudley, N. (editor) (2008) Guidelines for applying protected area management categories. IUCN, Gland, Switzerland.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m; Pelagic). The full set of ecological assets identified for assessment and in some cases ongoing monitoring are presented in North Coast Ecosystem Management Figure 3.

Risk Assessment of Bioregional Level Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined in North Coast Ecosystem Management Figure 3 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (North Coast Ecosystem Management Table 2) provides an overview and cumulative assessment of the current risks to the ecological assets of the North Coast Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department's Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which, if implemented, have the potential to impact on the aquatic environment. The Department is working closely with the Commonwealth Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the biosecurity risks associated with increased shipping in the Pilbara and Kimberley regions. Within WA, this will be achieved through the Fish Resources

Management Act 1994 and the Biosecurity and Agriculture Management Act 2007. Associated regulations and subsidiary legislation are currently being developed.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch has recently completed a pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The project focussed on an extensive survey of the research literature relating to the coastal and marine environments in the Pilbara and Kimberley. The review of the literature has highlighted those areas of research that are lacking from the region. These knowledge gaps ranged in scope from fine scale life history trait studies of particular species; to large-scale oceanographic studies to identify major ocean current dynamics, and oceanic primary production from plankton.

The vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. The project concentrated on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments, and set bench marks for which to assess environmental change, within the Pilbara and Kimberley.

The Department has been provided with funds for an ongoing monitoring program in the Camden Sound Marine Park. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy.

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2011 – 2012. All projects aim to detect the presence of introduced marine pests (IMPs) using a suite of tools including ongoing background monitoring and large-scale port monitoring. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. Two large-scale, nationally approved, surveys have been implemented for the Ports of Dampier and Port Hedland that have informed the Department of the status of IMPs in those Ports. Background monitoring programs are also continuing within Dampier and Port Hedland Ports waters with assistance from the Dampier Port Authority and Port Hedland Port Authority. Further detail may be found in the Introduced Pests Status Report at the end of this chapter. This work complements introduced aquatic organism incursion and fish kill incident response programs already in place in this bioregion.

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

The areas and proportions of the North Coast Bioregion making up State Waters and continental shelf waters where habitats are protected from the physical disturbance of trawl fishing. The areas, 200 m depth which are formally closed to trawling would be equivalent to meet category IV of the IUCN criteria for classification as marine protected areas. The area effectively protected covers those areas of the shelf < 200 m depth where state managed trawling doesn't occur.

Total Area of Shelf	Area of shelf equivalent to IUCN marine protected area category IV (%)	Maximum area of actual trawling activity	Total area of habitat effectively protected (%)
98600 sq nm	40700 sq nm (41%)	10500 sq nm	88100 sq nm (89%)

**NORTH COAST ECOSYSTEM MANAGEMENT TABLE 2
RISK LEVELS FOR EACH NORTH COAST ASSET.**

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level (bioregional) components. Negligible, Low and Moderate values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by '(non-fishing)', this indicates that all, or the majority of the risk value, was not generated by fishing activities but by some external factor including those activities which are managed by other government agencies (State or Federal).

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Nearshore/ Estuarine	Marine	LOW (non fishing)	With the onshore developments that are proposed in this area, while some specific areas may be locally impacted, these still only pose a low risk to the overall nearshore/estuarine ecosystem of this bioregion.
Pilbara	Marine	LOW	Given the large areas closed to both trawling and to all commercial fishing, there is only a low risk that the level of fishing in this region is changing the community structure at a regional level to an unacceptable level. A recent study by Hall and Wise (2011) ¹ found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A proposal to further examine recovery of this area from the impacts of Taiwanese fishing that occurred in the 1980s is currently under development.
Kimberley	Marine	LOW (non fishing)	While there are a number of specific oil and gas related offshore developments that are proposed in this region, at the overall ecosystem level there is only a negligible risk that the ecosystem will be altered measurably. A recent study by Hall and Wise (2011) ¹ found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact. A significant level of planning has been undertaken to study this region as part of the Kimberley Science Plan.

¹ Hall, N.G. and Wise, B.S. 2011. Development of an ecosystem approach to the monitoring and management of Western Australian fisheries. FRDC Report – Project 2005/063. Fisheries Research Report No. 215. Department of Fisheries, Western Australia. 112pp.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Nearshore/ Estuarine	MODERATE	The barramundi and threadfin salmon stocks are considered to be at acceptable levels.
	Shelf demersal	MODERATE	The current status of demersal finfish stocks captured by the Pilbara trawl fishery requires a review. A research survey is underway to assist determine if the recent low catch rates are due to changes to trawl gear or to localized depletion.
	Pelagic	MODERATE	The Spanish mackerel stock in this region is at acceptable levels and there are few other pelagic fish that are impacted.
Crustaceans	Nearshore/ Estuarine	LOW	There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas.
	Shelf	MODERATE	There are a number of separate prawn stocks and fisheries within this bioregion that each have limited entry, seasonal and area closures. Annual recruitment to these stocks is variable, which combined with the higher costs of operating in this region, has resulted in fishing effort being much lower in recent years.
Molluscs	Pearls	LOW	The pearl oyster fishery only targets a very small section of the stock both spatially and the available size range. Recent catches have been well below the quota levels due to low market demand but are beginning to increase again,

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Non fish	NEGLIGIBLE	Crocodiles are occasionally captured in nets but are released alive. Sea snakes and occasionally turtles are encountered in the trawl catches and both of these species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. The number of turtles captured now is very low and most of these are returned alive. Turtle captures and their status at release are monitored and reported.
	Mammals	MODERATE	Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels with further refinements in net design currently being trialled.
Protected 'Fish' Species	Fish	LOW	The sawfish (Pristidae), spartooth shark (Glyphis glyphis) or the northern river shark (Glyphis garricki), are captured in small numbers by net fishing in small regions of the Kimberley region.

Benthic habitat

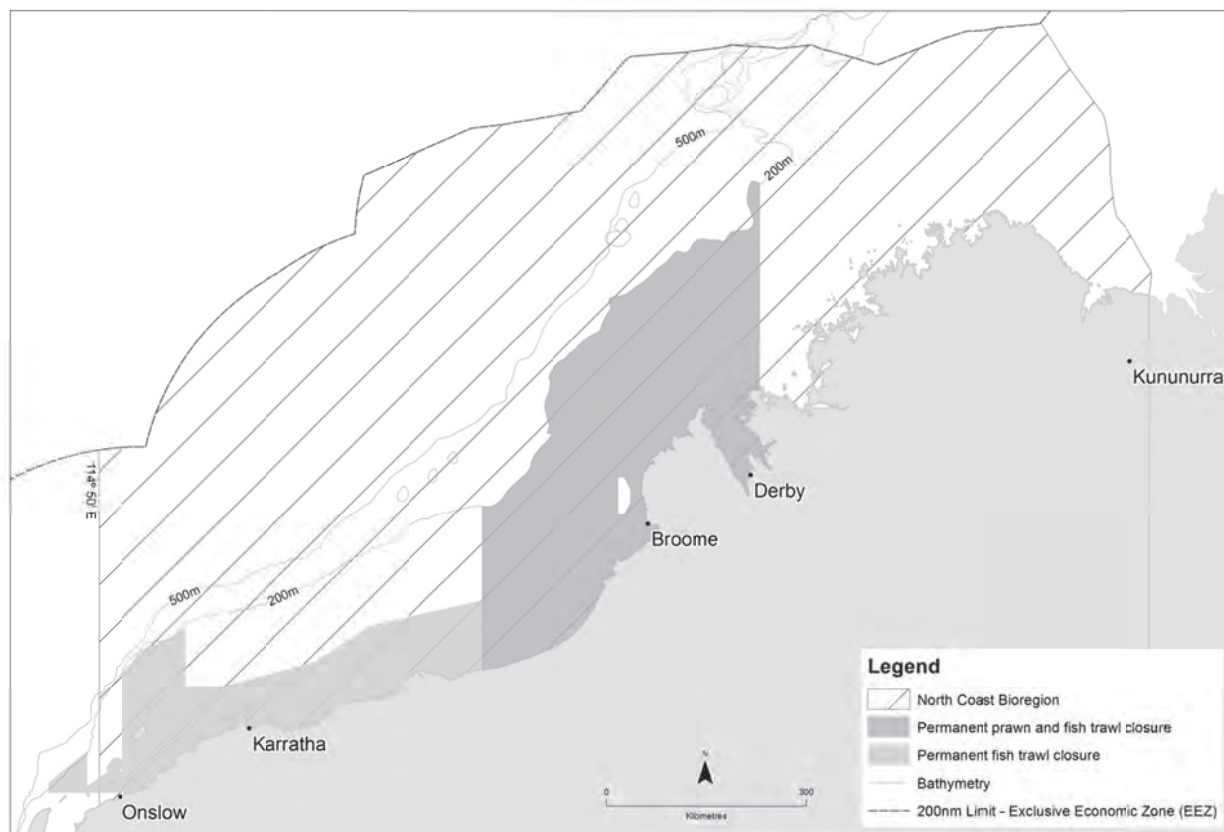
Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries/ Nearshore		LOW (non Fishing)	The main risks to nearshore habitats come from oil and gas developments.

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Benthic Habitat	Category	Risk	Status and Current Activities
Pilbara		MODERATE	This bioregion has fish trawling but this activity is tightly constrained. The large area permanently closed to trawling and the relatively small area where trawling actually occurs indicates that the habitat in this region is appropriately managed.
Kimberley		LOW (Non Fishing)	Except for some small areas where prawn trawlers operate for short periods each year, most of this region is closed to trawling. These activities may be examined as part of the proposed Camden Sound marine park. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure and operations.

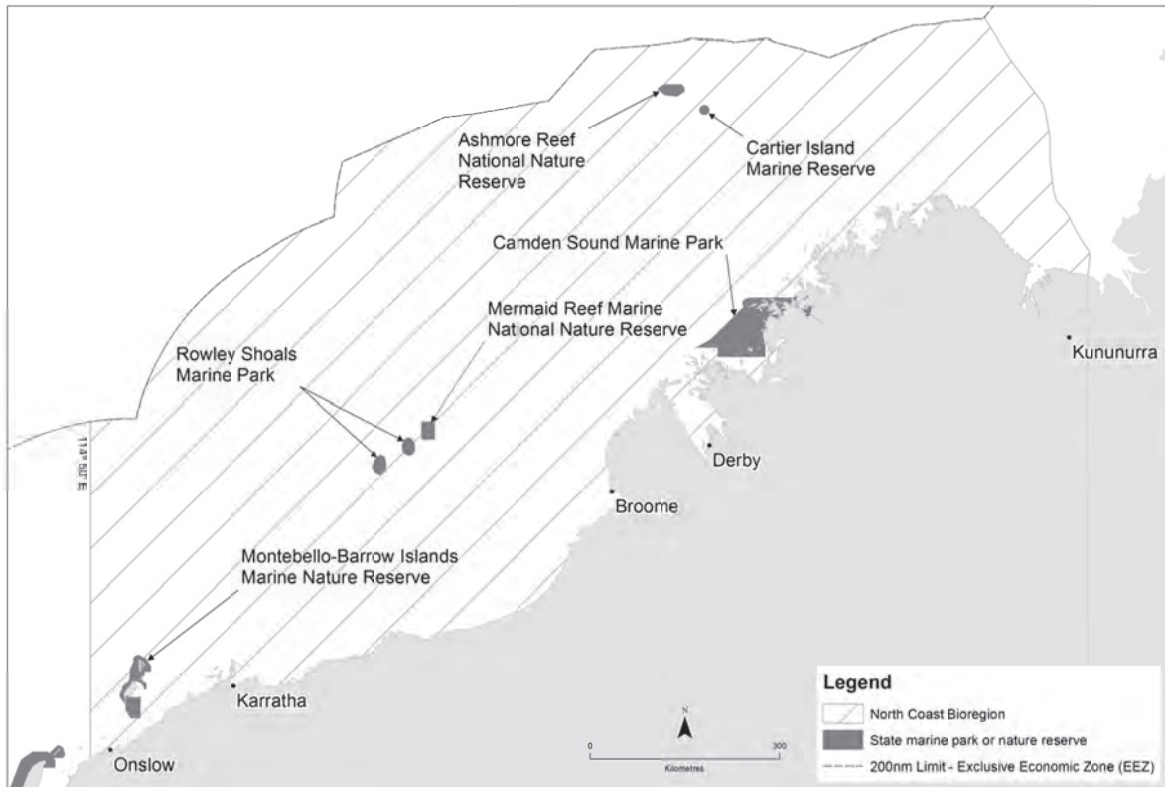
External Drivers (NON FISHING)

External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The extremely high level of international shipping that operates in this region poses a high risk that an introduced pest may be introduced. The department has implemented a targeted IMP monitoring and inspection program. The extent and findings of monitoring activities in this bioregion are detailed in the Introduced Pests Status Report at the end of this chapter.
Climate	LOW	This area is predicted to have relatively minor impacts from climate change, especially in the coming decade compared to more southerly locations. Projects to examine potential impacts are planned.



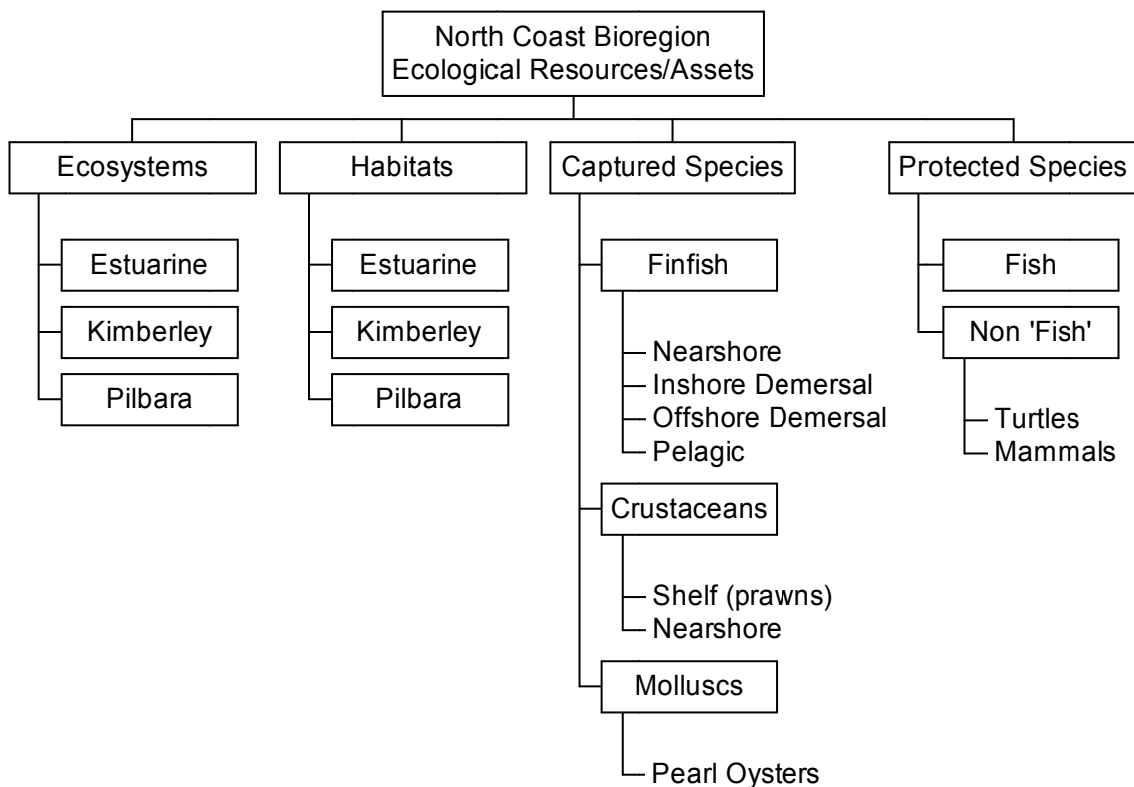
NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas permanently closed to trawling by WA state managed fisheries in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current areas of protected fish habitat in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 3

Component tree showing the ecological assets identified and separately assessed for the North Coast Bioregion.

INTRODUCED PESTS STATUS REPORT

Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. To this end the Marine Biosecurity Research group are actively involved in developing and implementing targeted marine pest monitoring and research programs in two ports in the North Coast bioregion. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research group previously completed large-scale marine pest monitoring programs in Dampier and Port Hedland ports in early 2011. These biennial programs adhered to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. In recognition of the risks IMPs pose to WA ports DoF have

developed complementary monitoring to occur every alternate year to National monitoring. These surveys are scheduled for mid 2012. This supplementary monitoring is a smaller more focussed version of the national approach designed to target select high risk sites in each port between the larger surveillance trips.

In addition the Marine Biosecurity Research group, with financial and *in-kind* assistance from Dampier and Port Hedland Port Authorities and stakeholders, are using *in-situ* sampling arrays to aid in the early detection of marine pests in both ports.

Through this combined surveillance the species that have been detected in this region are reported in Introduced Pests Table 1.

INTRODUCED PESTS TABLE 1

Introduced marine species detected in this bioregion.

Common name	Scientific name	Type of organism	IMS/IMP listing
	<i>Theora fragilis</i>	Mollusc	Introduced species
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species – likely pest

FISHERIES

North Coast Prawn Managed Fisheries Status Report

E. Sporer, M. Kangas, M Shanks and L Pickles.

Main Features			
Status		Current Landings	
Stock level	Adequate	Onslow:	16 t
		Nickol Bay:	178 t
Fishing level	Acceptable	Broome:	5 t
		Kimberley:	155 t

Fishery Description

There are four prawn fisheries that operate in the north coast bioregion, all using otter trawls. These fisheries extend northward from the north eastern boundary of the Exmouth Gulf Prawn Fishery to 126° 58' east longitude (Cape Londonderry – boundary of the Northern Prawn Fishery).

The Onslow (OPMF) and Nickol Bay (NBPMF) Prawn Managed Fisheries operate along the western part of the North-West Shelf. The OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) whereas the NBPMF primarily targets banana prawns (*Penaeus merguensis*).

The Broome Prawn Managed Fishery (BPMF) operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).

The Kimberley Prawn Managed Fishery (KPMF) operates off the north of the state between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*).

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

Kimberley Prawn Fishery Management Plan 1993

Kimberley Prawn Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. For statutory management plan processes, the Director General consults with licensees

Boundaries

The boundaries of the OPMF are ‘*all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114°39.9' on the landward side of the 200 m depth isobath*’. The fishery is divided into three parts with associated size management fish grounds (SMFGs) and nursery areas as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG (Northern Prawn Figure 1).

The boundaries of the NBPMF are ‘*all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath*’. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey SMFGs. (Northern Prawn Figure 2).

The boundaries of the BPMF are ‘*all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath*’. The actual trawl area is contained within a delineated small area north west of Broome as shown in Northern Prawn Figure 3.

The boundaries of the KPMF are ‘*all Western Australian waters of the Indian Ocean lying east of 123°45' east longitude and west of 126°58' east longitude*’. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF). The KPF has four inshore closures and two SMFGs in place (Northern Prawn Figure 4).

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Management arrangements

Management of all the north coast prawn fisheries is based on input controls including limited entry, seasonal and area closures, and gear controls including bycatch reduction devices. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats. Fish Escape Devices are mandatory in all trawl nets.

OPMF: The management arrangements in the OPMF involve using a standardised net headrope allocation whereby each Managed Fishery Licence (MFL) has an equal allocation of net headrope length in each Area. However, there are different net sizes permitted between Areas. Area 1 boats are authorised to use two trawl nets each having a maximum headrope length of 10.98 metres (6 fathoms). These boats operate under an exemption to fish with larger size nets. In Areas 2 and 3 a maximum headrope length of 29.27 metres (16 fathoms) is permitted in either twin or quad gear configuration. Trawl net headrope amalgamation between MFLs has been permitted in the OPMF consistent with other trawl fisheries. The fleet is composed of trawlers up to 23 metres in length. Additionally, the fishery is exempt from the 375 boat unit rule.

Different licence classes apply to the OPMF, allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating number of licensed boats:

Class A	Areas 1, 2 and 3 (four MFLs)
Class B	Areas 2 and 3 (three MFLs)
Class C	Area 2 (11MFLs, that are also Exmouth Gulf Prawn MFLs)
Class D	Area 3 (12 MFLs that are also Nickol Bay prawn MFLs)

The approved season arrangements during 2011 for the various areas in the OPMF were as follows:

Areas 1, 2, 3	24 April – 12 October
Fortescue SMFG	25 May – 12 August
Ashburton SMFG	25 May – 15 July
Weld Island SFMG	25 May– 12 August
Mangrove Island SFMG	25 May –12th October

Moon closures were implemented this season on a voluntary basis. The moon closure period was three days around each full moon during the fishing season across all areas.

NBPMF: The management arrangements in the NBPMF provide for authorised boats to tow any combination of standard otter trawl nets provided that the total headrope length does not exceed 29.27 metres (16 fathoms). Each licence has an equal allocation of headrope length and the maximum total headrope length for the entire fleet is 409.78 metres (224 fathoms). The 2011 season opened on 17 March and closed on 1 November with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Nickol Bay	22 May – 1 September (Day fishing only 22 May – 5 June)
Extended Nickol Bay SMFG	22May –1 November
Depuch SMFG	22May – 1September (Day fishing only 20 May – 5 June)

De Grey SMFG

22May – 1 November

BPMF: The BPMF management arrangements provide for the use of standard otter trawl nets not exceeding 73.16 metres (40 fathoms) in either twin or quad gear configuration. Each licence has an equal allocation and the maximum total headrope length for the entire fleet is 365.8 metres (200 fathoms).

The Fishery opened on 19 May and officially closed on 5 September, providing for 110 fishing nights. Only one boat entered the BPMF fishery during the season to assess if commercial fishing was viable and to inform the other operators of the abundance of king prawns available. The boat fished a limited time then left the fishery. The king prawn catch rates were considered relatively low and given the current economic conditions and high cost of fishing, other operators did not send boats to the Broome fishery to undertake commercial fishing in 2011.

KPMF: The KPMF Management Plan permits the use of two otter trawl nets where the total headrope length does not exceed 58.5metres (32 fathoms).

There are 124 boats licenced to fish in the KPMF and at 30 June 2011, 31 of these also held an NPF licence.

Seasonal dates for the KPMF are generally aligned with those of the adjacent NPF. This strategy aims to prevent large shifts of fishing effort into the KPMF. A total allowable effort cap system is in place that restricts the number of fishing days to a total of 1500 days, with 600 and 900 boat days allocated to the first and second part of the season respectively.

The 2011 season opened on 1 April with a mid-season closure commencing on 27 May. The fishery re-opened on 1 August, with a final season closure on 30 November. A comprehensive Ecologically Sustainable Development (ESD) assessment of these fisheries has been undertaken to identify any potential sustainability risks requiring direct management action. The only issue identified through this process related to the breeding stock levels of target species (e.g. banana, tiger and king prawns). Boxed text in this status report provides the annual assessment of performance for this issue. The SEWPac (formerly DEWHA) completed the reassessment of the NBPMF, OPMF, KPFM and BPMF trawl fisheries and export approval has been granted until 20 August 2015 for all fisheries under the one approval.

Research summary

Research programs are focused to underpin the sustainable management of these small fisheries involving stock monitoring and assessment utilising information from daily logbooks and processor unloads. For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana prawns. In the OPMF a field-based consultative process is normally undertaken whereby industry and the Departments' Research Division decide on the extent of an area to be fished within the areas that are officially opened, and to limit the fishing of small size prawns. For 2011 this did not occur because only one boat fished and the late opening date and market prices mitigated the risk of taking small size prawns. For the BPMF a depletion analysis is undertaken when sufficient fishing activity occurs which assists in the assessment of the king prawn stocks within the permitted fishing area. Due to insufficient effort in 2011 the depletion analysis could not be undertaken.

Retained Species

Commercial production (season 2011):

Onslow:	16 tonnes
Nickol Bay:	178 tonnes
Broome:	5 tonnes
Kimberley:	155 tonnes

Landings

OPMF: The total landings of major penaeids for the 2011 season were 16 t, comprising 1 t of king prawns, 14 t of tiger prawns, <1 t of endeavour prawns and <1 t of banana prawns. Tiger prawn landings in 2011 were low but within the target catch range and at the expected level given the low effort in this fishery. King and endeavour prawn landings were extremely low and below the target catch range (Northern Prawn Figure 5). Recorded landings of by-product species in the OPMF included <1 t of bugs (*Thenus australiensis* and *parindicus*) and <1 t of blue swimmer crabs (*Portunus amartus*). No other byproduct species landings were recorded this year.

NBPMF: The total landings of major penaeids for the 2011 season were 178 t comprised 174 t of banana prawns, 4 t of tiger prawns and less than 1 t of king and endeavour prawns combined (Northern Prawn Figure 6). The recorded landings of banana prawns in 2011 were below the projected catch range (205 to 310 t) but within the target catch range. Recorded byproduct landings for 2011 were extremely low with < 1 t of blue swimmer crabs (*Portunus amartus*), bugs (*Thenus australiensis* and *parindicus*) and squid combined the only species recorded.

BPMF: Recorded landings for target species were very low at 5 t for king prawns and <1 t of coral prawns. No byproduct species was recorded in 2011 (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 155 t, comprising 145 t of banana prawns, 7 t of tiger prawns and 3 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were below their target catch range (200-450 t) and the projected catch range (310 to 460 t) calculated using the relationship between summer rainfall and catches. Both tiger and endeavour prawns were slightly below their target catch ranges. Fishing occurred in both fishing periods for 2011 but effort was still low, possibly reducing total catches for these species. Negligible quantities of byproduct were reported.

Recreational component: Nil

Fishing effort/access level

OPMF: One boat fished in 2011 with a total of 60 boat days, a decrease compared to the 97 days recorded in 2010. This effort is extremely low compared to the days fished between 2000 and 2005 inclusive (mean of 726 days) and the second lowest effort ever recorded in this fishery. However, the actual fishing effort since 2007 is not directly comparable due to the amalgamation of headrope for the boat that fished. In Area 1, this boat was exempted to fish with larger nets using a total net headrope length of 18 fathoms (four 4.5-fathom nets) instead of the permitted 16 fathoms total net headrope length. This required the amalgamation of net

allocations from two boats, licensed to fish all areas, onto one boat, resulting in a reduction of net headrope length from 32 fathoms to 18 fathoms for fuel efficiency.

NBPMF: Five boats fished during the 2011 season for an aggregated total of 253 boat days. This is the highest effort recorded since 2006 reflecting the increased banana prawn abundance this season.

BPMF: Only fifteen nights of fishing effort was expended by one boat in this fishery in 2011.

KPMF: Ten boats operated in the fishery during 2011. The total number of days fished was 200 days well under the total days (1500) allocated to fish and the lowest since 1990 when effort estimates were first made.

Stock Assessment

Assessment complete: Yes

Assessment level and method: Level 1 - Catch
(Rainfall-catch relationship for NBPMF and KPMF for banana prawns,

Depletion analysis for BPMF - when appropriate)

Breeding stock levels: Adequate

Projected catch next season (2012):

NBPMF: 165 t banana prawns

KPMF: 260 t banana prawns

For the northern prawn fishery stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from depleting breeding biomass to unacceptable levels. Historical catch levels from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for calculating target catch ranges. These catch ranges are used as an indicator of breeding stock adequacy.

The low annual landings of prawns in general are still a feature in these northern fisheries and these low catches are in part due to low effort caused by the current economic conditions including, high fuel and equipment prices and low market prices and variable market conditions. Catches of banana prawns are highly variable and related to the amount of rainfall recorded in the region with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment.

OPMF: The 2011 season tiger prawn landings (16 t) were lower compared to 2010. The effort in this fishery since 2006 inclusive has been very low with a maximum three boats fishing in any one year but in most of these years only one boat fished. The low overall landing for 2011 is mainly due to low effort. Most of the season's catch was taken from Area 1 where tiger prawns are mainly caught. Generally boats search in other areas of the fishery (Areas 2 and 3), however, because of the high catch rates of tiger prawns in Area 1 there was little incentive to search for prawns and byproduct in these other areas in the current economic environment. Although the landings were below the average landings (the mean reference landings range for 1987 to 1995 is 61 t) these tiger prawn catches were taken at efficient catch rates. The total catch of tiger prawns, taking into account the level of effort, indicates adequate breeding stock.

NORTH COAST BIOREGION

King prawn catch (1 t) remains low compared to the mean catch of 33 t for 1985 to 2009. Since the early 2000's, there has been a decline in king prawn abundance in this fishery and since 2006, the decline in effort may also be contributing to the low catches. There were extremely low landings of banana prawns this season. Generally there is a positive correlation between early seasonal rainfall and the catch of banana prawns. However, this generally requires a few consecutive years of rainfall to provide a stock build-up.

NBPMF: The landing of banana prawns (174 t) in 2011 is within the target catch range but below the predicted catch range. The tiger prawn landings were at the lower end of the target range, whereas, the king and endeavour prawns were below the target range.

The catch projection for banana prawns in Nickol Bay is based on the summer rainfall level between December and March (Northern Prawn Figure 9). The total rainfall between December 2011 and March 2012 (at Roebourne) was 258 mm and the predicted catch for 2012 is around 165 t with a range of 130–200 t of banana prawns.

BPMF: Very low fishing effort reflecting the low king prawn landings of 5 t, taken in this fishery during 2011 so no stock assessment was completed. The king prawn catch rates at 33 kg/hr were in line with historical catch rates in this fishery, however, because of high fishing costs it was not economically viable to continue fishing.

KPMF: Banana prawns were below the target catch range (200 to 450 t) and both tiger and endeavour prawns were below their target ranges. Effort levels were at historic low levels and the low tiger and endeavour prawn landings are likely to be effort related.

The relationship between the early season rainfall and catches of banana prawns (the dominant species taken in this area) is based on the rainfall in Kalumburu and Derby in January and February (451 mm). The predicted catch of banana prawns in 2012 is 260 t, with a range of 210 to 315 t. The 2011 catch was well below the expected catch given the high level of rainfall. This may be due to the reduced levels of fishing effort, which was the lowest recorded.

The main performance measures for the OPMF, NBPMF and KPMF relate to maintenance of breeding stocks for each of the major target prawn species. In 2011 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) for tiger prawns were met whereas king, banana and endeavour prawns were below the target catch range due to low effort.

Environmental conditions i.e. summer rainfall was relatively high, however and it was not expected to benefit banana prawn production this year because the breeding stock was low the previous year, therefore, available prawn abundance was expected to be low.

The breeding stock indicator for banana and tiger prawns in the NBPMF was met and the landings were within the target catch range. Banana prawns were below the projected range. There were low recorded king prawn landings, therefore, they were below the target ranges. This is likely to be a result of limited targeting of this species this year.

An assessment of breeding stock could not be made for the BPMF due to very low fishing effort.

The breeding stock indicators in KPMF (catches within specified ranges) for banana, tiger and endeavour prawns were below the target range and the projected range for banana prawns. This may be due to record low levels of effort.

Non-Retained Species

Bycatch species impact: **Low**

Bycatch from the northern prawn fisheries is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species' populations. The introduction of fish escapement devices (FEDs) within all the nets towed by each vessel has reduced this risk even further. The NBPMF and KPMF fishery operates predominantly by specifically targeting schools of banana prawns. This targeting results in relatively low effort and minimal bycatch compared with other trawl fisheries. The impact on bycatch in the BPMF was negligible due to very low effort. All trawl nets have grids to exclude large fish and protected species.

Protected species interaction:

OPMF: **Low**

NBPMF, BPMF, KPMF: **Negligible**

The northern prawn fisheries have previously caught the occasional turtle and sea snakes and the overall low effort level and targeted coverage suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') and FEDs are now fully implemented minimising the capture of large animals including turtles. No turtles or sea snakes were reported as caught in the OPMF in 2011. For the NBPMF six sea snakes were reported as caught but released alive and no turtle captures. For the KPMF there were no reported turtle captures but thirty sea snakes were reported of which 14 were released alive. One sawfish was reported as caught and released alive. For the BPMF two turtles were captured but returned to the sea alive whilst eighteen sea snakes were reported as dead.

Ecosystem Effects

Food chain effects: **Low**

For all the northern prawn fisheries and in particular the OPMF and BPMF the limited spatial coverage of the fisheries and low levels of effort and catch, it is unlikely to have any significant ecological consequences. In addition for the NBPMF and the KPMF, the highly variable nature of banana prawn recruitment, positively related to cyclonic rainfall, any food chain impacts from fishing are likely to be minimal.

Habitat effects:

BPMF: Negligible
OPMF, NBPMF, KPMF: Low

In 2011 the area fished in all four fisheries was less than 1-3% of the overall fishery (Northern Prawn Figures 1-4). The fisheries are generally restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

Social Effects

Estimated employment in these fisheries for 2011 was 50 to 70 including skippers and other crew with additional people involved in local processing.

Economic Effects**Estimated annual value (to fishers) for 2011:**

OPMF/NBPF/BPMF:
 Level 2 - \$1 - 5 million (\$1.7 million)
KPMF: Level 2 - \$1 - 5 million (\$1.3 million)

Fishery Governance

OPMF Target catch range: 60 – 180 tonnes
Current fishing level: Acceptable

Under normal effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

King prawns	10 – 55 t
Tiger prawns	10 – 120 t
Endeavour prawns	5 – 20 t
Banana prawns	2 – 90 t

NBPMF Target catch range: 90 – 300 tonnes
Current fishing level: Acceptable

Banana prawns	40 – 220 t
King prawns	20 – 70 t
Tiger prawns	2 – 40 t

BPMF Target catch range: 55 – 260 tonnes

Current fishing level: Acceptable

Under current effort levels and previous environmental conditions, the target ranges of prawn catches are as follows:

King prawns	35 – 170 t
Coral prawns	20 – 90 t

For king prawns the target range is based on the catches of the 1990s, while for coral prawns it is based on the seven-year range (1996 – 2002) since catches were first recorded.

KPMF Target catch range: 240 – 500 tonnes

Current fishing level: Acceptable

Under current effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	200 – 450 t
Tiger prawns	15 – 60 t
Endeavour prawns	7 – 80 t

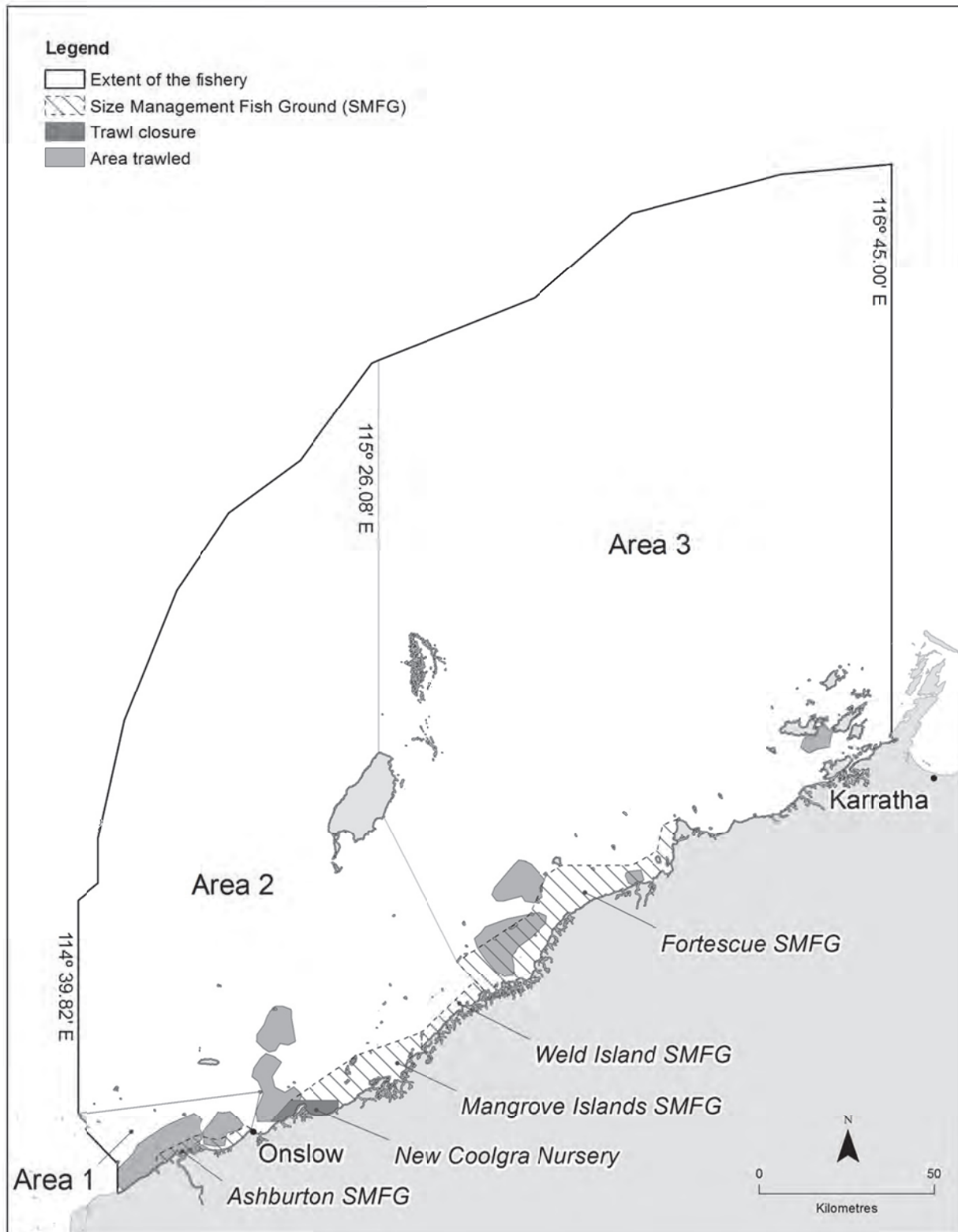
The overall target range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species. Effort is now a considered a factor when reviewing target catch ranges in these northern fisheries.

New management initiatives (2012): None

External Factors

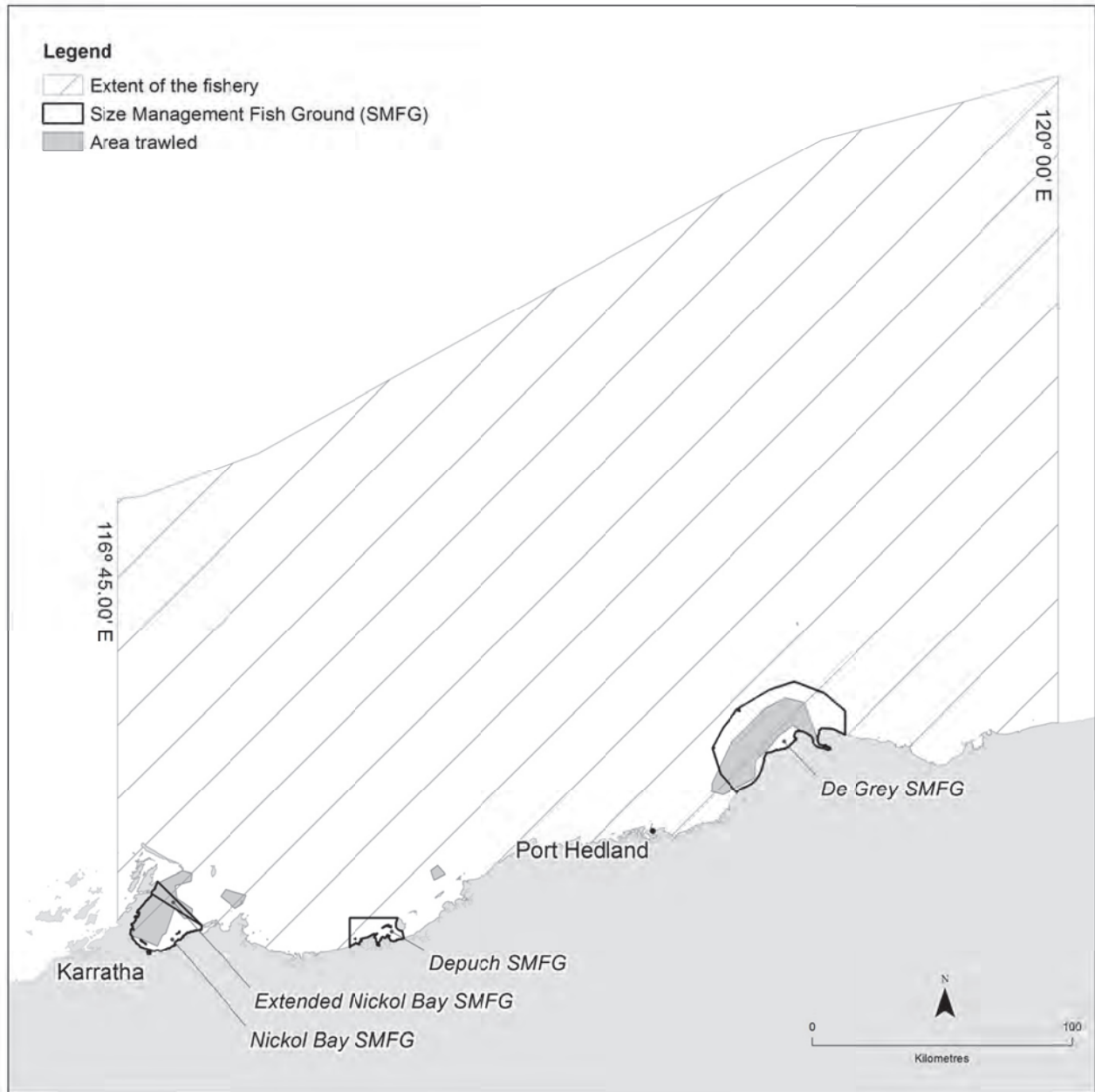
Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River. Due to high costs of fishing and low prawn prices, some boats in these fisheries are choosing not to fish in years of relatively low banana prawn catches. There is also competition for boat crew with the oil and gas resource sector.

In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in significant abundances in the permitted fishing area. The success of this fishery also depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period.



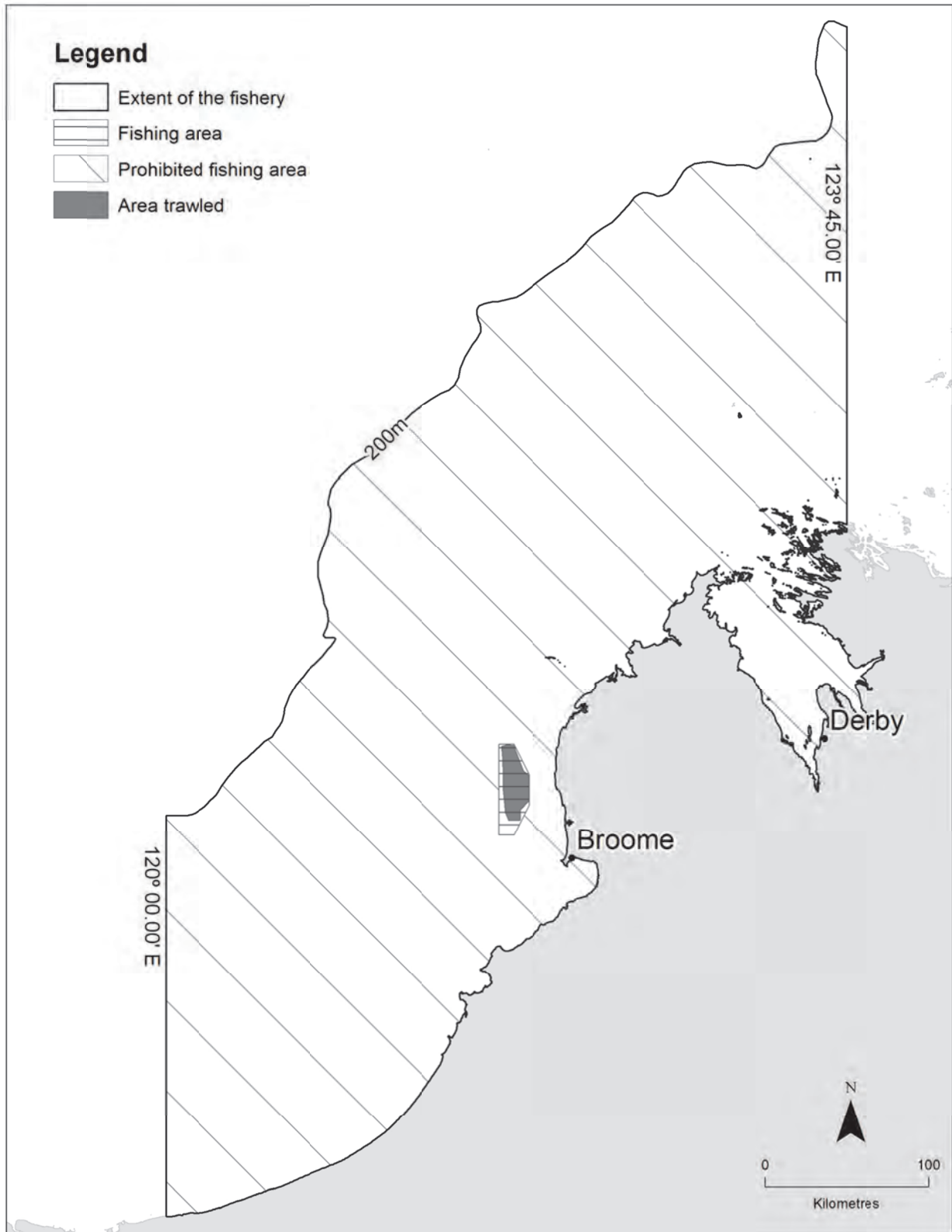
NORTHERN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds and area trawled in 2011.



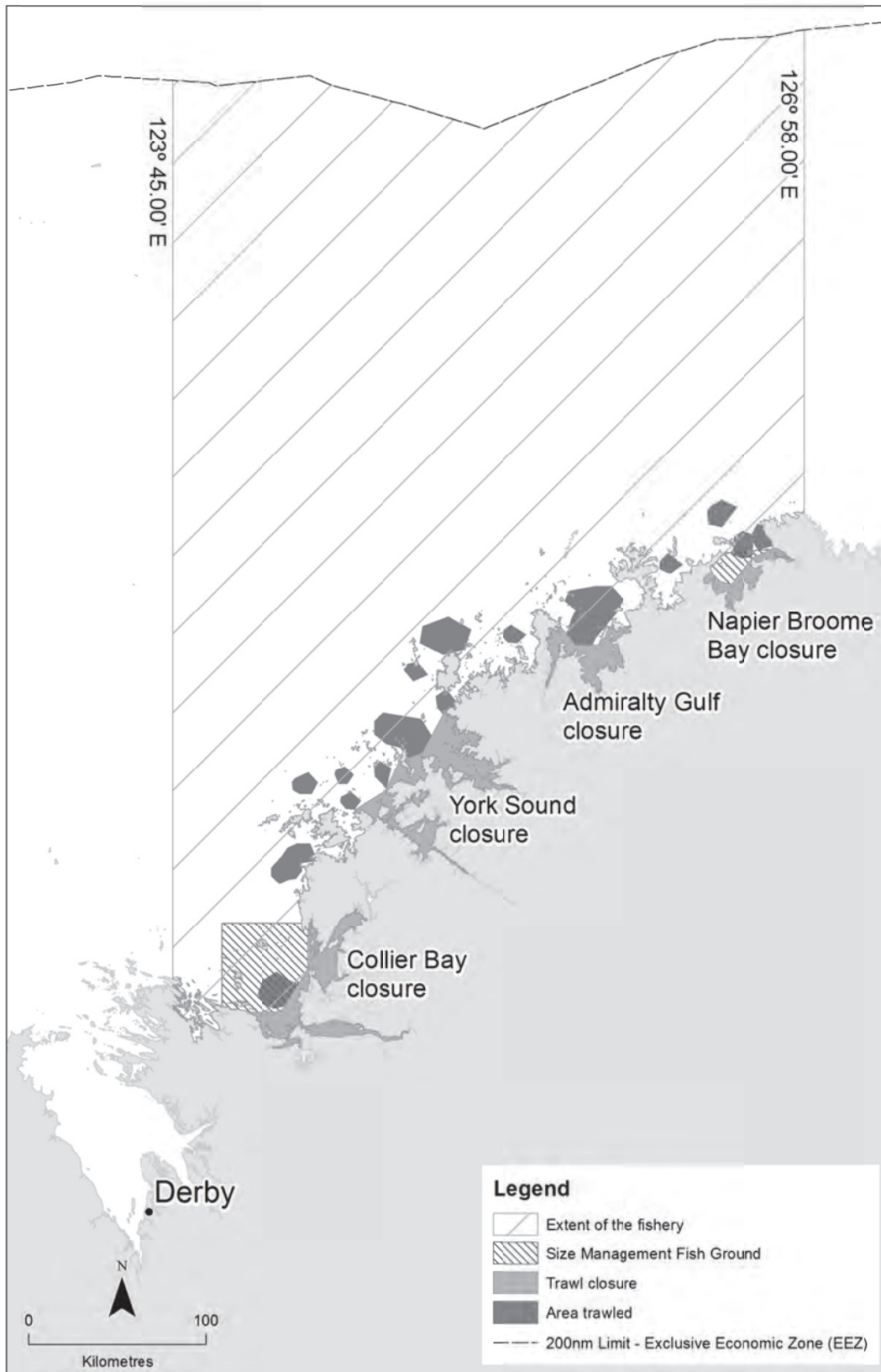
NORTHERN PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2011.



NORTHERN PRAWN FIGURE 3

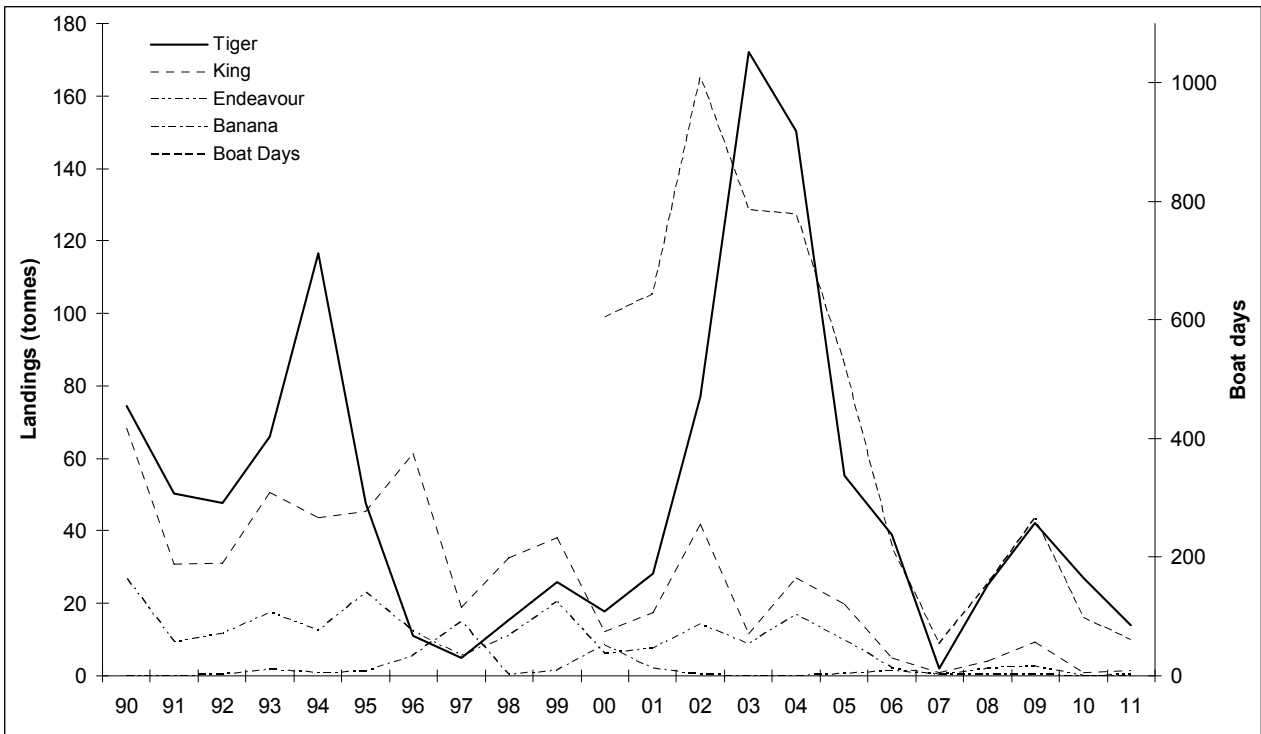
Boundaries of the Broome Prawn Managed Fishery indicating area trawled in 2011.



NORTHERN PRAWN FIGURE 4

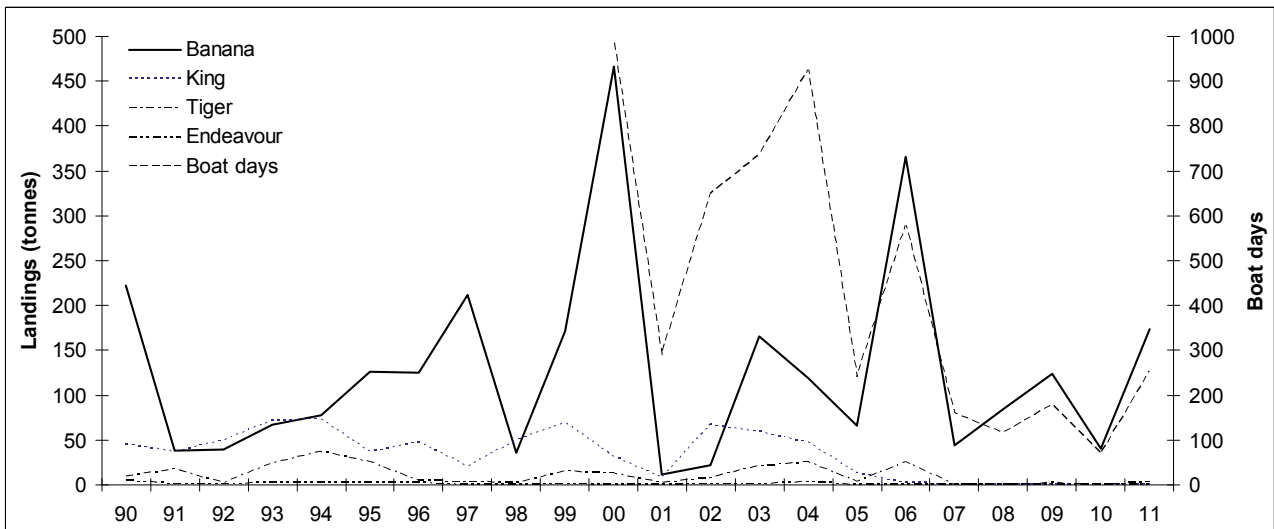
Areas fished in the Kimberley Prawn Managed Fishery in 2011, Size Management Fish Grounds and the inshore trawl closures.

NORTH COAST BIOREGION



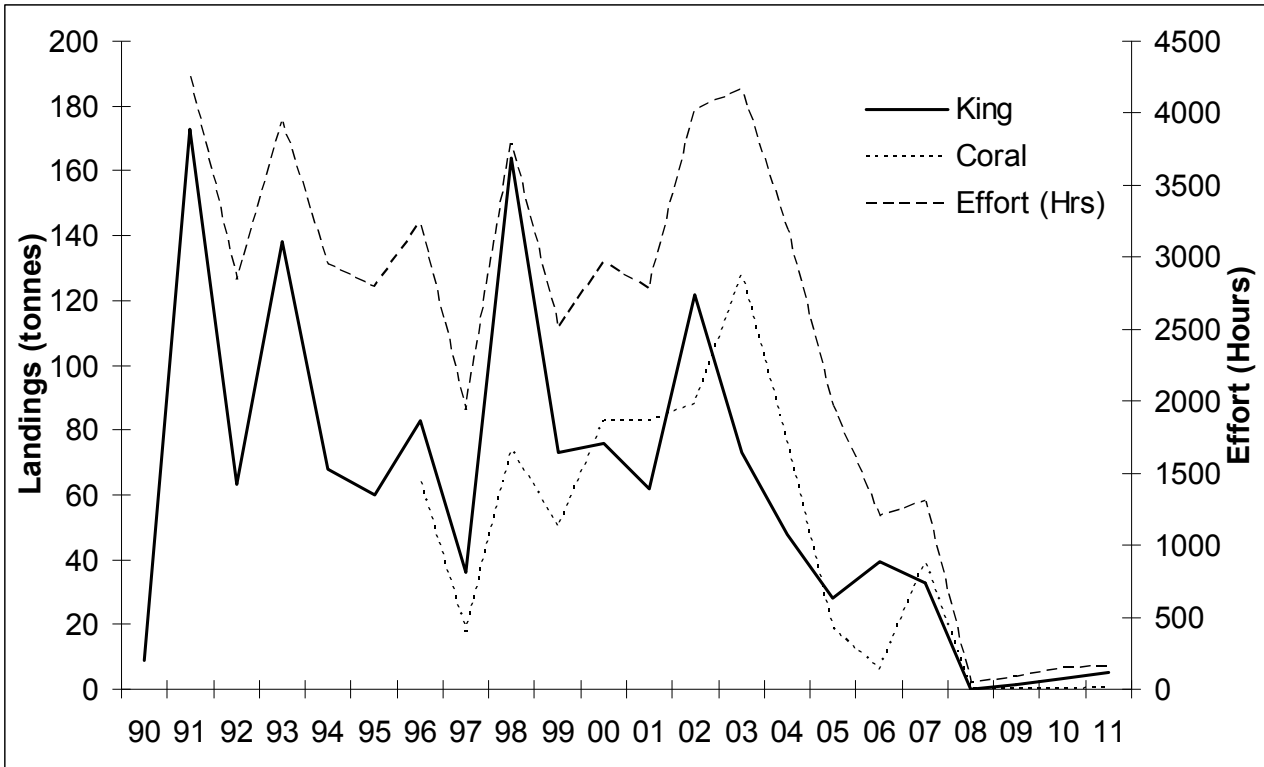
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2011.



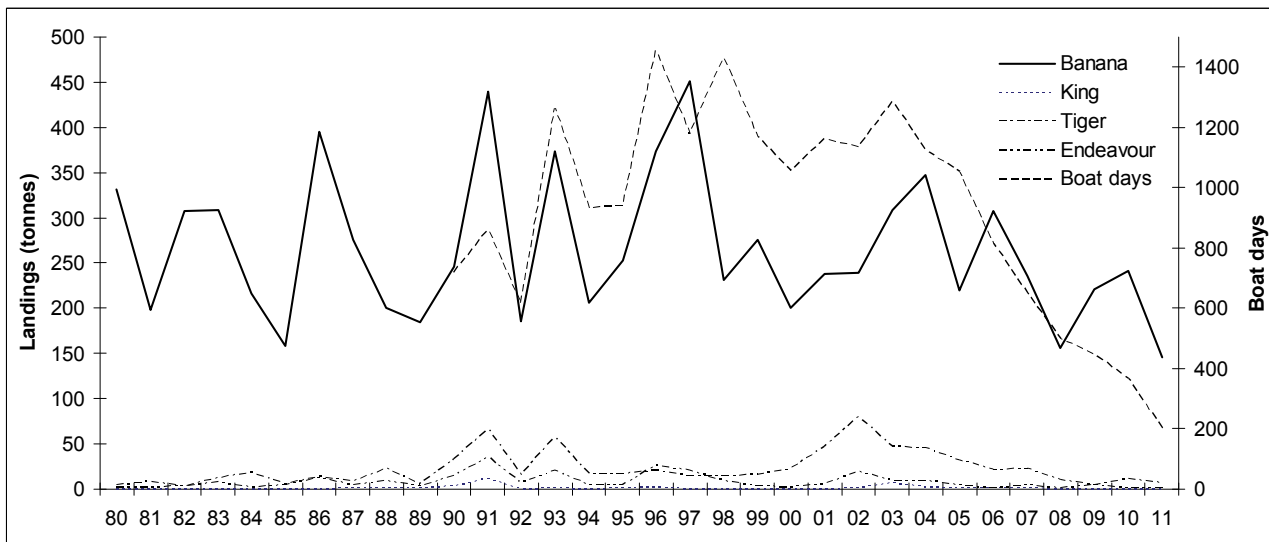
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2011.



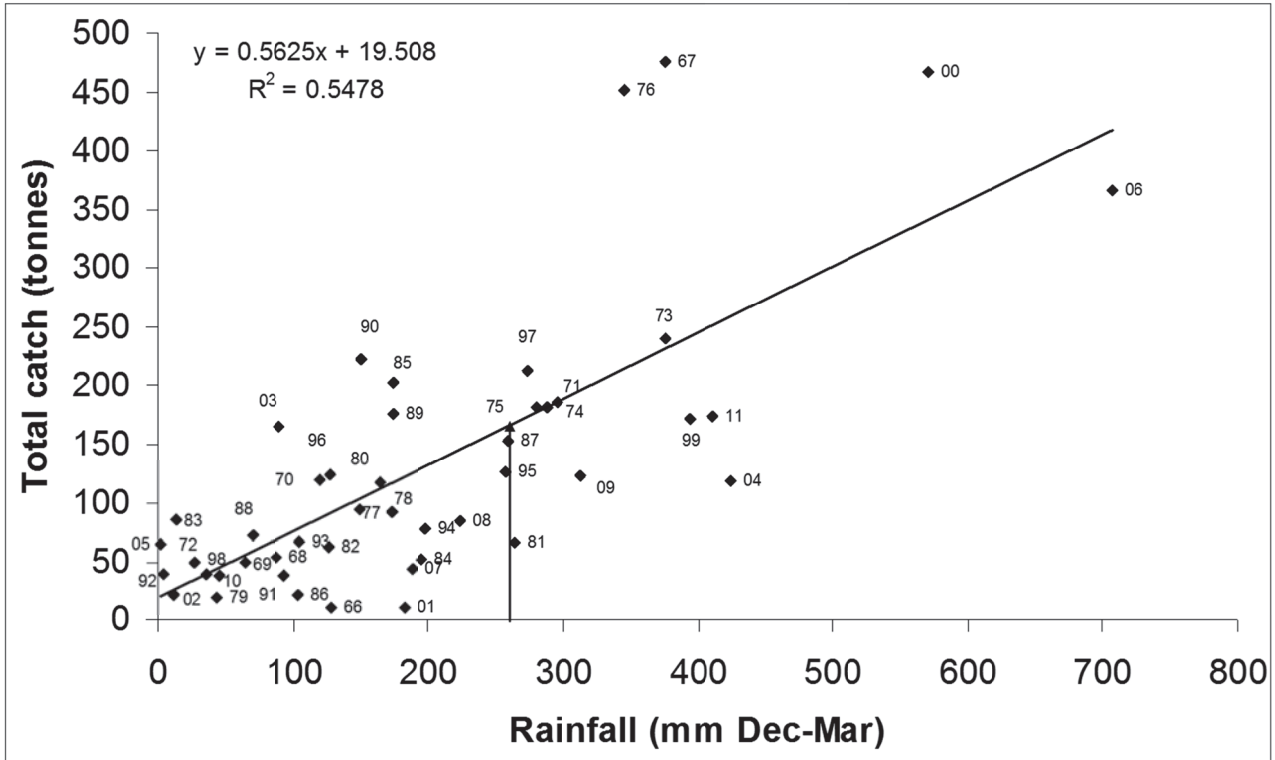
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2011.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2011.



NORTHERN PRAWN FIGURE 9

Relationship between banana prawn landings in Nickol Bay and rainfall between December and March for 1966 – 2011 with rainfall level for 2012 indicated.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, G. Mitsopoulos, B. Rome, R. McAuley, R. Mason and P. Carter

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	110.5 t
		Barramundi	28.5 t
Fishing Levels	Acceptable	Threadfin	74.2 t
		Recreational	2-10% of total (last estimate 2000)
		Charter	< 6 t (barramundi and threadfin)

Fishery Description

Commercial

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129°E) to the top of Eighty Mile Beach, south of Broome (19°S). It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means.

The other species taken by the fishery are predominantly king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). The main areas of operation for the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19°S.

Recreational

Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence.

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation processes

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are now convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Annual Broome Consultative Forum.

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues. There is also an annual Broome Consultative Forum.

Boundaries

Commercial

The waters of the KGBF are defined as 'all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within three nautical miles seaward of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47' south latitude. The principal fishing areas from the Broome coast to Cambridge Gulf in the KGBF are illustrated in Kimberley Gillnet Figure 1.

Recreational

The North Coast Bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21°46'S latitude and east of 114°50'E longitude).

Management arrangements

Commercial

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. Access to the KGBF is limited to seven licences.

There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123°08.23' E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year. There are also limits on the length of net and mesh sizes to be used in the fishery.

There are four principal fishing areas within the KGBF: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound and the Broome coast (Roebuck Bay).

NORTH COAST BIOREGION

There are commercial fishing area closures around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River and all its creeks and tributaries south of 17°27' S, Whistle Creek and Admiral Bay, and the lower Ord River upstream of Adolphus Island.

Recreational

As a precautionary measure to ensure that breeding stock levels of barramundi are maintained, special fishing rules are in place for three key fishing areas: Fitzroy River area and King Sound (bag and possession limit of 2 fish, maximum size limit of 800mm); Broome area (bag limit of 1 fish, possession limit of 2 fish); and the Ord River area (bag and possession limit of 1 fish, maximum size limit of 800mm). Fish species in the North Coast Bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management. The bag and size limits are species-specific (e.g. Barramundi) or species group specific (e.g. mullet). Recreational set and haul netting is prohibited in all waters of the North Coast Bioregion with the exception of haul netting in the waters of the Dampier Archipelago (between Cape Preston and Cape Lambert) with the following restrictions: haul nets must not exceed 30 metres in length; mullet are the only species to be retained and all other species must be returned to the water.

Research summary

Monthly catch and effort data from the commercial fishery are used to assess the status of barramundi and threadfin populations targeted by this fishery. This status report is compiled annually and provided to industry and regional management.

The biological characteristics required for fisheries management for both the threadfin species have been completed (Pember et al. 2005)¹. These data may be used to provide a stock assessment of threadfin in the KGBF and Pilbara in the future. The bycatch of elasmobranchs in the KGBF and the previous Pilbara Coast fishing area was examined during 2002 and 2003 (McAuley et al. 2005)². The stock structure of both threadfin species was defined in FRDC Project 2007/032 (Welch et al. 2010)³.

¹ Pember, M.B., Newman, S.J., Hesp, S.A., Young, G.C., Skepper, C.L., Hall, N.G. and Potter, I.C. 2005. Biological parameters for managing the fisheries for Blue and King Threadfins, Estuary Rockcod, Malabar Grouper and Mangrove Jack in north-western Australia. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 2002/003. Centre for Fish and Fisheries Research, Murdoch University, Murdoch, Western Australia, Australia. 172p.

² McAuley, R., Lenanton, R., Chidlow, J., Allison, R. and Heist, E. 2005. Biology and stock assessment of the thickskin (sandbar) shark, *Carcharhinus plumbeus*, in Western Australia and further refinement of the dusky shark, *Carcharhinus obscurus*, stock assessment, Final FRDC Report – Project 2000/134, Fisheries Research Report No. 151, Department of Fisheries, Western Australia. 132p.

³ Welch, D.J., Ballagh, A.C., Newman, S.J., Lester, R.J.G., Moore, B.R., van Herwerden, L., Horne, J.B., Allsop, Q.,

Retained Species

Commercial landings (season 2011):

All species	110.5 tonnes
Barramundi	28.5 tonnes
Threadfin	74.2 tonnes

The principal species landed are two species of threadfin (king threadfin and blue threadfin) and barramundi. Small quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed. The composition of the elasmobranch catch varies considerably between fishing areas but it mainly consists of whaler shark species (Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays. Sawfish (Pristidae) are totally protected under the *Fish Resources Management Regulations 1995* and may not be retained by this fishery, and are released alive wherever possible.

The total reported catch of all species in the KGBF in 2011 was 111t (Kimberley Gillnet Figure 2). The total landings of barramundi from the KGBF were 28.5 t for 2011 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), a decrease on the reported catch of 57.1 t in 2010. The 2011 landings of threadfin from the KGBF were 74.2 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), lower than that reported in 2010 (83.3 t) and within the midrange of catches reported from the fishery over the last decade (Kimberley Gillnet Table 1). The composition of the KGBF catch in 2011 is summarised in Kimberley Gillnet Table 2.

Recreational catch estimate (last estimate 2000):

2-10% of total catch

The most recent non charter boat data available are from a 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara and West Kimberley region conducted from December 1999 to November 2000 (Williamson et al., 2006⁴). In the entire survey area (Onslow to Broome), the total recreational fishing effort for the year was estimated to be 190,000 fisher days and the total recreational scalefish catch approximately 300 t. Recreational fishers in the survey area reported an estimated total catch of approximately 18 t of threadfin, whereas the estimated total catch of barramundi was less than 1 t. As this survey covered the Broome coast and Pilbara coast areas, the recreational catch can be estimated at around 10% of the combined

Saunders, T., Stapley J.M. and Gribble, N.A. 2010. Defining the stock structure of northern Australia's threadfin salmon species. Final Report to the Fisheries Research and Development Corporation, Project 2007/032. *Fishing and Fisheries Research Centre Technical Report No. 10*, Fishing & Fisheries Research Centre, James Cook University, Townsville, Australia. 180p.

⁴ Williamson, P. C., Sumner, N.R. and Malseed, B.E. 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, Western Australia, 61p

(commercial and recreational) threadfin catch and around 2% of the combined barramundi catch in these areas in 2000. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

The reported charter vessel catches for the north coast bioregion in 2011 were estimated to be approximately 4.5 t of barramundi and less than 1.0 t of threadfin.

Fishing effort/access level

Commercial

The fishery's 'effective effort' is calculated from the validated data as the total length of net set per gillnet hour (km gn.hr⁻¹). During 2011, the total effective effort across the fishery was 1023.3 km gn.hr⁻¹, which is a significant decrease on the 2010 effort figure of 2059.5 km gn.hr⁻¹ (Kimberley Gillnet Figure 2). This significant decrease in effort is linked to one vessel not operating in 2011, thus reducing the overall effort in the fishery and in particular the effort expended in Cambridge Gulf. There is considerable latent effort in the KGBF.

Recreational

Not assessed this season.

Stock Assessment

Assessment complete:

Barramundi	Yes
Threadfin	Yes

Assessment level and method:

Level 2 - Catch Rate

Breeding stock levels:

Barramundi	Adequate
Threadfin	Adequate

The level of catch of barramundi decreased substantially in 2011 due to a marked decrease in fishing effort in the Cambridge Gulf area. Fishing effort in the Broome Coast region (Roebuck Bay) has remained somewhat stable.

The catch rates for barramundi in the KGBF stabilised in 2011 (27.9 kg/km gn.hr⁻¹) at a similar level to that reported in 2010 (27.7 kg/km gn.hr⁻¹) but lower than the catch rates reported in 2008 (35.5 kg/km gn.hr⁻¹) and 2009 (38.8 kg/km gn.hr⁻¹; Kimberley Gillnet Figure 3). The catch rate for threadfin increased to 72.5 kg/km gn.hr⁻¹, compared to 40.4 kg/km gn.hr⁻¹ in 2010, a level similar to that reported in 2008 (65.5 kg/km gn.hr⁻¹) and 2009 (58.6 kg/km gn.hr⁻¹; Kimberley Gillnet Figure 4).

There is a need to update the stock assessments for both barramundi and threadfin and also a need to re-evaluate the effort measure used in the fishery. There is the potential for localised depletion risks to threadfin populations given their fine scale spatial stock structure.

Non-Retained Species

Bycatch species impact: Low

The fishery operates at a relatively low intensity over a wide area of the Kimberley region, specifically targeting barramundi and threadfin. The fishing gear uses large mesh sizes, and hence does not generate a significant bycatch of species important to other sectors, but does take some sharks and rays. Where practicable, sharks and rays are released alive. However, there is some mortality of sharks and rays associated with gillnet capture. Because of the low spatial density of fishing effort relative to the widespread distribution of these species and the size-selectivity of the permitted mesh sizes, these impacts are unlikely to be significant to the stocks involved.

Protected species interaction: Low

The fishing gear used for this fishery (gillnets) is known to result in the bycatch of protected crocodiles (*Crocodylus porosus*) and sawfish (Family Pristidae). These species are generally released alive or avoided as far as is practicable. Because of the low effort levels and the low spatial intensity of fishing effort, these impacts are unlikely to pose a significant threat to the sustainability of the stocks of these species. One crocodile was reported in 2011 and this was returned alive.

Catches of the spartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered and endangered, respectively, are rare in the KGBF. However, as these species look similar to other whaler shark species, they may be captured but misidentified. Given the fishery's overall low effort levels, particularly inside the freshwater drainages in which these species are most likely to occur, the fishing operations of the KGBF are unlikely to pose a significant threat to the sustainability of the stocks of these species. Any increase in effort levels inside freshwater drainages will need to be monitored.

Ecosystem Effects

Food chain effects: Low

This fishery is unlikely to be having anything but a minimal effect on the nearshore and estuarine ecosystem of the Kimberley region.

Habitat effects: Low

The fishing gear has minimal impact on the habitat. The area and habitat fished is subject to extreme tidal currents and associated effects.

Social Effects

Commercial

During 2011, six vessels fished in the KGBF with an average crew level of approximately 2.5 people, with an estimate of at least 15 people directly employed in the fishery. There was additional employment through local processors and

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distribution networks. The fishery provides fresh fish for the local communities and the tourism industry throughout the Kimberley region.

Recreational

A significant number of recreational and charter anglers also fished across the region.

Economic Effects

Estimated annual value (to fishers) for 2010-11:

Level 1 - < \$1 Million

The value of the North Coast Nearshore and Estuarine Fishery is reported using the 6 categories defined in Fletcher et al. (2010¹) that are used to assess the relative economic (based on gross value product, GVP) and social amenity value associated with each ecological asset. These values are based on GVP figures derived from the 2010-2011 financial year.

The KGBF principally targets the high-value species barramundi and threadfin. The fishery's score value in 2010-11 was estimated to be 1 (i.e. Risk level – Negligible; Economic value – <\$1 million; However, the social amenity definition for the KGBF is Important, this is an important asset locally and/or the use or existence of the asset is important to the broader community).

Fishery Governance

Target commercial catch range:

Barramundi **25-40 tonnes**

Current Fishing (or Effort) Level: **Acceptable**

The target catch range for barramundi (25–40 t) was derived from a double exponential smoothed forecasting model of the annual barramundi catches of the KGBF up to 1999. For the five years from 1999 to 2003, the level of barramundi catch was at the top end of the target catch range. The catch in 2004 exceeded the target range, although this was achieved at

a CPUE suggesting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2010 was above the target range for the third successive year. The catch for this species dropped within the catch range of this fishery in 2011 due to reduced effort levels. A review of the fishery is still recommended. This review should include the status of the barramundi stock, the current fishing and effort levels, the target catch range for barramundi along with the development of a target catch range for threadfin.

New management initiatives (2011/12)

The Department plans to review the KGBF management plan in order to modernise the fishery management arrangements.

External Factors

The barramundi stocks utilising the Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the impact of increasing exploitation from the charter and tourism sectors, as well as population growth associated with the gas and mining development sectors on barramundi stocks needs to be investigated.

Furthermore, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience highly variable recruitment due to environmental fluctuations (e.g. the amount of rainfall). These stocks will be subject to increased exploitation pressure from recreational fishers (driven in the main by population growth resulting from gas and mining developments), and are likely to need specific management arrangements in the future.

In addition, the introduction of marine parks across the Kimberley region has the potential to concentrate fishing effort from multiple sectors into those areas that are easily accessible, further increasing risks of local depletion of barramundi and threadfin stocks.

KIMBERLEY GILLNET TABLE 1

Annual catches of the major target species by the KGBF from 2000-2011.

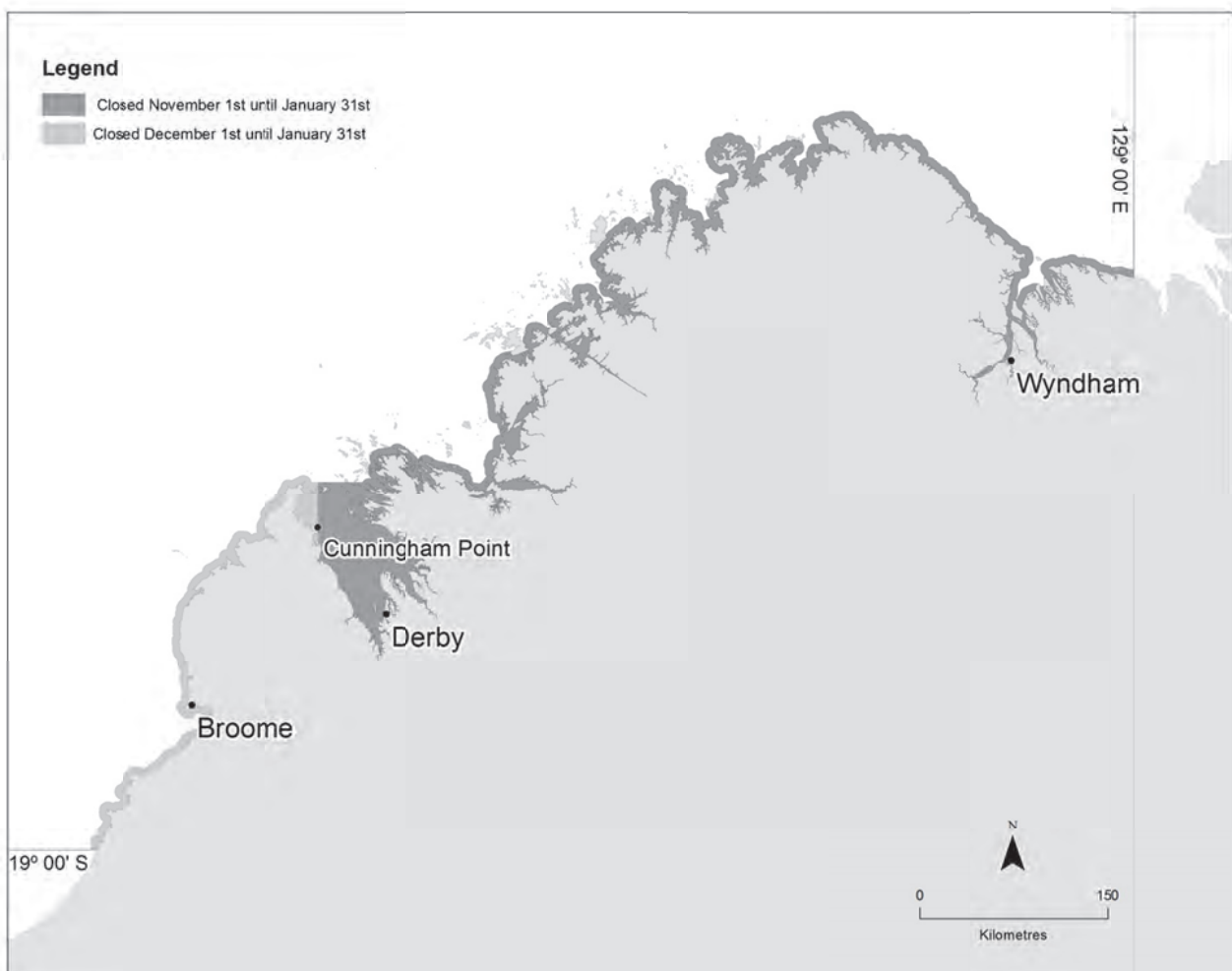
Species	Kimberley Gillnet Annual Catch (tonnes)											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Barramundi	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8	59.6	57.1	28.5
Threadfin	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2	89.9	83.3	74.2
Total	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6	167.3	150.9	110.5

¹ W.J. Fletcher, J. Shaw, S.J. Metcalf & D.J. Gaughan (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy* 34 (2010) 1226–1238

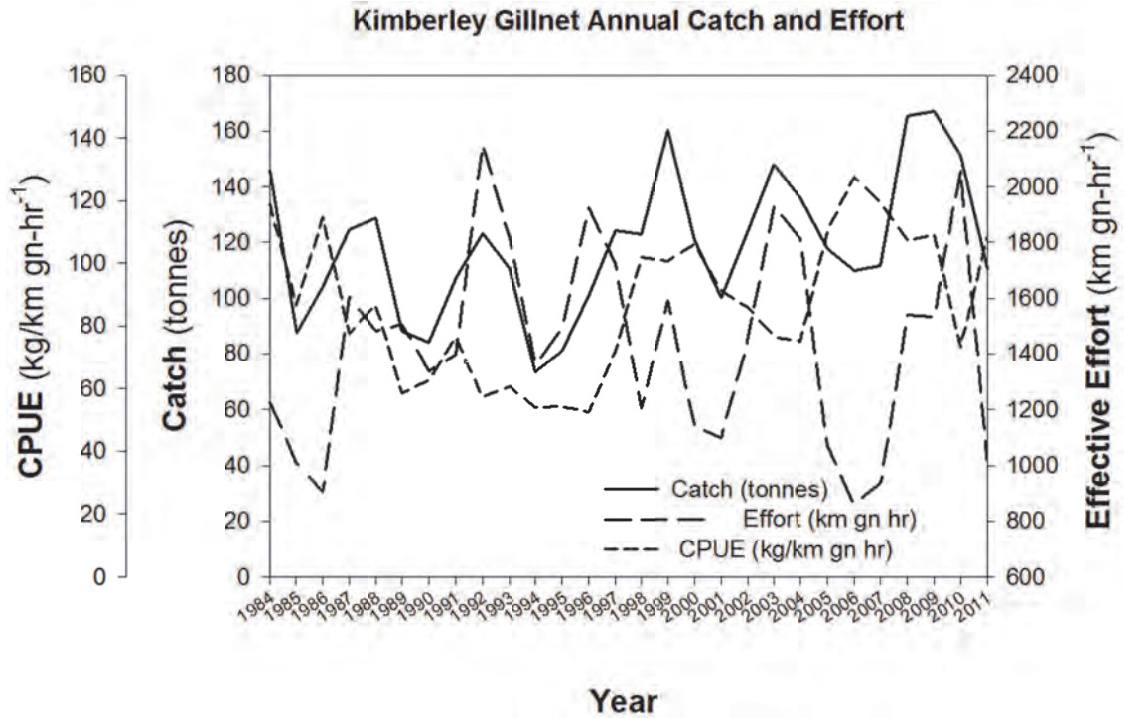
KIMBERLEY GILLNET TABLE 2

Summary of the reported catch (t) in the KGBF in 2011 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	74.2	67.2
Barramundi	28.5	25.8
Tripletail	2.4	2.2
Black jewfish	2.5	2.2
Sharks and rays	1.5	1.4
Other fish	1.4	1.2
Total	110.5	100

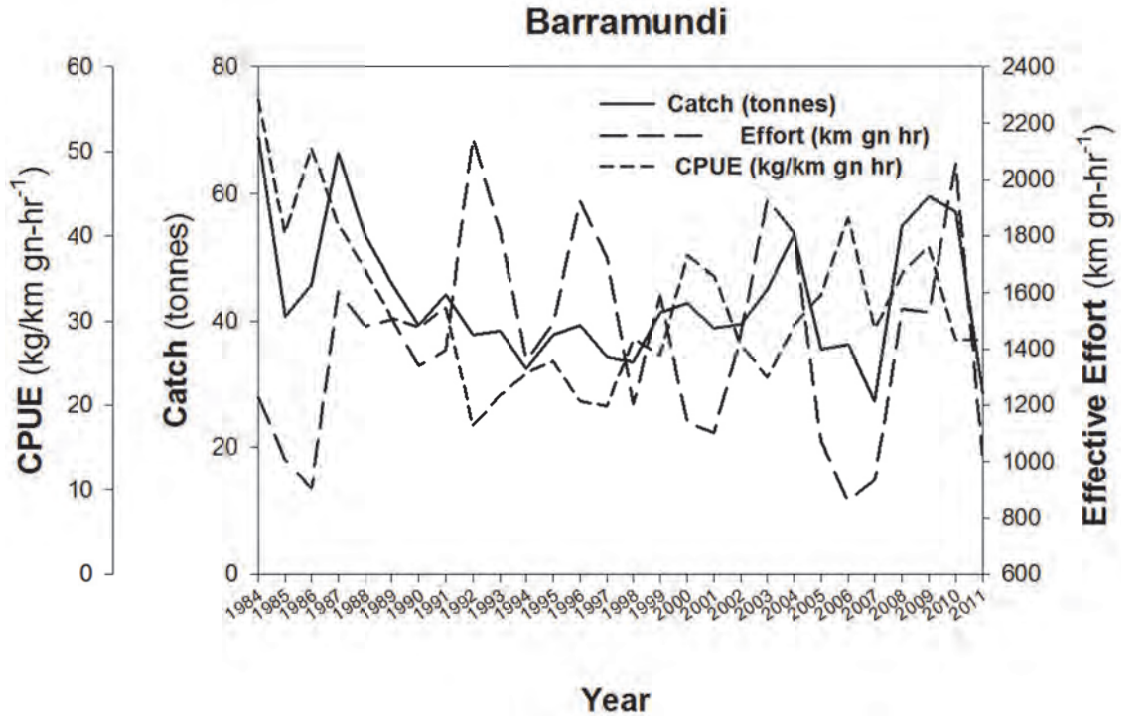
**KIMBERLEY GILLNET FIGURE 1**

Location and extent of the KGBF within the Kimberley region of Western Australia. Note: this map is indicative only.



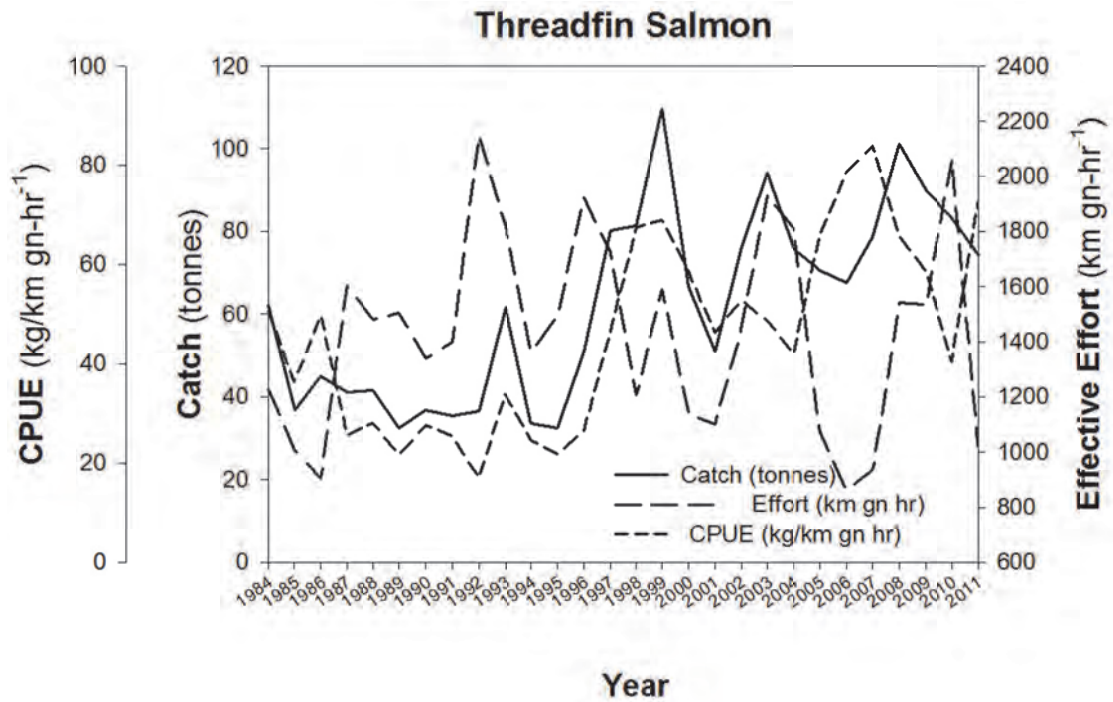
KIMBERLEY GILLNET FIGURE 2

The annual total catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) from the KGBF over the period 1984 to 2011.



KIMBERLEY GILLNET FIGURE 3

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr⁻¹) for barramundi from the KGBF over the period 1984 to 2011.



KIMBERLEY GILLNET FIGURE 4

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, km gn.hr-1) for threadfin from the KGBF over the period 1984 to 2011.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Skepper, C. Wakefield, M. Sawyer, D. Boddington and R. Green

Main Features			
Status		Current Landings	
Pilbara:		Total North Coast Demersal landings	2,693 t
Stock level	Adequate	Pilbara:	
		Total	1,656 t
Fishing Level		Red emperor	118 t
Trawl Fishery	Acceptable	Rankin cod	78 t
Trap Fishery	Acceptable	Bluespotted emperor	223 t
Line Fishery	Acceptable	Pilbara Fish Trawl Fishery	1,085 t
		Pilbara Fish Trap	459 t
Kimberley:		Pilbara Line	112 t
Stock level	Adequate	Charter (Recreational)	< 20 t (1.2% of total)
		Kimberley (NDSF):	
Fishing Level	Acceptable	Total	1,037 t
		Red emperor	128 t
		Goldband snapper	487 t
		Charter (Recreational)	< 5 t (1.5% of total)

Fishery Description

There are a number of commercial and recreational fisheries that operate in the northern bioregion which target, to varying degrees, the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidentis*), bluespotted emperor (*Lethrinus punctulatus*), red emperor (*Lutjanus sebae*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*). Each of these fisheries is outlined below.

Commercial

Pilbara

The Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery, which collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) targeting all the main demersal species, with smaller subsets of species taken by the Trap fishery and fewer still by the Line Fishery.

Kimberley

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. The permitted means of operation within the fishery include handline, dropline and fish traps, but since 2002 it has essentially been a trap based fishery which uses gear time access and spatial zones as the

main management measures. The main species landed by this fishery are red emperor and goldband snapper.

Recreational

Recreational fishing activities on these species are mostly line based fishing from boats which are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months, April/May to September/October).

Governing legislation/fishing authority

Commercial

Pilbara

Pilbara Trap Managed Fishery Management Plan 1992

Pilbara Trap Managed Fishery Licence

Pilbara Fish Trawl Fishery (Interim) Management Plan 1997

Pilbara Fish Trawl Interim Managed Fishery Permit

Prohibition on Commercial Fishing for Demersal Scalefish (Pilbara Area) Order 1997

Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Pilbara Fish Trawl)

Kimberley

Northern Demersal Scalefish Managed Fishery Management Plan 2000

Northern Demersal Scalefish Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation.

Consultation processes

Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department. Annual Broome Consultative Forum (Kimberley).

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues. Annual Broome Consultative Forum (Kimberley).

Boundaries

Commercial

Pilbara

The Pilbara Fish Trawl Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath (North Coast Figure 1).

The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas. Areas 1 to 6 each cover 1,300; 1,800; 880; 1,500; 2,300 and 7,200 square nautical miles, respectively. The total area available for trawling in Zone 2 is 14,980 square nautical miles, however, only 6,900 square nautical miles are currently open (i.e. ~46% of Zone 2 is currently open to trawling). This represents less than 5% of the total shelf area available in the North Coast Bioregion. The exact latitudes and longitudes delineating the areas are listed in the *Pilbara Fish Trawl Fishery (Interim) Management Plan 1997*.

The Pilbara Trap Managed Fishery (North Coast Figure 1) lies north of latitude 21°44'S and between longitudes 114°9.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the *Pilbara Trap Management Plan 1992*.

The Pilbara Line fishing boat licensees are permitted to operate anywhere within "Pilbara waters". This means all waters bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia; thence west along the parallel to the intersection of 21°56'S latitude and the boundary of the Australian Fishing Zone and north to longitude 120°E. The exact latitudes and

longitudes delineating the Fishery are listed in the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*.

Kimberley

The waters of the Northern Demersal Scalefish Fishery are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120°E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles) (North Coast Figure 2). The fishery is further divided into two fishing areas; an inshore sector (Area 1) and an offshore sector (Area 2; see North Coast Figure 2). Under a voluntary industry agreement (now formalised under an Exemption), the offshore sector (Area 2) has been further divided into 3 zones; A, B and C. Zone B comprises the area with most of the historical fishing activity. Zone A is an inshore developmental area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m. The inshore waters in the vicinity of Broome are closed to commercial fishing. This closure was put in place to reduce the potential for conflict between commercial fishers and recreational, charter and customary fishers (North Coast Figure 2).

Recreational

Recreational fishing in the North Coast Bioregion encompasses all waters in both the Pilbara and Kimberley regions, extending from the Ashburton River south of Onslow to the WA/NT border with the exception of some areas within Marine Parks.

Management arrangements

Commercial

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery is managed through a combination of area closures, gear restrictions, and by the use of input controls in the form of individual transferable effort allocations monitored by a satellite-based vessel monitoring system (VMS). This Interim Management Plan was implemented for the Fish Trawl Fishery in the Pilbara in 1998, with effort levels determined to achieve the best yield from the Fishery while keeping exploitation rates of the indicator species at sustainable levels.

A large amount of the area within the boundaries of the Trawl Fishery is closed to trawling. Much of this has been closed since the implementation of the (Interim) Management Plan (1998) including Zone 1 of the Fishery and Area 3 of Zone 2 of the Trawl Fishery. In addition, Area 6 of Zone 2 has been closed since the commencement of the Interim Plan except for two periods of research trawling in 1998 and 1999. The area inshore of the 50 m depth isobath is also closed to trawling. Areas 1, 2, 4 and 5 are open to fishing all year, with separate effort allocations (in hours) in each Area, as outlined in the Interim Plan. The open areas of the Trawl Fishery are trawled with varying intensity due to differing effort allocation, substrate composition and economic considerations (e.g. distance from ports).

There are 11 permits for the Fishery, with the combined effort allocations being consolidated over time onto 3 full time vessels.

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The Trap Fishery is also managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based VMS. There has also been a closure to trapping in Area 3 since 1998.

The authority to fish in the Trap Fishery is limited by reference to a specified number of trap days expressed in terms of units of entitlement. The capacity is currently limited to 5,456 trap days. However, the Management Plan allows the Director General to alter the value of these units. There are 6 licences in the Fishery, with the allocation consolidated onto 3 vessels.

The Line Fishery is managed under the Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order, 2006. Nine Fishing Boat Licences are exempted from this prohibition for any nominated 5-month block period within the year.

Comprehensive ESD assessments were submitted to the Commonwealth Government environmental agency, now called SEWPaC, in 2004 for both the Pilbara Trap and Trawl Fisheries to allow product to be exported. These ESD assessments determined that performance should be assessed annually for breeding stock levels, protected species interactions and habitat effects. As a result, the Pilbara Trap Fishery was declared an approved Wildlife Trade Operation in November 2004 for a period of three years. This was not renewed after December 2007 as the fishery was not exporting. The Pilbara Fish Trawl Interim Managed Fishery is an approved Wildlife Trade Operation until June 2013.

Kimberley

The Northern Demersal Scalefish Fishery is managed primarily through input controls in the form of an annual fishing effort capacity, with supplementary gear controls and area closures. The annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch (NTAC). The annual effort capacity is set by the Director General based on the available research advice in consultation with licensees. This effort capacity is then allocated among license holders through units of entitlement on Managed Fishery Licences, for use in Area 2 of the Fishery. An Exemption provides for additional effort in Zone A (56 standard fishing days per 160 unit licence) and Zone C (50 standard fishing days per 160 unit licence), in order to encourage fishers to explore the lesser-fished waters of the NDSF.

The notional target TAC for Zone B is a recommended level of catch for the entire demersal species suite and is derived from the estimated sustainable catch of the key target species (determined through stock assessments) and their historical proportions in the catch. In 2011, Zone B effort allocation was 985.6 standard fishing days.

The areas that encompass Zone A and Zone C are likely to have a lower sustainable catch compared with Zone B, and thus exploratory TACs are set for Zone A and Zone C. These will need to be revised as effort and catches in these zones increase. In 2011, the Zone A effort allocation was 616 standard fishing days.

Access to the offshore sector (Area 2) of the NDSF is limited to 11 licences under an individually transferable effort (ITE) system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2011, 7 vessels (trap fishing only) collectively held and operated the

effort individually assigned to the 11 licences. Each trap must have an internal volume equal to or less than 2.25 m³. While there is no restriction on the number of traps that can be fished per vessel, each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day. If the number of traps (or lines) being fished increases beyond this level, the number of allowable fishing days declines. The number of days and traps fished, as recorded by the vessel monitoring system, is converted to standard fishing days. A comprehensive environmental risk assessment of this fishery has determined that performance should be reported against measures relating to breeding stocks of the two indicator species, red emperor and goldband snapper, and the cod/grouper complex (a suite of more than 10 species), as reflected by their catch levels.

Recreational

The recreational fishery for demersal fish in the North Coast Bioregion is managed in a similar manner to other Bioregions across the State through the use of input controls (e.g. size limits) and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats – these are assigned based on a number of risk categories).

From 2 March 2010 all persons fishing from a powered boat anywhere in the state have been required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder. The Recreational Fishing from Boat Licence provides a state-wide database of recreational boat fishers that can be utilised for survey purposes.

Demersal fish, particularly the icon species such as coral trout and red emperor, are considered prime recreational target species. As such, resource-sharing issues will be a consideration in future management arrangements across this Bioregion.

Research summary

Pilbara

Monitoring and assessment of the Pilbara Trawl, Trap and Line Fisheries includes the collection of spatial data on effort and catch of 11 major target species from logbooks, VMS data, and weighed catches from unload data. Assessment of the status of the suite of retained demersal scalefish is based on the performance of indicator species (red emperor, Rankin cod, bluespotted emperor, brownstripe snapper, goldband snapper and ruby snapper) using various assessment methods constituting a weight-of-evidence approach. These methods include trend analysis of trawl catch rates using two measures of effort (time spent trawling reported in logbooks and time spent in each management area derived from VMS) for five indicator species and the total catch in each of the trawl-managed areas. In addition, ages are determined from otolith sections for selected indicator species in each trawl-managed area and the Trap Fishery, and for ruby snapper from the Line Fishery.

Estimates of fishing mortality are derived from age structures and compared to internationally recognised biological reference points (see Stock Assessment section).

Approximately every 4-5 years the spawning biomass of two indicator species, red emperor and Rankin cod, are assessed using the age-composition and catch rate data synthesised into an integrated age-structured model.

In 2010, a fishery independent research survey was conducted which was aimed at describing the demersal fish assemblages associated with trawl, trap and closed management areas.

Kimberley

Assessment of the status of the demersal fish stocks in Zone B of the NDSF is determined annually using catch and catch rates of the major species or species groups, and every 4-5 years using an age-based stock assessment model to assess the status of two indicator species, red emperor and goldband snapper, based on age-composition data collected in previous years. Ongoing monitoring of this fishery is being undertaken using both catch and effort logbook and VMS data.

The catch from the NDSF also includes components from Zone A of the fishery. This zone has a somewhat similar catch composition to Zone B of the fishery. The level of catch from Zone A will be monitored closely in the future as this area of the fishery has been receiving more effort in recent years.

The catch from the NDSF also includes at times some species from the waters of Zone C in depths greater than 200 m. The resources of this Zone are unlikely to be substantial, and given the lower productivity of these longer-lived, deeper-slope reef fish, the sustainable catch from this zone is likely to be significantly lower than for Zone B.

Retained Species

Commercial landings (season 2011):

Pilbara Fish Trawl	1,085 tonnes
Pilbara Fish Trap	459 tonnes
Pilbara Line	112 tonnes
Kimberley (NDSF)	1,037 tonnes

The commercial catches of key species and species groups from across the North Coast Bioregion and their relative contribution to catches within the Pilbara and Kimberley sectors in 2011 are summarised in North Coast Table 9. The relative contribution of the Kimberley sector has been increasing as the catch from the Pilbara sector has been stable.

Pilbara

The total catch of demersal scalefish taken by the trawl fishery has declined from annual average catch levels of close to 2,500 t during the period 1995 – 2004 to an average of 1,200 t per annum since 2008 (North Coast Tables 1 and 2). These total annual catches have been below the target catch range (2,000 to 2,800 t) for five consecutive years, with less than 1,100 t landed in 2011 (North Coast Table 2). These reductions are considered to be a response to the effort reductions imposed on the trawl fishery since 2008.

The major target species landed by the trawl fishery in 2011 were bluespotted emperor 152 t (164 t in 2010), crimson snapper 130 t (93 t in 2010), brownstripe snapper 63 t (76 t in 2010), goldband snapper 56 t (63 t in 2010), red emperor 54 t (76 t in 2010), saddletail snapper 43 t (50 t in 2010), spangled emperor 18 t (15 t in 2010) and Rankin cod 12 t (14 t in 2010). The total retained by-product was 18 t (32 t in 2010) including bugs, cuttlefish, and squid (North Coast Table 2).

The total annual catch taken by the Pilbara trap fishery has remained relatively consistent since 2006 averaging 469 t per year and remaining within the target catch range of 400-500 t (North Coast Tables 1 and 2). The total catch of approximately 460 t in 2011 was slightly lower than the 2010 catch (North Coast Table 2). The major species taken by the trap fishery in 2011 were goldband snapper 74 t (37 t in 2010), bluespotted emperor 71 t (90 t in 2010), red emperor 62 t (89 t in 2010), Rankin cod 60 t (52 t in 2010), crimson snapper 49 t (48 t in 2010) and spangled emperor 20 t (20 t in 2010).

The total annual catch of scalefish taken by the line fishery is historically much lower than is taken by the trawl and trap fisheries (North Coast Tables 1 and 2). In 2011, the total annual catch for the line fishery was approximately 110 t, similar to the catch in 2010 and towards the upper limit of the target catch range of 50-115 t (North Coast Table 2). In recent years (since ~2006), the line fishery catches have been dominated by ruby snapper and goldband snapper, typically accounting for more than 40% of the total annual catch. In 2011, the ruby snapper catch was 30 t (56 t in 2010) and the goldband snapper catch was 20 t (17 t in 2010) (North Coast Table 1). This fishery and the Commonwealth's North West Slope Trawl Fishery are likely to be targeting the same stock (management unit) of ruby snapper, so catches from both commercial fisheries would need to be considered in any future assessment or harvest strategy.

Kimberley

After the initial development period from 1990 to 1992, the catch of the NDSF reached the first peak in catch (> 900t) in 1996 before declining to levels of about 500 t in 2003 (North Coast Figure 4). The total catch began to increase again in 2003, and the past four years have the highest recorded catches (> 1000 t) since the inception of the fishery. The 2011 catch of 1,037 t is the third highest catch recorded during this period, and as in 2010 is mainly due to increased levels of catch from Zone A of the fishery (North Coast Tables 6 and 7).

The NDSF principally targets red emperor and goldband snapper, with a number of species of snappers (Lutjanidae), cods (Epinephelidae) and emperors (Lethrinidae) comprising the majority of the remainder of the catch (North Coast Table 6). The species composition of the landed catch in 2011 is similar to that reported in 2010, with goldband snapper dominating the landed catch. The landed catch of goldband snapper decreased from 523 t in 2010 to 487 t in 2011. However, these last two years represent the highest reported landings of this species, continuing an overall trend of increasing catches since 2005. The total catch of red emperor in 2011 was 128 t (141 t in 2010) and continues a decreasing catch trend for this species since 2005. The cods/groupers catch in 2011 (155 t) was similar to that reported in 2010 (153 t), and represents the highest level of catch reported for this species complex. Rankin cod dominates the composition of the cod/grouper catch complex. The catch of Rankin cod decreased from 49 t in 2010 to 41 t in 2011 (North Coast Table 7).

The catch rate of red emperor in Zone B in 2011 decreased slightly, continuing a declining trend in catch rates since 2007 (North Coast Figure 5). The catch rates for goldband snapper in Zone B also decreased slightly, but remained within the higher range reported since 2009. These high levels of catch rate (2009 – 2011) have followed the sharp

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increase in catch rates from 2006 to 2009 (North Coast Figure 6). The catch rates of the cod/grouper complex in Zone B also decreased slightly, but again remains comparatively high following the increasing catch rate trend from 2002 to 2010 (North Coast Figure 7).

The 2011 catch of red emperor, goldband snapper and cods/groupers were within acceptable levels as defined in the Export exemption for this fishery (see 'Fishery Governance' section), with no species or species complex exceeding the trigger point (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2011):

Pilbara 1.2%

Kimberley <1.0%

Pilbara

While there is a major recreational fishery in the Pilbara and the charter sector is an increasing user of the resource, the inshore closures to the commercial sector provide a high degree of spatial separation between the user groups. The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial Pilbara demersal scalefish fisheries. The reported charter vessel catch of demersal scalefish in the offshore waters of the Pilbara (depth > 30 m) in 2011 is estimated to be ~1.2% (~20 t) of the commercial catch. However, due to the increasing population in the Pilbara from mining developments, catches are likely to increase in the future. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

Kimberley

Historically, there has been little recreational or charter boat fishing effort directed towards the demersal fishes in Area 2 of the NDSF, the species that are targeted by commercial fishers. However, this is now changing with charter vessels moving into the inshore demersal waters of the NDSF. The reported charter vessel catch of demersal scalefish in the inshore demersal waters of the NDSF (depth > 30 m) in 2011 is estimated to be less than 1% (< 5 t) of the commercial catch. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Area 1, which is closed to commercial fishing. The magnitude of recreational fishing catch is small relative to the total commercial catch. However, the increasing number of people associated with oil and gas developments in the Kimberley region has the capacity to significantly increase the level of recreational catch taken from nearshore and inshore demersal waters of the NDSF. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

Fishing effort/access level

Pilbara

Fishing effort used by the trap and line sectors of the commercial fishery are based on monthly catch and effort returns (North Coast Table 3). Trawl Fishery effort is recorded as the net bottom time (hours) taken from skippers' logbook data, along with the time spent in each management area derived from VMS data.

The trawl fleet had the equivalent of three full-time vessels. The percentage of allocated hours used by the trawl fleet during the 2010/11 season were 102% in Area 1, 109% in Area 2 (noting that vessels can exceed their entitlement within an area by 48hr as long as overall entitlement is not exceeded), 92% in Area 4 and 57% in Area 5. Trawling has not been permitted in either Area 3 or Area 6 since 1998 and trapping has not been permitted in Area 3 since 1998 (North Coast Figure 1).

In 2011, trap fishers were allocated 5,457 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 89% of the units used as calculated from the VMS.

In 2011, line fishers reported operating for 376 days, compared with 266 days in 2010.

Kimberley

The seven fish trap vessels that fished in the NDSF in 2011 reported using between 10 and 36 fish traps per day. Line fishing has not been reported since 2002 and no line fishing was undertaken in Zone B of the NDSF in 2011. Effort across all zones of the fishery decreased in 2011 to 1,042 days (1,178 days in 2010; North Coast Table 8).

The total effort allocated in Zone B in 2011 was 986 standard fishing days (i.e. using 20 traps) (North Coast Table 8). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 879 SFD's (89%). That is, 11% of effort allocated to Zone B in 2011 was not used. A total of 616 standard fishing days was allocated to Zone A in 2011. The number of SFDs recorded using VMS data was 163 (237 SFD's in 2010), indicating that ~74% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2011 was negligible.

Thus, latent effort exists in all Zones of this fishery.

Stock Assessment

Assessment complete:

Pilbara Yes

Kimberley Yes

Assessment level and method:

Pilbara

Level 2 - Catch and catch rates (Annual)

Level 3 - Fishing mortality (Periodic - 2008)

Level 5 - Integrated model (Periodic - 2007)

Kimberley

Level 2 - Catch and Catch rates (Annual)

Level 5 - Integrated Model (Periodic -2007)

Breeding stock levels:

Pilbara

Trawl Fishery Adequate

Trap Fishery Adequate

Line Fishery Adequate

Kimberley Adequate

Pilbara

There are three tiers of assessment used in the Pilbara, that when combined constitute a weight-of-evidence approach to determine overall stock status based on the performance of indicator species that represent the entire demersal suite of species. The different tiers of assessment (see How to Use This Volume for more details) are applied to the various indicator species of this suite. Catch and catch rate analyses are used to assess five indicator species and the total combined retained catch on an annual basis. Fishing mortality estimates (F) derived from age structure data are used to assess red emperor, Rankin cod, goldband snapper and bluespotted emperor relative to internationally recognised biological reference points (BRP) based on ratios with natural mortality¹ on a periodic basis with the last analysis completed using 2008 data. An age-structured model incorporating catch rates, catch history and age structure data is used to assess spawning biomass levels for red emperor and Rankin cod also on a periodic basis (~5 years) with the last assessment completed in 2007.

Catch Rates

Catch rates are derived from logbook catch data and adjusted according to the unload data, so that catches match reported unloads with the area component obtained from logbooks. There are two measures of effort used to derive catch rates including the duration of the trawl shots as reported in logbooks and the time spent in each management area on each trip derived from VMS data. VMS data have only been available since 2000. Catch rates were calculated using the adjusted catch divided by effort (separately for both methods) by area for each trip. A moderate efficiency increase (0-4% per year) is applied to nominal catch rates based on trawl-time as this level of efficiency increase is typical for many trawl fisheries internationally.

Mean trawl catch rates of the indicator species and the total catches decreased each year from 2004 to 2008 (North Coast Figures 3). Since 2009, the catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper) and total catch have increased each year, whereas those of longer lived indicator species (red emperor, Rankin cod and goldband snapper) have remained relatively stable (North Coast Figures 3).

Fishing Mortality

The high rate of fishing mortality of red emperor (> BRP Limit level) in the western areas (Areas 1 and 2) of the trawl fishery (North Coast Table 4), and the declining catch rates of several species including the indicator species of red emperor and Rankin cod led to a reduction in effort of 16% in Areas 1 and 2 and 4% in Area 4 in 2009. This followed an industry agreed effort reduction in Area 1 in 2007 and 2008.

Age Structured Model

The age-based stock assessment models for the two indicator species, red emperor and Rankin cod, were last run in 2007.

The outcomes of these model runs indicated that; 1) red emperor spawning biomass was greater than 40% of virgin biomass overall, with declining trends forecast for Areas 1 and 4 and stable forecast trends for Areas 2 and 5 for future years; and 2) Rankin cod spawning biomass was greater than 40% of virgin biomass overall, with a declining trend forecast for future years across most management areas. However, this assessment indicated that the spawning biomass for these indicator species of the Pilbara Demersal Fishery as a whole were above their target levels, indicating satisfactory breeding stock levels and a moderate risk of recruitment overfishing. These assessments were last run prior to effort reductions in the trawl fishery and the fishing mortality estimates from age structures of indicator species collected in 2007, 2008 and 2011. These age-based stock assessment models are scheduled to be updated following the completion of fishing mortality estimates derived from age structures of these indicator species collected in 2011.

Current Assessment

Following concerns for the sustainability of the Pilbara demersal scalefish resource based on; 1) declining catch rates of all indicator species and the total catch from 2003-2008, and; 2) fishing mortality estimates that exceeded limit references levels for red emperor in Areas 1 and 2 in 2007, voluntary effort reductions were undertaken by the trawl industry in 2008 in Area 1 and implemented legislatively in 2009, in Areas 1, 2 (16% combined) and 4 (4%). This has resulted in the lowest recorded level of effort for the trawl fishery since the individual transferable effort system was introduced in 1998. It has been two years since these effort reductions were introduced and early signs of stock rebuilding are evident from increasing catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper). These species are expected to display positive responses earlier than the longer lived indicator species (red emperor and Rankin cod) considering they are selected by the trap and trawl fisheries at a younger age (i.e. 2-3 vs. 5-6 years) and they have inherently higher population productivity. The longer lived indicator species (red emperor and Rankin cod) have displayed marginal increases in catch rates in some management areas and stable catch rates in others since the implementation of effort reductions (2009). If they are also recovering, it is expected increases in catch rates will be start to be reported from 2013/14 onwards due to the lag between recruitment and vulnerability to the trawl fishery (5-6 years of age). Otoliths of the indicator species, red emperor, Rankin cod, bluespotted emperor, brownstripe snapper and ruby snapper were collected in 2010/11 from each management area of the trawl, trap and line fisheries. The age structures derived from these otolith collections will be used to evaluate changes in fishing mortality since previous estimates in 2007/08 and therefore the sustainability of current exploitation levels.

¹ The BRPs for long-lived (> 20 years) species include (1) the Target level, where $F \leq 2/3$ the ratio of natural mortality (M), for which fishing mortality is sustainable; (2) Threshold level, where $F = M$, which indicates fishing has exceeded sustainable levels; and (3) Limit level, where $F = 1.5M$, which indicates that fishing has greatly exceeded sustainable levels.

Pilbara: The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-lived indicator species, i.e. red emperor and Rankin cod. The target level of spawning biomass is 40% of the initial level when the catch was first recorded. The limit level is 30% of the initial spawning biomass. The spawning biomass levels of the target species were assessed as adequate (spawning biomass was greater than 40% of virgin biomass) in 2007 by synthesising the available data in an age-structured model.

Kimberley

Assessment of the indicator species in the NDSF is also undertaken using a multi-tiered approach. Catch and catch rates are assessed annually and an age structured stock assessment model is applied using relevant data on a periodic (5 year) basis with the last assessment completed in 2007.

Catch Rates

The determination of catch per unit of effort (CPUE) prior to 2009 was based on mean catch rates calculated from monthly returns. During 2009 a transition from monthly returns to trip returns was undertaken to establish an improved level of spatial and temporal catch reporting. As a consequence there were two sources of catch returns for vessels operating in the NDSF during 2009; daily returns and monthly returns. In 2010 and 2011, all NDSF vessels reported catch and effort using daily logbook returns. Catch per unit of effort for daily logbook data is determined by calculating the mean CPUE from the analysis of catch and effort for every fishing trip undertaken in a year. Catch rates for Zone B only are presented in North Coast Figures 5-7, as this area represents the historical core fishing area of the NDSF prior to zoning in 2006. During 2011, Zone B catch rates for the indicator species were 119 kg/std day for red emperor, 544 kg/std day for goldband snapper and 150 kg/std day for cods/groupers. Catch rates for these three principal species/species groups were slightly lower than those reported in 2010 (132 kg/std day for red emperor, 577 kg/std day for goldband snapper and 164 kg/std day for cods/groupers). The catch rate for red emperor has been declining gradually since 2007, while the catch rates for goldband snapper and cods/groupers have only decreased slightly from recent years, where the catch rates were the highest recorded.

While both the 2011 catch of goldband snapper and cods/groupers from all zones exceeded the average of the previous four years, they did not exceed the ESD trigger point of a 20% increase in catch above the average of the past four years. The catch of red emperor was below the average of the previous 4 years.

Increases in catch levels are, by themselves, not very sensitive indicators of stock status but combined with the previous estimates of fishing mortality of goldband snapper being close to the upper acceptable limit, further material increases in their catch would represent an unacceptable risk given the information currently available. While several scenarios may explain the increased catches of goldband snapper in recent years, their validity should be resolved following the next collection and analysis of the representative age samples. In addition, recent work has been undertaken to standardise catch rates in the fishery for input into the next age structured stock assessment model evaluation.

Age Structured Model

The spawning biomass of the key target species in the NDSF was last estimated by an age-structured stock assessment model in 2007, which indicated the spawning biomass was above the international reference point of 40% of virgin biomass but with a slight declining trend for both red emperor and goldband snapper. These model outputs were reviewed by Prescott and Bentley in 2009, who concluded that the model was appropriate for use but would benefit from modifications, including the better determination of levels of model uncertainty. The model is currently being updated with continuous ongoing improvements being undertaken until the next assessment evaluation.

Current Assessment

The most recent model based assessment estimates indicated that there was a high probability that the spawning stocks of the indicator species were both above their respective threshold levels at that time. The overall catch levels and the species based catches were all within the acceptable ranges for the fishery, noting significant increases in goldband catches since 2007. The catch rates for the indicator species were either stable or declining gradually and the F based assessments indicated that the fishing level on the indicator species were either lower than the target level or between target and threshold levels. Consequently the stocks for the suite of species targeted by this fishery are effectively fished and currently considered to be at acceptable levels. If catches in Zone B are maintained at current levels, there is a low likelihood that the spawning stocks of any species within this suite declining to unacceptable levels. The current risk to sustainability for this suite is therefore moderate. Zone A of the fishery continues to receive increasing levels of effort and catch. There is currently a low to moderate risk to the sustainability of the fishery resources in this zone. Zone C of the fishery received a negligible level of effort in 2011. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

NDSF: The performance measures for this fishery relate to the maintenance of adequate breeding stocks for the key indicator species as indicated by the catch levels. In 2011, the catches of goldband decreased from 2010, and did not exceed the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2011 level of catch of cods/groupers was above that taken in 2010, and although also above the average of the previous four years, did not exceed the trigger point.

The 2011 red emperor catch was below the average of the preceding four years. The spawning biomass was greater than 40% of virgin biomass in 2007 with a slight declining trend for both red emperor and goldband snapper. All three species/groups are thus considered to currently have adequate breeding stock levels.

Non-Retained Species

Bycatch species impact:

Pilbara	Moderate
Kimberley	Low

Pilbara

An independent observer program designed to monitor bycatch and interactions with protected species was completed in September 2009. The outcomes of the observer program are reported in the FRDC report for Project No. 2008/048. This project suggested trialling a top-opening in the trawl nets to potentially further reduce the incidental capture of dolphins and turtles. Investment in a top-opening net along with additional modifications has been in development and undergone flume tank tests and sea trials by industry since 2010. This modified net design and other mitigation measures ('pingers') are being trialled within a dedicated observer program in 2012 in consultation with SEWPaC. The fish trap and line fisheries have minimal bycatch (see Kimberley below).

Kimberley

As a result of the catching capacity of the type of gear used and the marketability of most species caught, there is a limited quantity of non-retained bycatch in this fishery. The most common bycatch species is the starry triggerfish (*Abalistes stellaris*), but the numbers taken are not considered to pose a significant risk to the sustainability of this species.

Protected species interaction:

Pilbara	Moderate
Kimberley	Negligible

Pilbara

The fish trawl fishery has an incidental capture of bottle nosed dolphins, turtles, sea snakes, pipefish and seahorses (North Coast Table 5). Turtles and sea snakes are generally returned to the water alive but dolphins, pipefish and seahorses are generally moribund when landed. The catch of these species is recorded in compulsory skipper logbooks and reported annually to SEWPaC. The bycatch of dolphins and turtles has remained well below the levels observed prior to the introduction of exclusion grids in trawl nets in 2006. Given the area of distribution and expected population size of these protected species, the impact of the fish trawl fishery on the stocks of these protected species is likely to be minimal. There is a small catch of green sawfish, a species that is protected in WA waters. Measures to further mitigate protected species interactions by the fish trawl fishery (outlined above) have been under development since 2010 in consultation (and within timeframes established) with SEWPaC and these will be trialled in 2012 using dedicated above and below water observer programs.

The reporting of interaction with protected species has improved for the Kimberley and Pilbara trap fisheries. These fisheries regularly capture sea snakes. In 2011 the Pilbara and Kimberley trap fisheries reported 151 and 231 sea snakes respectively, all of which were returned alive.

Pilbara: The performance measures for the impact of the trawl fishery on protected species: skippers are required to record incidents of capture and to minimise mortality. Despite dolphins foraging inside trawl nets during ~98% of trawls (FRDC report, Project No. 2008/048) their capture is very rare (~0.005 trawl⁻¹ in 2011, reported by skippers in compulsory logbooks).

Based on estimates from independent observers, exclusion devices that were made compulsory in fish trawl nets in 2006 reduced the incidental catch of dolphins by 64% and turtles by 97%. Subsequently, dolphin mortalities reported in skipper logbooks have reduced to less than 20 per year since 2006 (North Coast Table 5).

Kimberley

Using trap gear in continental shelf regions is very unlikely to interact with protected species. Recent video observations indicate that the potato cod (*Epinephelus tukula*), a totally protected species, is present in high numbers at discrete locations within the fishery. Potato cod rarely enter traps due to their large size and girth limiting their capacity to pass through the entrance funnel into the traps.

Ecosystem Effects

Food chain effects:

Pilbara	Low
Kimberley	Negligible

Pilbara

The current Fish Trawl Fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by foreign vessels. Historical research by CSIRO has suggested that the extensive Taiwanese pair Trawl Fishery caused a significant decrease in the biomass of finfish on the North West Shelf, and a change in species composition towards smaller (shorter lived) species. The current WA Fish Trawl Fishery, which developed when the fish stocks had begun to recover, uses a much larger mesh size and much lighter ground gear, and operates at lower exploitation rates and only in restricted parts of the shelf. At the present levels of catch and effort by the fish trawl, fish trap, and line catch, the broader effect of the Fishery on the trophic levels and community structure of the North West Shelf is considered to be at an acceptable level. Significantly, Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Pilbara (i.e. no fishing down of the food web) over the past 30 years.

Kimberley

The need to maintain relatively high levels of biomass for the species caught in this fishery to meet stock recruitment requirements results in a negligible risk to the overall ecosystem from the fishery. Hall and Wise (2011) demonstrated that there has been no reduction in either mean trophic level or mean maximum length in the finfish catches recorded within the Kimberley (i.e. no fishing down of the food web) over the past 30 years.

Habitat effects:

Pilbara	Moderate
Kimberley	Low

Pilbara

Direct impacts to the habitat are limited to those of the Pilbara Fish Trawl Fishery, which is restricted to less than 7% of the North West Shelf (North Coast Figure 1). Area 3

NORTH COAST BIOREGION

and the waters inside 50 m are permanently closed to fish trawling, Zone 1 is closed to fish trawling, and Area 6 has had no fish trawl effort allocation since 1998.

Within the areas actually trawled, past research has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) are detached per year. It is not known whether the detachment rate exceeds the rate of re-growth. Considering effort for the trawl fishery is at historically low levels, the effective area trawled within the managed areas has been greatly reduced.

Kimberley

As a result of the gear design, the fishery has little impact on the habitat overall, although there may be some rare interactions with coral habitats which are not common in areas where the fishery operates.

Pilbara: The performance measure for the fish trawl impact on the North West Shelf habitat was set as a maximum area of operation by the trawlers. With the current closures within the licensed area of the fishery (50 m to 200 m depth), 46% of the area is accessible to the trawl vessels. Plots of trawl activity from VMS data indicate the actual area trawled is significantly less than this.

Social Effects

Pilbara

It is estimated that 14 fishers on 3 vessels were directly employed during 2011 in the Pilbara Fish Trawl Fishery, and 8 fishers on 3 vessels in the Trap Fishery, and at least 21 fishers on 7 vessels in the line fishery. Overall, at least 41 people were directly employed in the Pilbara Demersal Scalefish Fisheries.

This fishery supplies significant amounts of fish to Perth, with catches from the Pilbara fisheries dominating the Perth metropolitan markets and supporting the local fish-processing sector. The exports from this fishery have been minimal in the last few years due to the increased value of the Australian dollar.

Kimberley

Seven vessels fished in the 2011 fishing season, with approximately three crew per vessel, indicating that at least 21 people were directly employed in the NDSF. Approximately half the fish from this fishery are supplied to Perth metropolitan markets, while the other half are supplied to east coast metropolitan markets.

Economic Effects

Estimated annual value (to fishers) for 2010-11:

Pilbara Level 3 - \$5 - 10 million

Kimberley Level 3 - \$5 - 10 million

The value of each of the North Coast Demersal fisheries is reported using the 6 categories defined in Fletcher et al. (2010) that are used to assess the relative economic (based on gross value product, GVP) and social amenity value associated with each ecological asset. These values are based on GVP figures derived from the 2010-2011 financial year.

Pilbara

The fish trawl demersal finfish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its score value in 2010-11 was estimated to be 2 (i.e. Risk level – Low; Economic value – \$1-5 million; Social amenity definition – Some, the asset may be caught recreationally and/or there is some specific interest in the asset by the broader community). The fish trap and line catches are dominated the valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was estimated to have a score value in 2010-11 of 2 (fish trap; i.e. Risk level – Low; Economic value – \$1-5 million; Social amenity definition – Some, the asset may be caught recreationally and/or there is some specific interest in the asset by the broader community) and 1 (line; i.e. Risk level – Negligible; Economic value – < \$1 million; Social amenity definition – Minimal, there is no recreational fishing for the asset and no specific broader community interests), respectively.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery's score value in 2010-11 was estimated to be 3 (i.e. Risk level – Moderate; Economic value – \$5-10 million; Social amenity definition – Important, this is an important asset locally and/or the use or existence of the asset is important to the broader community).

Fishery Governance

Target commercial catch range:

Pilbara Fish Trawl 2,000–2,800 tonnes

Pilbara Fish Trap 400–500 tonnes

Pilbara Line 50–115 tonnes

Kimberley (NDSF) 600–1000 tonnes (All Zones)

Current Fishing (or Effort) Level

Pilbara

Trawl Fishery Acceptable

Trap Fishery Acceptable

Line Fishery Acceptable

Kimberley Acceptable

Pilbara

In the Fish Trawl Fishery, the total catch was still well below the target catch range continuing a trend of the last four seasons. Considering that; 1) catch rates of indicator species are increasing or stable since effort reductions; 2) effort within the trawl fishery is currently at historically low levels; and 3) results from a higher level fishing mortality-based stock assessment and ecosystem based ecological assessment will be available in 2013 and 2014; current levels (2011) of effort and catch in the Pilbara fish trawl fishery are considered to impose a moderate risk for stock sustainability for the Pilbara Demersal Scalefish resource.

In the fish trap fishery, the total catch was within the target catch range in 2011. The line catch was at the upper limit of the acceptable catch range in 2011.

Kimberley

For the 2011 calendar year, the total allowable effort was set at 986 standard fishing days in Zone B, and 616 standard fishing days in Zone A, of the fishery respectively. The Zone A allocation aims to facilitate the exploration and development of this area of the fishery, while there is also further scope for fishers to develop Zone C (the deep slope area). At these levels of total effort and at recent catch rates, the total catch of the fishery is expected to be in the range of 600–1,000 t. The 2011 catches were marginally above the reported range. However, given the recent increases in fishing effort in Zone A, there is a need to review the target catch range for this fishery.

In addition to the overall catch target, ESD performance measures state that the annual catch of each of the key target species/groups (red emperor, goldband snapper and the cod/grouper complex) taken by the fishery should not increase by more than 20% above the average for the previous four years. Of the key target species/groups, the 2011 catch of goldband snapper and the cods/groupers complex were above the average of the previous four years, but did not exceed the ESD performance measure, while the red emperor catch remained significantly below the trigger level. Several different scenarios could explain the increased catches of goldband snapper in recent years and the validity of each of these scenarios should be resolved with the collection of the next representative age sample.

New management initiatives (2011/12)

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was recently extended to 30 June 2013. The extension was provided to allow for the implementation of the Fisheries Research and Development Corporation (FRDC) Project 2008/048 *Reducing dolphin bycatch in the Pilbara finfish trawl fishery* recommendations, being; 1) the need for further net modifications, i.e. the installation of top opening escape hatches, to potentially further reduce dolphin capture rates; and 2) observer coverage combined with deployment of net-mounted video cameras in underwater housings for the trials, to be assessed. Following this, assessment regarding the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the Fishery to “managed” Fishery status will be carried out.

Kimberley

There is a need to incorporate the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF into the management plan. The Department continues to consider projects related to the outcomes of the Prescott Review in consultation with licensees.

External Factors

The Commonwealth’s North-west Marine Bioregional Plan incorporates the aim of introducing marine reserves, which are likely to contain areas closed to fishing. This has the potential to restrict access to fishing in parts of the North Coast Bioregion to all sectors, i.e. commercial, recreational and charter.

Under the Offshore Constitutional Settlement, commercial trawl vessels licensed by the Commonwealth may operate in waters outside of a line that is meant to represent the 200 m isobath as part of the North West Slope Trawl Fishery (NWSTF). However, as this line encompasses waters in Zone B of the NDSF, any future catches by Commonwealth trawl vessels in the these waters that are shallower than 200 m will impact on the demersal fish resources of the NDSF.

Climate change and climate variability has the potential to impact fish stocks in a range of ways including influencing their geographic distribution (e.g. latitudinal shifts in distribution). However, it is unclear how climate change may affect the sustainability risk to North Coast demersal fisheries.

Pilbara

The available fishing area has decreased slightly over recent years as a result of exclusion zones for gas pipelines and associated facilities. Seismic surveys also restrict the operation of fishers. However, there is little information as to the impacts and therefore the risks from seismic operations on demersal scalefish.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as target species are long-lived and inter-annual variability is likely to be ‘smoothed’. Some commercial fishers within the fishery have raised concerns about the increasing numbers of charter vessels operating in the offshore waters of the NDSF, which could generate resource-sharing issues in the future. In addition, offshore developments in the energy/gas industry may involve exclusion zones thus potentially limiting fisher access to some areas of the fishery. Increasing development of the Kimberley region is also likely to see a marked increase in the recreational effort and this may impact on stock sustainability. The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2011 (estimates rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	152	68%	71	32%	-	-	223
Crimson snapper	<i>Lutjanus erythropterus</i>	130	70%	49	26%	6	3%	185
Rosy threadfin bream	<i>Nemipterus furcosus</i>	79	99%	1	1%	-	-	80
Brownstripe emperor	<i>Lutjanus vitta</i>	63	77%	19	23%	-	-	82
Goldband snapper	<i>Pristipomoides multidens</i>	56	37%	74	49%	20	13%	150
Red emperor	<i>Lutjanus sebae</i>	54	46%	62	53%	2	2%	118
Saddletail snapper	<i>Lutjanus malabaricus</i>	43	66%	16	25%	6	9%	65
Spangled emperor	<i>Lethrinus nebulosus</i>	18	39%	20	43%	8	17%	46
Frypan snapper	<i>Argyrops spinifer</i>	30	94%	2	6%	-	-	32
Rankin cod	<i>Epinephelus multinotatus</i>	12	15%	60	77%	6	8%	78
Ruby snapper	<i>Etelis carbunculus</i>	-	-	-	-	30	100%	30
Other demersal scalefish		448	79%	85	15%	34	6%	567
All demersal scalefish		1,085	66%	459	28%	112	7%	1,656

NORTH COAST TABLE 2

Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl in the Pilbara fishery, as well as by-product from the fish trawl fishery for the past decade.

Year	Demersal Scalefish				By-product*
	Line	Trap	Trawl	Total	Trawl
2002	90	306	2,310	2,706	180
2003	81	363	2,860	3,304	154
2004	240	395	2,837	3,449	113
2005	260	408	2,371	3,005	80
2006	105	473	2,222	2,800	46
2007	102	460	1,704	2,266	36
2008	86	508	1,210	1,804	37
2009	123	455	1,044	1,622	37
2010	117	489	1,259	1,865	32
2011	112	459	1,085	1,656	18

* By-product in 2011 consists mainly of bugs, cuttlefish, and squid.

NORTH COAST TABLE 3

Summary of the fishing effort in the Pilbara Demersal Scalefish Fisheries for the past decade. The trap, line and trawl effort (days) are derived from monthly catch and effort returns. The trawl effort (hours) is nominal effort from operators' logbook data.

Year	Line (days)	Trap (days)	Trawl (days)	Trawl (hours)
2001	401	446	1,162	15,330
2002	660	418	1,035	14,830
2003	715	412	1,014	14,663
2004	816	418	953	15,372
2005	993	425	886	14,721
2006	418	467	914	15,792
2007	344	429	841	14,197
2008	278	428	831	11,966
2009	282	483	713	10,605
2010	366	472	659	9,723
2011	376	420	545	7,338

NORTH COAST TABLE 4

Estimates of fishing mortality (F) relative to Exploitation Reference Points (ERPs) calculated for each of the indicator species collected in different management areas of the commercial trawl and trap fisheries in the Pilbara region from 2006 to 2008. ns = not sampled.

Indicator species	Year	Trawl area (Zone 2)				Trap
		1	2	4	5	
Red emperor	2007	$F > F_{\text{limit}}$	$F > F_{\text{limit}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F_{\text{limit}} > F > F_{\text{threshold}}$
Rankin cod	2006	$F = F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	$F = F_{\text{threshold}}$	$F < F_{\text{target}}$
Goldband snapper	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	$F < F_{\text{target}}$	$F < F_{\text{target}}$	$F_{\text{threshold}} > F > F_{\text{target}}$	ns
Bluespotted emperor	2008	$F_{\text{threshold}} > F > F_{\text{target}}$	ns	ns	ns	ns

NORTH COAST TABLE 5

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2011.

	Number released Alive	Number deceased*	Total Reported
Bottlenosed dolphins	2	16	18
Pipefish	21	32	53
Green sawfish	6	0	6
Narrow sawfish	36	1	37
Seahorses	0	1	1
Sea-snakes	58	7	65
Turtles	8	0	8

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST TABLE 6

Recent total annual catches of major target and by-product species or species groups across all zones in the NDSF.

Species	NDSF annual catch (tonnes)						
	2005	2006	2007	2008	2009	2010	2011
Goldband snapper (<i>Pristipomoides spp.</i>)	429	336	405	457	485	523	487
Red emperor (<i>Lutjanus sebae</i>)	192	166	179	173	156	141	128
Saddletail snapper (<i>Lutjanus malabaricus</i>)	92	79	99	104	108	125	87
Spangled emperor (<i>Lethrinus nebulosus</i>)	21	28	15	18	23	30	20
Cod/grouper (Epinephelidae)	110	129	126	148	142	153	155
Other species	78	63	107	110	132	144	161
Total demersal scalefish catch	922	801	933	1010	1046	1116	1037

NORTH COAST TABLE 7

Catches of major target and by-product species or species groups by zone in the NDSF in 2010 and 2011.

Species	NDSF annual catch (tonnes)			
	2010		2011	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	29.5	493.1	13.1	473.7
Red emperor (<i>Lutjanus sebae</i>)	41.1	100.4	38.8	88.8
Saddletail snapper (<i>Lutjanus malabaricus</i>)	21.0	104.6	12.5	74.8
Spangled emperor (<i>Lethrinus nebulosus</i>)	3.5	26.4	1.9	17.8
Rankin cod (<i>Epinephelus multinotatus</i>)	16.0	33.0	17.8	23.4
Other Cods/groupers (Epinephelidae)	23.2	80.7	25.2	88.9
Other species	65.0	78.7	78.7	81.9
Total demersal scalefish catch	199	917	188	849

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF for the past decade.

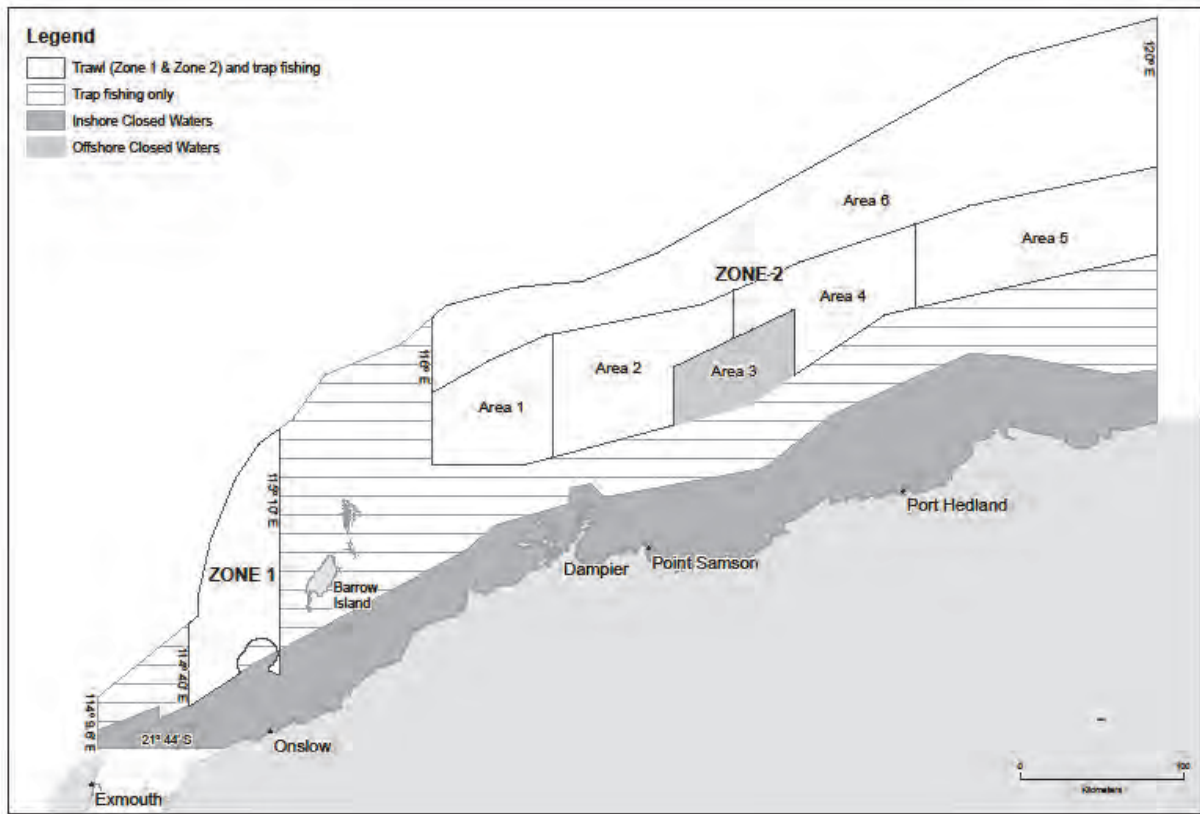
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	0	0	933	1,235#	933
2008	1,144*	7	0	1,003	1,150#	1,010
2009	1,144*	0	0	1,046	1,090#	1,046
2010	1,038*	0	0	1,116	1,178#	1,116
2011	986*	0	0	1,037	1,042#	1,037

(* = TAE is for B Zone only; # = total effort is from all zones; 2011 Estimated Catch: Zone A = 188 t, Zone B = 849 t; 2011 Estimated Effort: Zone A = 163 SFDs, Zone B = 879 SFDs)

NORTH COAST TABLE 9

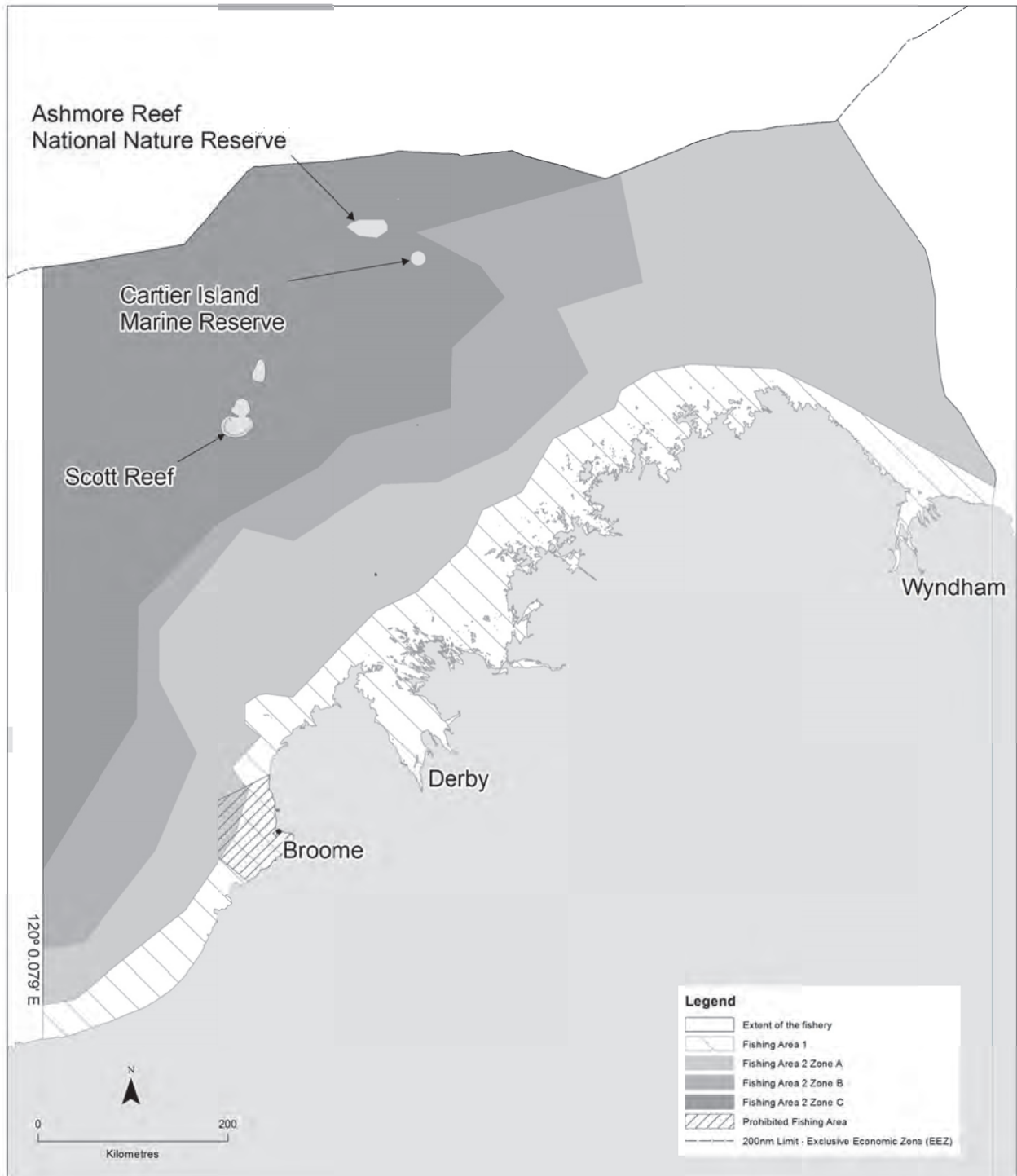
Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast bioregion in 2011.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch
	tonnes	%	tonnes	%	tonnes
Red emperor	118	48	127.6	52	245.6
Saddletail snapper	65	43	87.3	57	152.3
Crimson snapper	185	80	45.2	20	230.2
Brownstripe snapper	82	96	3.0	4	85
Goldband snapper	150	24	486.7	76	636.7
Spangled emperor	46	70	19.6	30	65.6
Bluespotted emperor	223	85	38.3	15	261.3
Rankin cod	78	65	41.2	35	119.2
Frypan snapper	32	97	<1	3	33
Rosy threadfin bream	80	99	<1	1	81
Other demersal scalefish	567	75	187	25	754
Total all demersal scalefish	1656	61	1037	39	2693



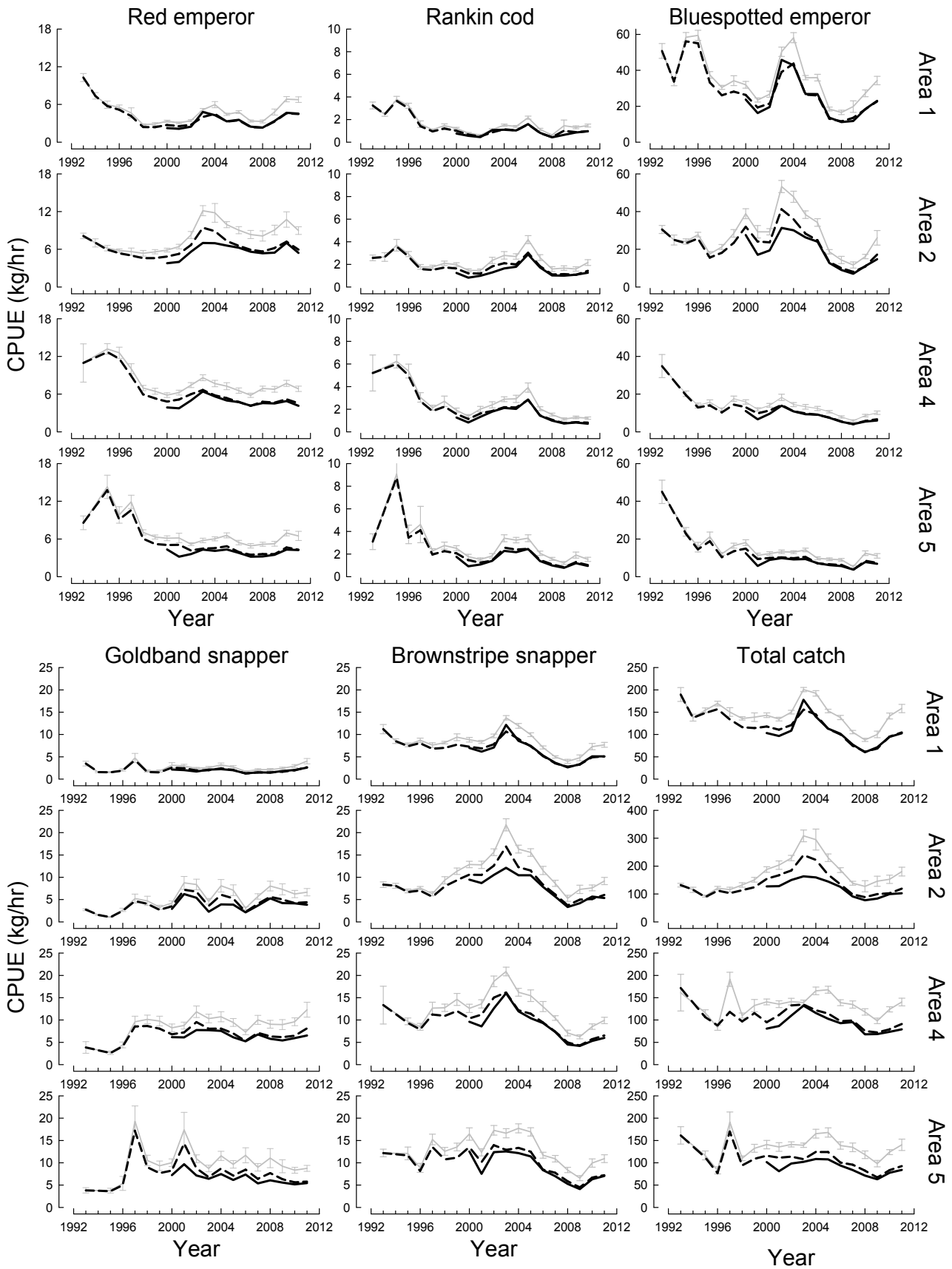
NORTH COAST FIGURE 1

Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6 refer to the management regions in Zone 2 of the trawl fishery. Zone 1 has been closed to trawling since 1998.



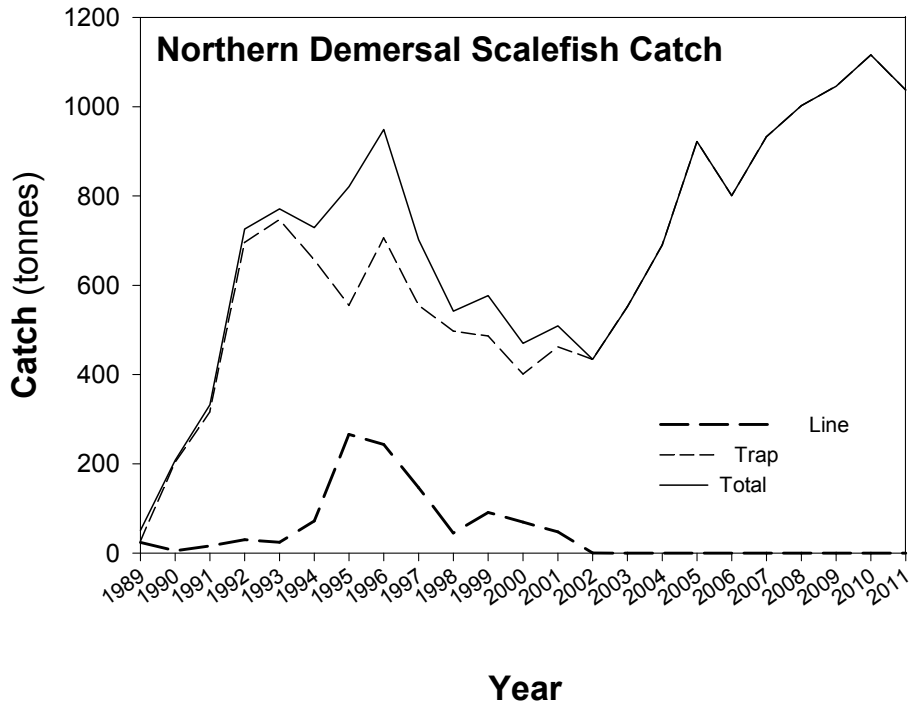
NORTH COAST FIGURE 2

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



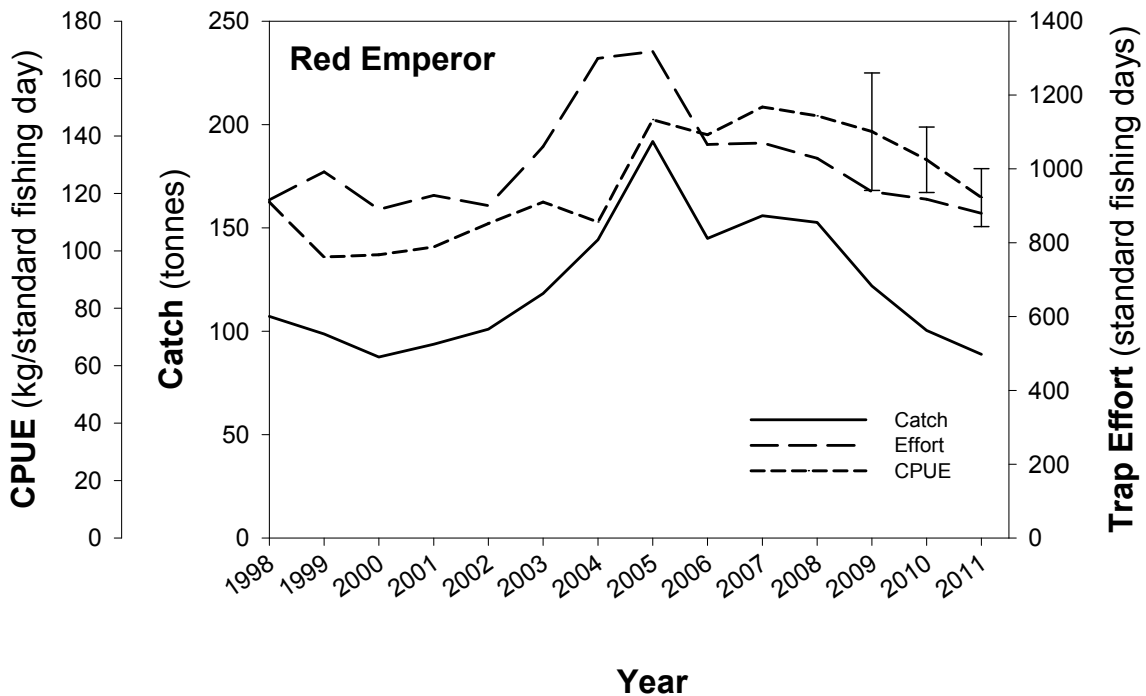
NORTH COAST FIGURE 3

Annual mean Catch Per Unit Effort (CPUE, kg/hour) for five indicator species and the total catch in Areas 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1993–2011. The solid grey line is nominal catch rate (± 1 se) with trawl time as the effort measure, the dashed grey line is catch rate incorporating efficiency increase (trawl time as the effort measure) and the solid black line is catch rate using the time spent in each area as the effort measure (derived from VMS, data available since 2000).



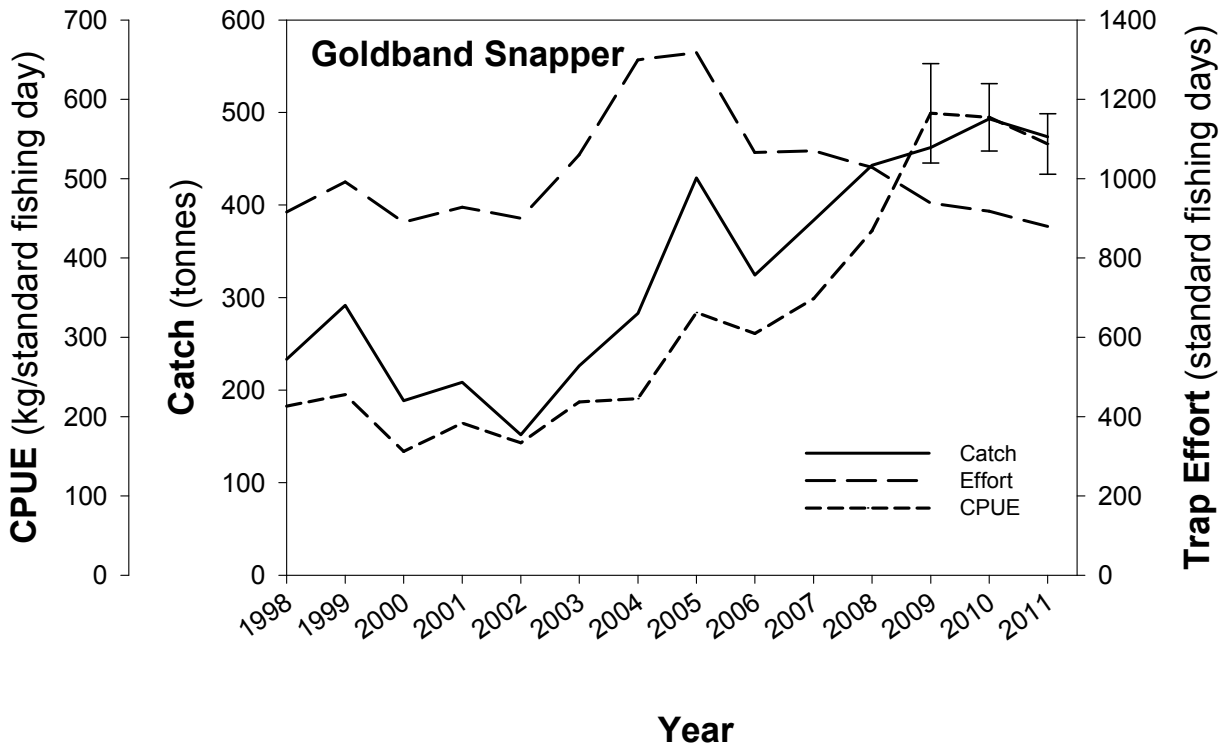
NORTH COAST FIGURE 4

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2011 (All Zones).



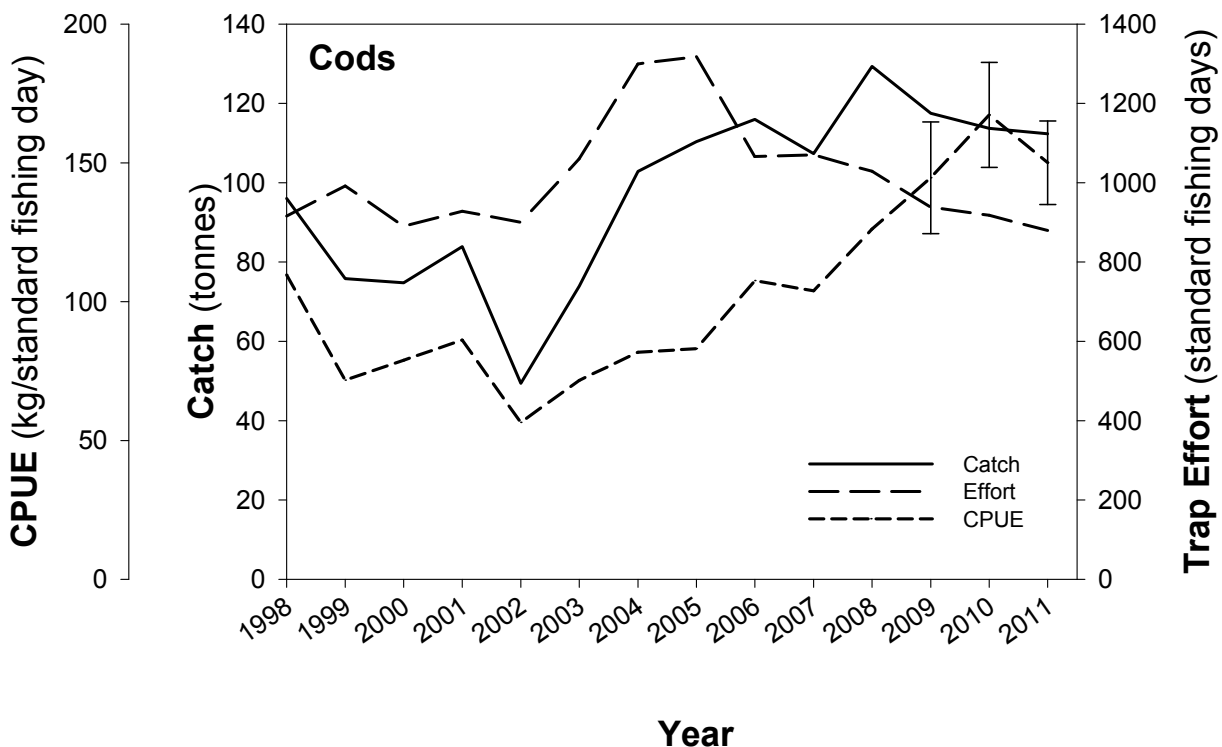
NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2011 (2006-2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010-11).



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2011 (2006-2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010-11).



NORTH COAST FIGURE 7

Catch, effort and catch per unit of effort of cod/grouper in the NDSF by trap, 1998–2011 (2006-2011 for Zone B only, catches represent total landings in B Zone, whereas effort and CPUE are determined from commercial vessel activity only). Standard error bars illustrate variability in CPUE from the two sources of catch returns since 2009, and variability in trip CPUE data from daily log books (2010-11).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, E. Lai and J. Wakefield

Fishery Description

Commercial

The Mackerel Fishery uses near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel (*Scomberomorus commerson*). Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.

Recreational

Recreational fishers target similar species using a range of gears including trolls, shore-based drift fishing with balloons and spear guns.

Boundaries

Commercial

The Fishery extends from the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Catches are reported separately for three Areas: Area 1 - Kimberley (121° E to WA/NT border); Area 2 - Pilbara (114° E to 121° E); Area 3 - Gascoyne (27° S to 114° E) and West Coast (Cape Leeuwin to 27° S) (Spanish Mackerel Figure 1).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

An Interim Management Plan was implemented for the Mackerel Fishery in August 2004, with fishing commencing under the plan in 2005. An Individual Transferable Quota (ITQ) system was introduced including setting Total Allowable Commercial Catches (TACCs) for each Area of the Fishery, allocation of the entitlement to take quota in the form of units, and establishment of minimum unit holding requirements to operate in the Fishery.

The maximum quantity of mackerel that may be taken from each Area of the Fishery during any permit period is limited to the quantity of mackerel determined by the Director General. The TACC for each Area of the Fishery for 2011 was:

	Spanish and other mackerel	Grey mackerel
Area 1:	205 t	60 t
Area 2:	126 t	60 t
Area 3:	79 t	60 t

The Plan includes limitations on the number of permits to fish in the Fishery and the type of gear that can be used. Boats operating in the Fishery are monitored by VMS and the master of an authorised boat is required to submit logbook

returns and catch and disposal records. Seasonal closures were removed in May 2008, as they were no longer a necessary tool to maintain sustainable and efficient management of the Fishery after quotas were put in place in 2006.

Permit holders may only fish for mackerel by trolling or handline. There are currently 65 permits in the Fishery with 23, 21 and 21 permits in Areas 1, 2 and 3 (respectively), with the combined quota allocations being consolidated onto 4, 3 and 9 boats operating within Areas 1, 2 and 3 (respectively).

A comprehensive ESD assessment of this Fishery determined that levels of Spanish mackerel breeding stock should be used as an annual performance measure for the Fishery. In November 2009, the Fishery was exempt from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of five years.

Landings and Effort (Season 2011)

Spanish mackerel	284.4 tonnes
Grey mackerel	13.4 tonnes
Other mackerel	0.7 tonnes

Commercial

The majority of the catch is taken in the Kimberley Area, reflecting the tropical distribution of mackerel species (Spanish Mackerel Figure 2). Estimates of catches are monitored through mandatory logbook systems with the total catch of Spanish mackerel in the 2011 season estimated at 284.4 t, similar to the total Spanish mackerel catch taken in previous years (2009: 284.2 t; 2010: 283.6 t) but lower than the peak catches in the early 2000s. Reductions in total catches since the early 2000s reflect reductions in fishing effort across all Areas with the highest effort reductions occurring in the Gascoyne Coast Bioregion.

A total of 14.1 tonnes of other mackerel were landed in the 2011 season, including 13.4 t of grey mackerel. The catch of grey mackerel in 2011 was the highest since 2006 but remains well below the TAC and the historical high catches of 'other mackerel' recorded in the late 1980s and 1990s.

All estimates reported do not include fish caught and released or lost to sharks.

Recreational

Catch estimates and resource sharing by this sector are currently only available through creel surveys which have occurred periodically (Spanish Mackerel Table 1). Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor. Anecdotal reports from recreational fishers indicated a higher than usual abundance of Spanish mackerel in the lower West Coast Bioregion during 2011. This is likely to be associated with a marine heat wave event that occurred during this period. New estimates of recreational catches will be available in late 2012.

Fishery Governance

Target commercial catch range (TACC):

246 – 410 tonnes

The total catch in 2011 of 284.4 t was within the acceptable catch range. The reported catch from the Kimberley Area of 182.7 t was within the Area's acceptable catch range (110 – 205 t), and within the range reported since 2005. Catches in the Pilbara Area have been relatively stable since 2006 and the 2011 catch of 54.8 t was below the acceptable range (80 – 126t). Catches from the Gascoyne/West Coast Area in 2011 were 46.8 t, below the acceptable range of 56 – 79 t but similar to the range of catches from this Area since 2004. A review of the acceptable catch ranges and the TACC has been discussed at annual management meetings for this fishery.

Current Fishing (or Effort) Level: **Acceptable**

Fishing effort throughout the Fishery has broadly stabilised since 2006 following reductions due to management changes. This is reflected by stable or increasing catch rates in all three Fishery Areas (Spanish Mackerel Figure 2). The 2011 catch rate in Area 1 (Kimberley) reverses the trend of recent years. This may be due to changes in biomass distribution and

availability of Spanish mackerel in this management Area due to oceanographic conditions (e.g. the influence of the marine heat wave of 2010/11).

The performance measure set for the Fishery is the status of the Spanish mackerel spawning stock. As the minimum legal size of 900 mm total length is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. In this context, catch rates across the major areas of the Fishery are a general indicator of breeding stock levels.

Additionally, the total catches of Spanish mackerel remain within the target range. The total catch for this Fishery has remained within the acceptable catch range since 1991.

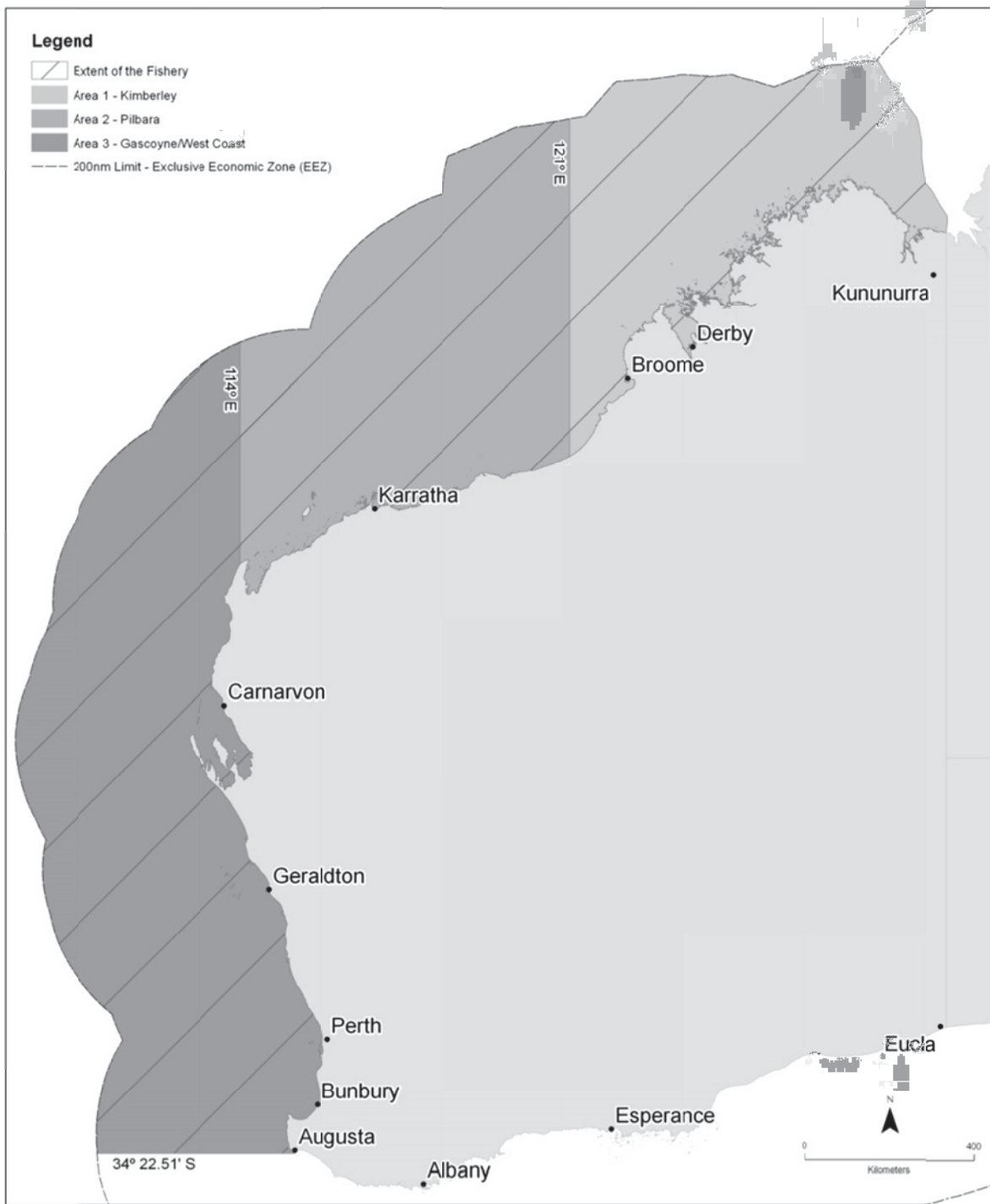
New management initiatives (2011/12)

The Mackerel Fishery (Interim) Management Plan 2005 expired on 31 December 2011 and was replaced by the Mackerel Managed Fishery Management Plan on 1 January 2012. Permit holders in the interim fishery were eligible for the grant of a Managed Fishery Licence under the new Plan. There are currently 49 fishing units in the Fishery with 15, 16 and 18 in Areas 1, 2 and 3 (respectively).

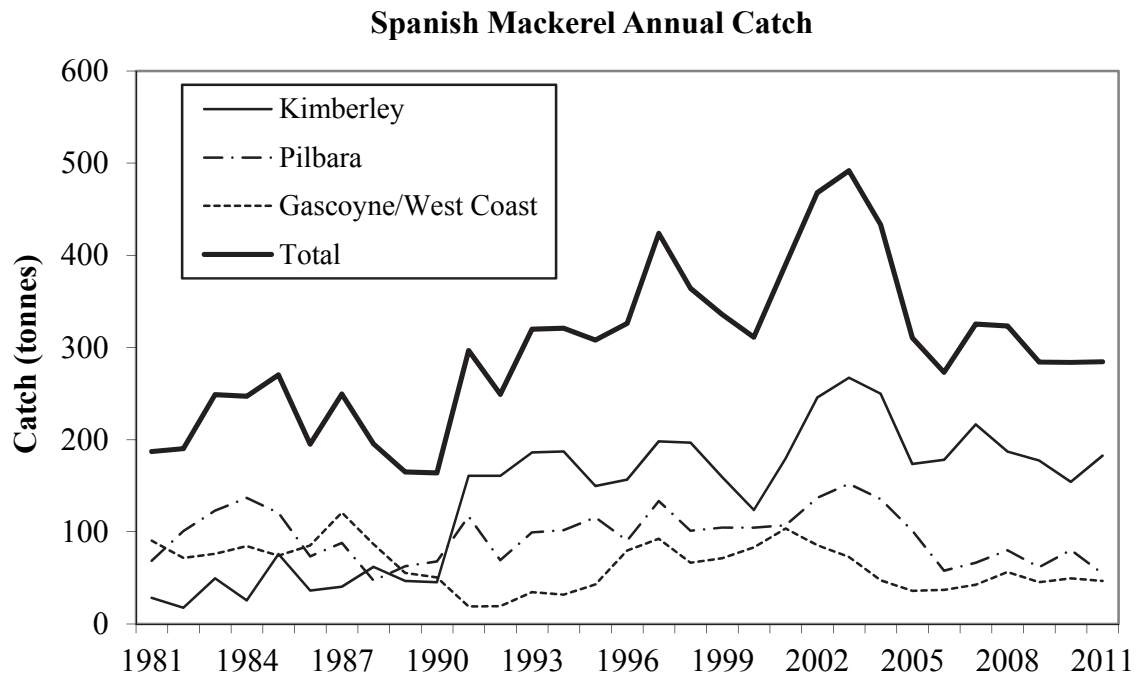
SPANISH MACKEREL TABLE 1

Recreational catch estimates of Spanish mackerel in Western Australia

Bioregion	Year	Retained catch	Share	Source
Pilbara (including Broome)	1999/2000	Spanish: 28 t Other: 11 t	21 % 15 %	Williamson et al. (2006)
Gascoyne	1998/1999	Spanish: 48 t Other: 8 t	42 % 10 %	Sumner et al. (2002)
West Coast	2005/2006	Spanish: 7 t Other: <1 t	45 % < 3 %	Sumner et al. (2008)

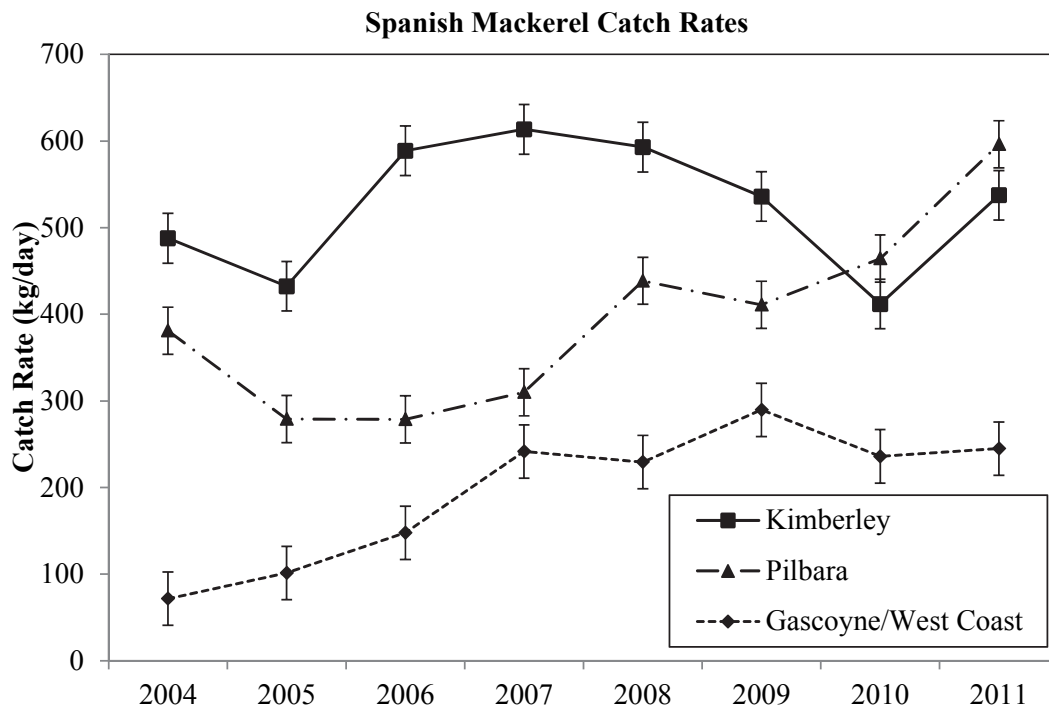


MACKEREL MANAGED FISHERY FIGURE 1
Map of the extent of the Mackerel Managed Fishery.



SPANISH MACKEREL FIGURE 2

Annual catches of Spanish mackerel in Western Australia, 1979–2011. Note: new management arrangements began in 2005 and quotas were introduced in 2006.



SPANISH MACKEREL FIGURE 3

Annualised catch rates of Spanish mackerel in Western Australia derived from daily logbooks, 2004–2011.

Northern Shark Fisheries Status Report

R. McAuley and F. Rowland

Main Features			
Status		Current Landings	
Stock level		Total sharks (2010/11)	0 t
Sandbar shark	Inadequate	Total scalefish (2010/11)	0 t
Blacktip sharks	Adequate	Shark catches by other commercial Fisheries (2010/11)	1t
Fishing Level	Acceptable	Recreational	Not assessed
	(potentially unacceptable)	Charter	Not assessed

Fishery Description

The 'northern shark fisheries' comprise the state-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley. Historically, the primary fishing method employed in these fisheries was demersal longlining with a relatively small amount of pelagic gillnetting in the JANSF. The northern shark fisheries have targeted various species since fishing commenced in 1994, including sandbar (*Carcharhinus plumbeus*), blacktip (*Carcharhinus* spp.), tiger (*Galeocerdo cuvier*), hammerhead (Sphyrnidae) and lemon sharks (*Negaprion acutidens*). Due to the small number of vessels authorised to fish in the northern shark fisheries and the commonality of gear-types and target species, data from the two fisheries are combined and they are considered as a single fishery for reporting purposes. As there was no reported fishing activity in the northern shark fisheries during 2009/10 or 2010/11, much of the following report is based on assessment of fishing returns submitted between 2006/07 and 2008/09. However, as only a few vessels reported fishing during those three years, annual catch and effort statistics cannot be reported separately and have been combined to ensure individuals' fishing activities cannot be identified.

Governing legislation/fishing authority

Fisheries Notice no. 476

Fisheries Notice no. 602

Fisheries Notice no. 601

Condition 127 and 129 on a Fishing Boat Licence

Other written authorities

Ministerial Exemption (WANCSF)

Consultation processes

WA Fishing Industry Council / Northern Shark Industry Association meetings.

Boundaries

The WANCSF extends from longitude 114°06' E (North West Cape) to 123°45' E (Koolan Island), and the JANSF from longitude 123°45' E to the WA/NT border (Northern Shark Figure 1).

Management arrangements

The commercial take of shark in northern Western Australian waters east of 123°45' E longitude is jointly managed by the Commonwealth Government and the State of Western Australia under an arrangement agreed through the Offshore Constitutional Settlement in February 1995. Under this arrangement, the State was given management responsibility for the JANSF on behalf of the WA Fisheries Joint Authority, whose members include the State and Commonwealth Ministers for Fisheries. Permitted fishing methods are demersal longlines and gillnets.

The solely Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order under the *Fish Resources Management Act 1994* in 2005. Those subsequently permitted to fish in the WANCSF were restricted to approximately 40% of the fishery's previous area under a Ministerial Exemption. This exemption entitles the use of longlines with metal snoods and pelagic gillnets. Longlines are restricted to a maximum of 1,000 hooks and gillnets are limited to 2 kilometres maximum length, 160 – 185 mm stretched mesh size, and a maximum drop of 100 meshes. Additionally, gillnets must be attached to vessels at all times and may not come into contact with the seabed.

The WANCSF is now effectively zoned into three areas with separate levels of access. The area between North West Cape and a line of longitude at 120° E and all waters south of latitude 18° S has been closed indefinitely, primarily to protect the breeding stock of sandbar sharks. Operators are only allowed to fish in the area between 16° 23' S and 18° S latitude between 1 October and 31 January. Operators are allowed to fish in the remaining area (north of 16° 23' S latitude and between 120° and 123° 45' E longitude) throughout the year. A total of 200 gillnet fishing days and 100 longline fishing days are permitted in the WANCSF,

with no more than 100 of those days allowed in the southern area (i.e. between 16° 23' and 18° S latitude). All vessels operating in the WANCSF are required to report fishing activities via the Vessel Monitoring System (VMS) and daily logbooks.

Formal management arrangements have not been implemented in the JANSF and management arrangements for this fishery (and the associated WANCSF) have been a matter of ongoing dialogue between the State and Commonwealth. In April 2008 the JANSF's export approval under the EPBC Act was revoked due to the lack of formal management arrangements and concerns about the fishery's ecological sustainability. In February 2009 the Wildlife Trade Operation approval that allowed the export of products from the WANCSF expired and therefore, no product from either fishery can currently be legally exported.

Given that the majority of income from these fisheries was historically generated by the export of shark fins, the ongoing economic viability of the northern shark fisheries is uncertain. The Department of Fisheries is currently reviewing future options for managing the WANCSF and is working with the Commonwealth Government to finalise management arrangements for the JANSF.

Research summary

Research to assess the status of northern shark stocks was initiated as an extension of research into the targeted shark fisheries operating in the South and West Coast Bioregions. A three-year FRDC-funded project that concluded in 2005 provided an age-structured demographic assessment of the status of the northern shark fisheries' then principal target species, the sandbar shark (*Carcharhinus plumbeus*) and an improved understanding of the fisheries and of northern shark stocks more generally. Additional information on these fisheries and others that take sharks as bycatch in the North Coast Bioregion was collected during a series of Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) and FRDC-funded research projects to assess sustainability risks to Australia's tropical sharks and rays. Results from those projects have provided risk assessments for 75 elasmobranch species caught by 29 fisheries operating across the northern half of Australia and concluded that numerous species taken in the WA northern shark fisheries were at high risk of unsustainable exploitation.

Demonstrating the ecological sustainability of the northern shark fisheries is dependent on establishing robust estimates of sustainable harvest levels for target, byproduct and bycatch species. In particular, issues associated with blacktip sharks, sandbar shark and mackerel sustainability, as well as Threatened, Endangered and Protected (TEP) species interactions with pelagic gillnets require evaluation. Further research to estimate key biological parameters and fishing mortality rates for these and other species is required before any robust assessment of the fisheries' ecological sustainability can be undertaken.

To improve understanding of the northern shark fisheries' operations, a new daily/trip catch and effort reporting system was introduced in 2006/07.

Retained Species

Commercial landings (season 2010/11)

Northern Shark Fisheries: 0 tonnes

Other Commercial Fisheries: 1 tonne

The Northern shark fishery has not operated since 2008/09 and the level of shark catch by other commercial fisheries in this bioregion is negligible.

Recreational catch estimate: Not assessed

Commercial Fishing effort/access level

There was no reported fishing effort in the northern shark fisheries in 2010/11.

Two or three vessels reported sporadic activity in the fisheries between 2006/07 and 2008/09, which amounted to approximately 47% of the fisheries' permitted longline effort and 3% of their permitted gillnet effort.

Stock Assessment

Assessment complete: Yes

Assessment level and method:

**Sandbar shark: Level 3 - Catch
(relative to previous direct survey)**

Blacktip sharks: Level 1 - Catch

Breeding stock levels:

Sandbar shark: Inadequate

Blacktip sharks:

Adequate (based on NT assessment)

For details of sandbar shark assessment, see Demersal Gillnet and Longline Fisheries Status Report.

The status of the multi-species northern Australian blacktip shark stock complex was previously assessed using an age-structured model and time-series of CPUE data from the various Australian and Taiwanese-operated fisheries that have targeted them since the 1970s. However, that assessment did not provide specific advice on the status of Western Australian stock components and the reliability of the catch, effort and biological data upon which the model relies is questionable. Assessing the status of these stocks is further complicated by the cryptic impacts of illegal foreign fishing, unreported catches in domestic fisheries and uncertainty in the species composition of the target fisheries' catches. While the NT assessment of blacktip sharks was this stock was at acceptable levels with a 2,000 tonne per year maximum sustainable yield, these results may be unreliable for the Western Australian blacktip stock.

Assessing the status of other North Coast bioregion shark stocks is also complicated by poor species identification in catch returns prior to 2000 and a general lack of basic biological information. Thus, monitoring the status of other northern shark stocks will remain limited to analyses of reported catches and catch rates from the target commercial fisheries and from a ten-year time series of fishery-independent survey data. Although between 2006/07 and

NORTH COAST BIOREGION

2008/09 the nominal commercial fisheries CPUE of tiger and hammerhead sharks were at their highest levels since the late 1990s, these rates were derived from relatively small catches and limited effort. Thus, previous declines of 78% and 84% in their respective CPUE between the late 1990s and mid 2000s, remain of concern.

Non-Retained Species

Bycatch species impact: Not fully assessed

There has previously been observed discarding of unsaleable sharks, rays and scatefish in these fisheries although the magnitude of this cannot be reliably estimated. Although risks to other scatefish species were previously rated as low to negligible during the ESD risk assessment process, these assessments will require reevaluation if levels of pelagic gillnet fishing effort escalate above historical levels.

Protected species interactions (Longline only)

The northern shark fisheries were rated as having a generally low risk of interacting with Threatened, Endangered and Protected (TEP) species through the ESD risk assessment process. However, as this assessment was based on the majority of fishing effort being applied by longlines, these interactions will need to be reassessed if levels of pelagic gillnet fishing effort escalate above historical levels. Previous ESD risk assessments for individual TEP species groups in the northern shark fisheries are discussed with reference to contemporary data below.

Sharks and rays: Because the northern shark fisheries generally operate some distance offshore, they pose a negligible risk to spartooth sharks (*Glyphis garricki* and *G. glyphis*) and sawfish (Pristidae), which have primarily inshore, estuarine and riverine distributions. The closure of the south western portion of the WANCSF is expected to reduce the risk of interactions with white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*), which have primarily temperate and sub-tropical distributions. Whale sharks (*Rhincodon typus*) are understood to spend the majority of their time feeding pelagically and are therefore unlikely to be caught by demersal longlines. However, the risk of entanglement in pelagic gillnets is uncertain.

Turtles: No turtle captures have either been observed or reported in the northern shark fisheries. Although turtles are possibly more susceptible to capture by pelagic gillnets than demersal longlines, the amount of active gillnet effort over the last several years has been small relative to the fisheries' operational area and historical levels of gillnet effort in the fisheries.

Billfish: The small observed bycatch of billfish by demersal longlines in the northern shark fisheries was assessed as being insufficient to impact breeding stocks. This level of bycatch is unlikely to increase given current restrictions on fishing effort.

Cetaceans: As almost all northern shark fishery effort prior to 2005/06 was applied by demersal longlines, the risk of interaction with cetaceans was previously assessed as negligible. Although potential increases in the use of gillnets may result in higher levels of interaction with cetaceans, there are no empirical data from domestic pelagic gillnet

fisheries to estimate cetacean capture rates. However, the bycatch of dolphins is cited as the primary reason for restricting the Taiwanese-operated pelagic gillnet fishery that operated in the same area during the 1970s and 1980s and the risk of cetacean interactions will need to be re-assessed should gillnet effort increase.

Ecosystem Effects

Food chain effects: Negligible

Given the relatively small shark catches intended under current effort restrictions, the associated risk of any detrimental food chain effects is likely to be negligible. However, given the long recovery times expected for overexploited stocks of long-lived sharks, such as sandbar sharks (and possibly other species, eg. tiger and hammerhead sharks), unassessed residual food chain effects may persist for decades. It may also be necessary to reassess this risk if higher levels of fishing effort resume in the future.

Habitat effects: Negligible

The principal types of fishing gear that may be used to target sharks in the region are set so that they either do not, intermittently or unintentionally come into contact with the seabed. The physical impact of these gear-types on the seabed is therefore considered to be minimal. Despite fishing being constrained to a reduced area in 2005, the concurrent reduction in overall effort capacity is likely to have reduced the risk of habitat effects further.

Social Effects

Direct: Northern shark fishing vessels reported crews of between 3 and 5 in 2008/09. However, as only two or three fishing vessels have operated for a few months each year, these fisheries represent a part time source of employment.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of recreationally prized fish. However, others consider them to be important components of marine ecosystems that need to be conserved.

Economic Effects

Estimated annual value (to fishers) for

2009/10 and 2010/11 nil

Fishery Governance

Target effort range:

600 gillnet days (1,200 kilometre gillnet days) maximum

300 longline days (300,000 hook days) maximum

Target catch range:

Sandbar sharks: < 20 tonnes

Current fishing (or effort) level:

Effort: Acceptable (2010/11)

Sandbar shark catch: Acceptable (2010/11)

There was no reported fishing effort in the northern shark fisheries in 2010/11 (or 2009/10).

Total fishing effort was significantly lower and more sporadic between 2006/07 and 2008/09 than prior to 2005/06 (Northern Shark Figure 2). The few vessels that have been active since 2005/06 reported using 516 (57%) of the 900 permitted longline fishing days and 59 (3%) of the permitted 1800 gillnet fishing days between 2006/07 and 2008/09. As operators generally reported using less than the maximum permitted amount of fishing gear (i.e. 1,000 longline hooks or 2,000 m of gillnet), 47% of the 900,000 permitted hook days and 3% of the 3,600 permitted km gillnet days were used during these three years.

Although total shark catches had declined significantly from their 2004/05 peak of 1,294 tonnes, the mean annual sandbar shark catch of 63 tonnes between 2006/07 and 2008/09 far exceeded the sustainable upper limit of 20 tonnes (Northern Shark Figure 2 and 3). As breeding biomass of the sandbar stock is likely to be at the minimal acceptable limit reference point (40% of unfished biomass) and possibly continuing to decline (see Demersal Gillnet and Longline Fisheries Status Report), the catches of this species by the northern shark fisheries were at unacceptable levels. With the fishery currently not operating, this would be assisting with breeding stock recovery.

New management initiatives (2011/12)

Future management arrangements for the JANSF and the WANCSF are the subject of continuing discussion between the State and Commonwealth Governments.

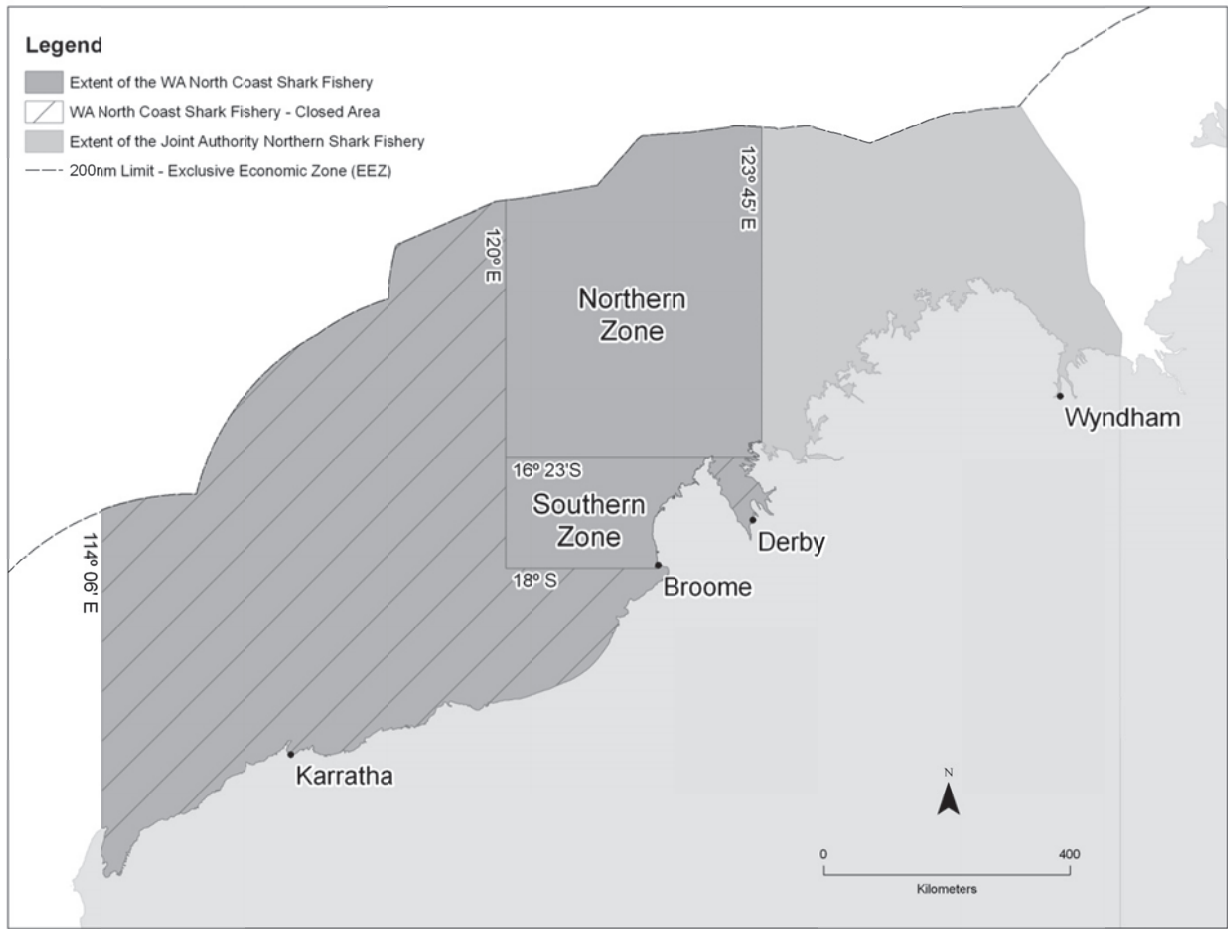
External Factors

The primary external factor affecting the northern shark fisheries is the withdrawal (JANSF) and expiry (WANCSF) of export approvals under the Commonwealth Government's EPBC Act. Development of demonstrably ecologically sustainable management arrangements required for the fisheries' re-approval is hampered by a lack of contemporary pelagic gillnet data in the North Coast Bioregion and other factors beyond the WA fisheries' control including: Illegal, Unregulated and Unreported (IUU) shark catches, cross-jurisdictional catches of target and byproduct stocks and long-term impacts on the breeding stock of sandbar sharks, the latter being critical to the sustainability of West Coast Demersal Gillnet and Demersal Longline Fishery catches (see Demersal Gillnet and Longline Fisheries Status Report)

NORTHERN SHARK TABLE 1

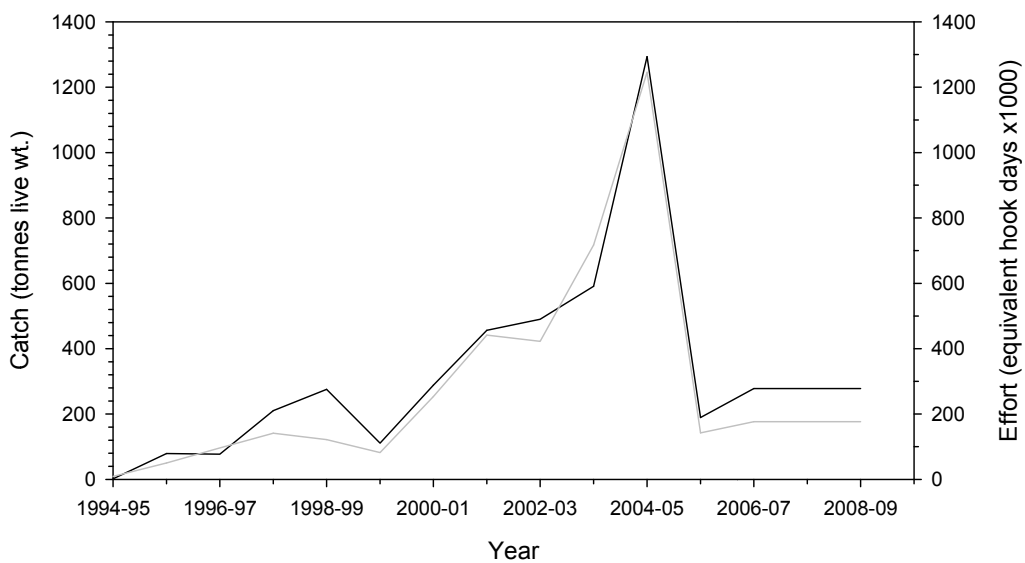
Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2006/07 to 2008/09. Data are amalgamated across these three years due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years.

Name	Species or taxon	2006/07 - 2008/09 catch (tonnes)	
		Total	Mean annual
Blacktip shark	<i>Carcharhinus</i> spp.	202.0	67.3
Sandbar shark	<i>Carcharhinus plumbeus</i>	188.5	62.8
Pigeye shark	<i>Carcharhinus amboinensis</i>	138.4	46.1
Tiger shark	<i>Galeocerdo cuvier</i>	103.1	34.4
Hammerhead sharks	Sphyrnidae	82.9	27.6
Lemon shark	<i>Negaprion acutidens</i>	45.4	15.1
Spot-tail shark	<i>Carcharhinus sorrah</i>	36.2	12.1
Dusky shark	<i>Carcharhinus obscurus</i>	10.4	3.5
Shovelnose rays	Rhinobatidae, Rhynchobatidae	8.5	2.8
Other elasmobranchs		18.9	6.3
Total elasmobranchs		834.4	278.1
Grey mackerel	<i>Scomberomorus</i>	6.2	2.1
Cod	Serranidae	1.3	0.4
Spanish mackerel	<i>Scomberomorus commerson</i>	0.6	0.2
Mackerel, other	Scombridae	0.3	0.1
Other scalefish	Teleostii	0.7	0.2
Total scalefish		9.1	3.0



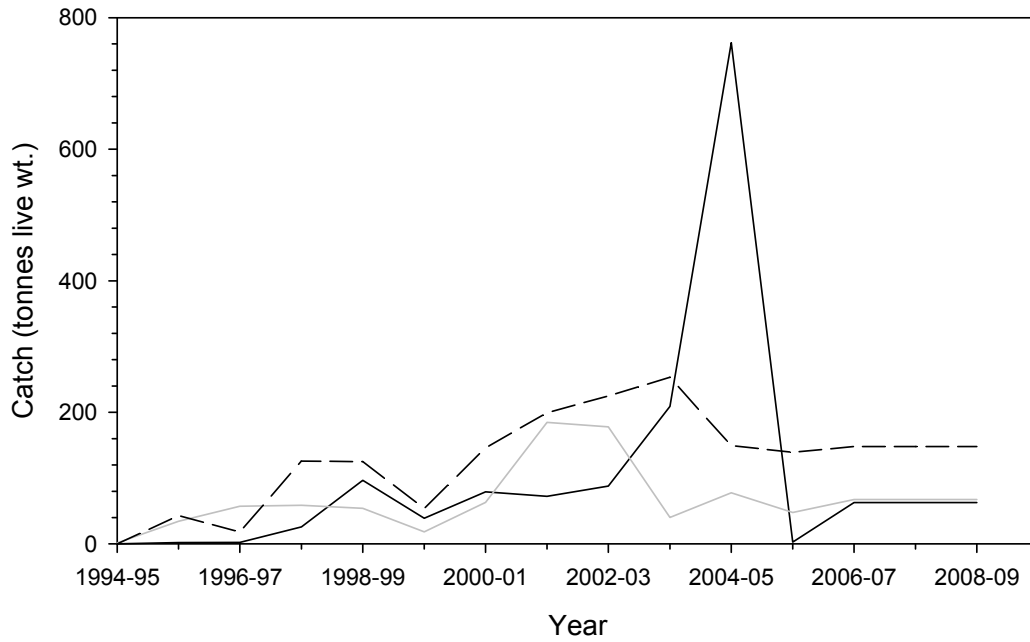
NORTHERN SHARK FIGURE 1

Management boundaries of the WA northern shark fisheries



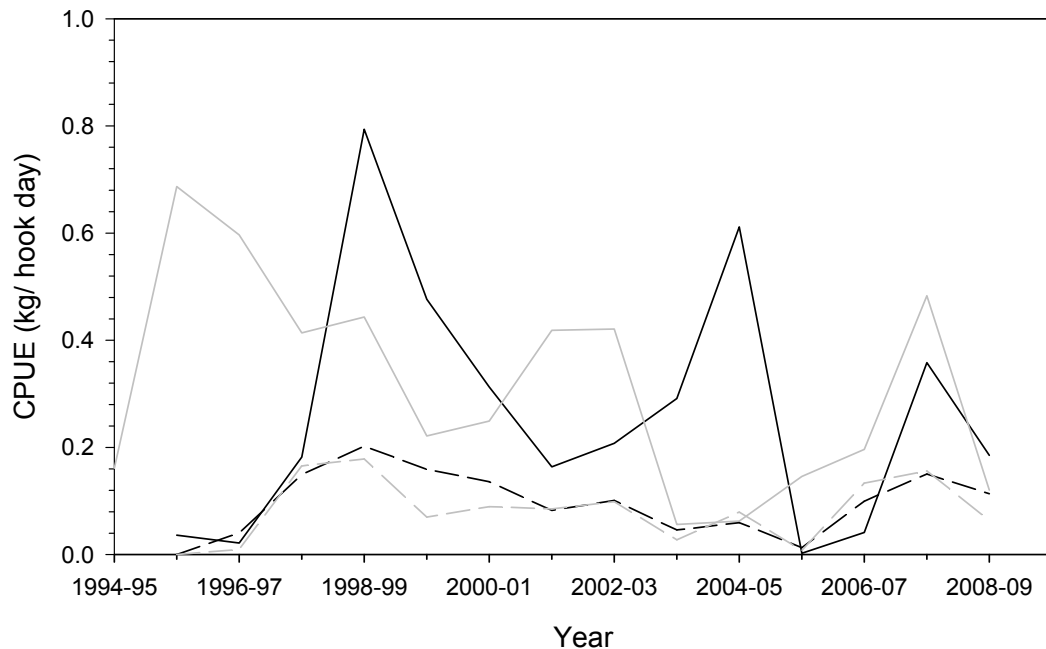
NORTHERN SHARK FIGURE 2

Total annual elasmobranch landings and standardised fishing effort (WANCSF and JANSF). Black line is catch (tonnes estimated live weight) and grey line is standardised total fishing effort (thousand hooks). Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years. There has been no effort or catches since 2009/10 in this fishery.



NORTHERN SHARK FIGURE 3

Annual catches (tonnes estimated live weight) of indicator and other shark species by the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2009/10. Solid black line is for sandbar shark, grey line is blacktip sharks and dashed black line is other sharks. Data from 2006/07 – 2008/09 have been averaged due to the confidentiality of records from the small number of vessels that were active in the fisheries in those years. There has been no effort or catches since 2009/10 in this fishery.



NORTHERN SHARK FIGURE 4

Nominal Catch Per Unit Effort (CPUE) of indicator and secondary target shark species in the northern shark fisheries. Solid black line is sandbar shark, solid grey line is blacktip sharks, dashed black line is tiger shark and dashed grey line is hammerhead sharks. There has been no effort or catches since 2009/10 in this fishery.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy and N. Moore

Main Features

Status

Stock level	Adequate
Fishing level	Acceptable

Current Landings

Commercial Pearl Oyster Catch	
Shell numbers (All Zones)	796,158 shells

Fishery Description

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the North-West Shelf.

The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal-sized oysters by hand as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*).

Governing legislation/fishing authority

Pearling Act 1990

Pearling (General) Regulations 1991

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

The Department undertakes consultation directly with licensees on operational issues. Formal licensee holder engagement is convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department.

Boundaries

The fishery is separated into 4 zones (Pearl Figure 1), as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30' E. There are 5 licensees in this zone.

Pearl Oyster Zone 2: East of Cape Thoun (118°20' E) and south of latitude 18°14' S. The 9 licensees in this zone also have full access to Zone 3.

Pearl Oyster Zone 3: West of longitude 125°20' E and north of latitude 18°14' S. The 2 licensees in this zone also have partial access to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20' E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.

There is also a 'buffer zone' between zones 1 and 2, which may be accessed by licensees from both Zones, although in practice, it is generally only utilised by Zone 1 licensees.

Management arrangements

The Western Australian pearling industry comprises three main components: the collection of pearl oysters from the wild; production of hatchery-reared pearl oysters; and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oysters from the wild to ensure the long-term sustainability of the resource.

In 1996 the WA Government granted hatchery options to licensees as part of an incentive program to encourage them to adopt new technology that enabled the production of pearls from oysters reared in hatcheries, thus reducing the reliance on the wild stocks of pearl oysters. Hatchery bred oysters are now a significant component of pearl production in Western Australia.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). There are 572 wild-stock ITQ units allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32) and 350 hatchery ITQ units allocated amongst 14 pearling licensees.

The value of a hatchery quota unit is 1,000 shell. The value of wild-stock quota units varies, depending on the status of wild stocks, but historically has been about 1,000 shell per unit when pearl stocks are at normal levels. However, wild stock quota units for Zone 2/3 for the 2011 season were set at 3,500 shell (TAC: 1,600,000), as result of high stock levels (Pearl Table 1).

Wild stocks are reviewed each year by the Department of Fisheries to enable the TAC to be set for each zone of the fishery. There is a new minimum legal size of 100 mm shell length; this is under trial for seasons 2011-2013. Historically the legal size limit has been 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate, for example in Exmouth Gulf in Zone 1.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of pearl oysters. Boxed text in this status report provides the annual assessment of performance for this issue.

NORTH COAST BIOREGION

Research summary

Current stock assessment research is focused on:

- Stock assessment using catch and effort statistics (taking into account discard rates), piggyback spat settlement (0+ and 1+) and length-frequency sampling to estimate the total allowable catch.
- Monitoring an index of settlement for predicting future years catch levels 4 – 6 years ahead using the relative number of piggy back spat.
- Research on decision rules for determining the TAC.
- Understanding environmental drivers of pearl oyster abundance.

The Department of Fisheries' Research Division's Fish Health Unit also provides a comprehensive disease-testing program to the industry.

There are several other significant research projects being carried out by the pearling industry focusing on environmental management, improved health and safety for pearl divers and pearl oyster health. The main aims of the pearl oyster health study are to:

- Investigate aspects of oyster oodema disease (OOD) in *Pinctada maxima*, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters.

Retained Species

Commercial landings (season 2011):

796,158 oysters

In 2011, the number of wild-caught pearl oysters was 796,158 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 1,600,000, thus only 50% of the TAC was caught, as this was the quantity required under market conditions. In comparison, only 397,947 oysters were caught in 2010. The increased take was due to continued improvement in economic conditions and return of buyers in the market after the Global Financial Crisis.

In 2011, only Zones 2 & 3 were fished (Pearl Table 1). The total of 796,158 shell includes 30,949 Mother of Pearl (MOP), which are the large oysters (>175 mm shell length). This represents a 144% increase on the quantity of MOP taken in 2010 (Pearl Table 1) and this is only the second time MOP have been caught since 1986. There has been no fishing in Zone 1 since 2008 (Pearl Table 2).

Fishing effort/access level

Total effort was 14,361 dive hours (Pearl Tables 1 and 2), an increase of 220% from the 2010 effort of 4,447 hours. Of this, 643 hours was applied to MOP diving.

Stock Assessment

Assessment complete: Yes

Assessment level and method Level 3

Catch rate predictions, standardised CPUE

Breeding stock levels: Adequate

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2011 fishing season based on catch and effort statistics, settlement analysis (64,406 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (12,100 shells measured), shell discard rates by size and location, population surveys, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

These were used to generate trends in stock indicators, from which the determination of the TAC for 2012 was undertaken and provided to the Stock Assessment Working Group (SAWG). The SAWG is a Department-Industry group that provides integrated advice to the Director General on the sustainable harvest of the pearl oyster resource. The results for each zone, and issues relevant to stock sustainability, were as follows:

Zone 2/3: The catch rate achieved by the fishery is an indicator of the abundance of the 3/4 to 6/7-year-old oysters specifically targeted for pearl production. Year-to-year variations reflect changes in recruit abundance, while the long-term trend in catch per unit effort (CPUE) involves an element of effort efficiency change. In 2011, CPUE was 55 shells per dive hour, a decline of 38% from 2010 (89 shells per dive hour), but this was the highest value since this time series began in 1979 (Pearl Table 1). Although the fishery maintained a relatively high CPUE in 2011 (the third highest), the decline indicates that stock levels are returning to normal levels after record spat recruitment in 2005.

Catch rate prediction: Recruitment to the fishery is predicted by the piggyback spat abundance index at 4 to 6 years prior to the current fishing year and is used in conjunction with effort controls to set the quota for forthcoming years. A very high 0+ recruitment detected in the Zone 2 fishery in 2005 was confirmed in the 1+ year class in 2006, and again in the 2+ age class from population surveys in 2007. This cohort entered the commercially fished population between 2009 and 2011 resulting in the highest CPUE for over 30 years.

The 2011 stock abundance in Zone 2 was predicted to be lower than 2010, but with an additional large residual stock left over from uncaught TAC in 2009 and 2010. To account for this, the 2011 TAC in Zone 2/3 was increased slightly to 1,600,000 (3,500 shell per unit). This is 250 % above the baseline level of 1,000 shell per unit (Pearl Table 1). Using the catch prediction system, the catch quota for 2012 has been reduced to 639,800 shell which is closer to historic levels of quota.

Zone 1: The Zone 1 fishery has not been fished for three years.

Breeding stock: Under average growth and mortality, recruitment into the pearl oyster breeding stock exceeds natural mortality, and hence breeding stocks are likely to be increasing in most years. This results from the 'gauntlet' fishing strategy employed by the industry, in which the young, fast-growing shell (principally males) of 120 – 165 mm shell length are targeted for their fast pearl-producing qualities. The fishery is trialling a minimum size of 100 mm for 3 years, however the basis of quota setting will still be the abundance in the 120-165 mm size class.

Animals that survive this 'gauntlet' are effectively protected from the age of 6 to 7 years onward, and may live for another 15 to 20 years. With very low natural mortalities, this results

in a large residual broodstock being built-up over time. In Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004, 2009 - 2011 (Pearl Table 2).

The performance measures for this fishery, which relate to breeding stock biomass, include the area of fishing compared to the distribution of the stock and the catch rates of young oysters within each of the fishing zones.

All performance measures were met for 2011. The area of fishing remains substantially less than 60% of the distribution of oysters within this region. The catch rates in Zones 2 and 3 were both still above their respective performance levels, with a combined catch rate of 55 oysters/hour.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

Ecosystem Effects

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research (see 'Research summary') has found categorically that pearl farming has negligible impacts on habitat and environment.

Social Effects

Direct

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 16 in 1997 (overall), mostly due to increased fleet efficiency and increased reliance on hatchery-produced shells. In 2009, with the negative impact of the Global Financial Crisis (GFC) on the industry, only two vessels fished. The number of vessels fishing increased to 5 in 2011, as the effects of the GFC began to abate.

Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and June each year. These vessels also support shell operations and a number of other pearl farm functions throughout the year.

Indirect

Prior to the GFC, the pearling industry provided employment for approximately 500 people in the northern coastal regions, including in the operation of the pearl farms. However the impact of the GFC resulted in a substantial reduction in personnel employed in the pearling industry.

Economic Effects

Estimated annual value (Total Industry value) for 2011 **Level 5 - > \$20 million (\$93 million)**

A precise estimate of the total industry value is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place. Based on information provided by the industry, the value of cultured pearls and by-products in 2011 was considered to be approximately \$93 million, which is slightly lower than 2010, in which it was around \$99 million.

Fishery Governance

Target effort range: **14,071 - 20,551 hours**

The target effort range relates to the time required to achieve the TAC in the pearl oyster fishery of 1,655,000 oysters in 2011 (1,600,00 oysters in Zone 2/3, and 55,000 oysters in Zone 1).

Acceptable effort ranges for individual management zones are 11,456 – 15,819 dive hours for Zone 2/3 and 2,615 – 4,732 dive hours for Zone 1. These ranges are based on the 5-year period (1994 – 1998) following the introduction of global positioning systems (GPS) into the fishery, and reflect the typical variation in abundance of the stock under natural environmental conditions.

Zone 2/3 of the pearl oyster fishery achieved its catch with 14,361 dive hours of effort (Pearl Table 1), which was within the target range.

Zone 1 of the pearl oyster fishery was not fished in 2011 (Pearl Table 2).

NORTH COAST BIOREGION

Current effort level: **Acceptable**

Overall fishery effort level is acceptable, but current catch levels reflect market issues and not stock abundance.

New management initiatives (2012)

DoF has approved a two-year trial (2012/2013) for industry to take smaller shell legally, 100-120mm, and to harvest MOP. The request to take smaller shell was put forward by industry to evaluate the economics for their business model. DoF confirmed there were no sustainability issues, under a fixed TAC.

In 2010, the Minister approved a new departmental funding model for the pearling industry through the establishment of wild stock fishery access fees based on the gross value of the wild stock pearl oysters taken, rather than a recovery of management costs model. The pearl oyster fishery first operated under the new funding model during the 2011 licensing period. The introduction of new consultation arrangements in 2009 saw the dissolution of the Pearling Industry Advisory Committee and consultation with the pearling industry is undertaken with WAFIC as the peak commercial fishing body in WA and the PPA as the relevant sector body.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources is

planned for introduction into Parliament in 2012. The new Act will replace both the Fish Resources Management 1994 and the Pearling Act 1990. The Department is facilitating a review of the current legislative framework ahead of the introduction of the new Act to adopt a more streamlined governance structure for the pearl oyster fishery and activities associated with pearl culture.

External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry, however preliminary research points to environmental factors being an external driver of the current high abundance. The industry will continue to experience difficulty from the Global Financial Crisis, which had a major impact on the market for luxury goods, including pearls. The low catch and effort between 2009 and 2011 are a direct result of companies opting not to fish because of this. Future signs for 2012 suggest a market recovery but natural declines in oyster abundance due to lower settlement. Finally, the on-going issue of the OOD (oyster oedema disease) continues to hamper hatchery-production capacity in some sectors of the Industry, however to date there is no evidence the disease has affected wild stocks.

PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3) for the past decade.

Year	Wild stock quota	No. of culture shells	No. of MOP ¹ shells	Total shells	Dive hours	Culture shells/hr	Average depth	Total shells/hr
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	457,000	456,988	0	456,988	14,242	32.1	13.6	32.1
2004	457,000	404,984	0	404,984	11,994	33.8	12.3	33.8
2005	502,500	488,303	0	488,303	14,807	32.9	12.1	32.9
2006	502,500	467,436	0	467,436	11,992	39.0	13.7	39.0
2007	548,400	550,972	0	550,972	12,514	44.0	12.9	44.0
2008	822,600	810,115	0	810,115	15,387	52.6	14.7	52.6
2009	1,005,400	260,002	0	260,002	3,285	79.2	11.4	79.2
2010	1,500,000	385,270	12,677	397,947	4,447	89.0	14.9	89.4
2011	1,600,000	765,209	30,949	796,158	14,361	55.8	12.2	55.4
2012	639,800							

Notes: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies. ¹ 'MOP' is an abbreviation for mother-of-pearl; ² wild stock quota in 2008 initially set at 639,800 (see SOF 2007 report), however a mid-season review increased it to 822,600 because of enhanced stock abundance

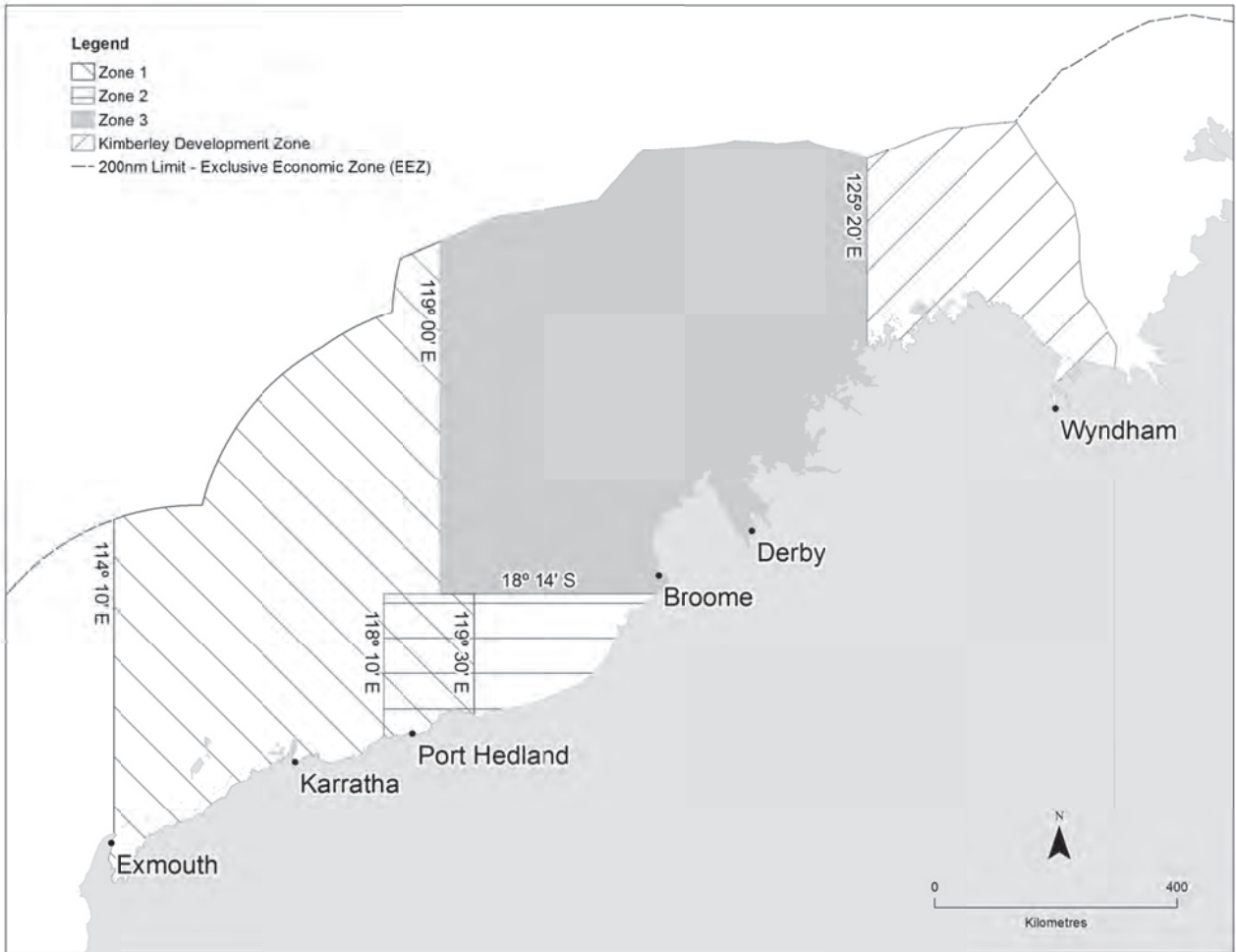
PEARL TABLE 2

Pearl shell catch and effort in Zone 1 for the past decade.

Year	Wild stock quota	No. of culture shells	Dive hours	Culture shells/hr
2001	115,000	68,931	9,480	7.3
2002	55,000	29,126	2,729	10.7
2003	45,000 ⁴	22,131	1,647	13.4
2004	45,000 ⁴	0 ⁵	0 ⁵	
2005	55,000 ⁶	25,572	1,084	23.6
2006a	55,000 ⁷	36,546	1,343	27.2
2006b	35,000 ⁷	34,900	349	100
2007	55,000	49,686	2,138	23.0
2008	55,000	10,092	398	25.3
2009	55,000	0	0	
2010	55,000	0	0	
2011	55,000	0	0	
2012	55,000			

1. A developmental period was introduced into the fishery from 1993 to 1997 to encourage hatchery production technology. The main undertakings were the introduction of 3 new Zone 1 pearl industry licences, and an increase in TAC of pearl shell in Zone 1 (from 55,000 to 115,000 shell).
2. Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell between 1999 and 2005.
4. In 2003 and 2004, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.
5. In 2004, no wild-stock quota was taken as only hatchery oysters were used.
6. Post 2005, the wild-stock quota for management and compliance purposes was returned to its long-term sustainable level of 55,000.
7. A higher TAC in 2006 was the result of an additional 35,000 experimental quota (2006b) allocated for a lightly-exploited stock within a pearl farm lease, and 34,900 of this quota was caught in 349 dive hours at a CPUE of 100 shells per hour. The remainder was caught at 27.2 shells per hour.

NORTH COAST BIOREGION



PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.

Beche-de-mer Fishery Status Report

A. Hart, D. Murphy and R. Green

Main Features

Status

Stock level	Adequate
Fishing level	Acceptable

Current Landings

Holothuria scabra – Sandfish 56 t

Fishery Description

Beche-de-mer, also known as 'sea cucumbers' or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

The Western Australian beche-de-mer fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border, however fishers do have access to all Western Australian waters. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. While six species have been taken, prior to 2007 it was primarily a single species fishery, with 99% of the catch being sandfish (*Holothuria scabra*). Since then, an additional species (deepwater redfish - *Actinopyga echinites*) has also been targeted and the fishery is now generally a two species fishery.

Governing legislation/fishing authority

Fisheries Notice no. 366

Exemption under Section 7(3)(c) of the *Fish Resources Management Act 1994*

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation)

Consultation process

Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum.

Boundaries

The beche-de-mer fishery is permitted to operate throughout Western Australian waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Management arrangements

The developing fishery for beche-de-mer is managed through input controls including limited entry, maximum number of

divers, species-dependent minimum legal size limits, and gear restrictions. Access to the fishery is limited to the 6 Fishing Boat Licence holders listed in the Instrument of Exemption enabling the take of beche-de-mer.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers operating under the authority of a Fishing Boat Licence that is listed on the Instrument of Exemption.

The maximum number of divers (per endorsed fishing boat licence) allowed to dive for beche-de-mer at any one time is four, with a maximum number of six crew allowed on the vessel.

There are six species of beche-de-mer harvested in Western Australia. At present, the minimum target lengths for these commercial beche-de-mer species are based on the Northern Territory's minimum sizes, which have been set based on size at sexual maturity.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of beche-de-mer. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort designed for the fishery was implemented in 2007. The logbook obtains species-specific, fine-scale catch and effort data and appropriate environmental information, such as depth fished.

Retained Species

Commercial landings (season 2011):

56 tonnes (live weight)

Landings

In 2011 the total beche-de-mer catch was 56 t live weight (Beche-de-mer Table 1), a decrease of 54% over last year's catch of 121 t, due to nil catch from the newly developing redfish fishery with all effort focused on the traditional sandfish fishery.

NORTH COAST BIOREGION

The 56 t catch was therefore just of *Holothuria scabra* (Beche-de-Mer Figure 1), which is 60 % higher than the 2010 catch of 35 t for this species. This is the first time in the last five years that *Actinopyga echinites* has not been caught and industry has advised they are adopting a rotational fishing strategy with *A. echinites*, with 2011 being a rest period.

Fishing effort/access level

Only 2 licensed vessels fished for beche-de-mer in 2011, the same as 2007 to 2010. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 1539 hours fished – about 104% higher than in 2010 and approximately 25% above the average of the last 6 years for sandfish fishing only (Beche-de-mer Table 1), comprising of 123 hours wading and 1416 hours diving.

Stock Assessment

Assessment complete: Yes

Assessment level and method:
Level 2 -Catch rate

Breeding stock levels: Adequate

The overall catch rate for sandfish (diving only in 2011) was 37 kg/hour, this is 20% below last year's catch rate of 46 kg/hour but close to the average of the last 10 years of 36 kg/hour (Beche-de-mer Figure 1).

Estimates of Maximum Sustainable Yield (MSY) of sandfish were obtained for the entire WA fishery and Kimberley sub-regions using a biomass dynamics model. Current average catch of sandfish is below the MSY (Beche-de-mer Table 2), indicating that the level of fishing is sustainable. However, large variability in the estimates of q (0.21 – 0.55) for the same species suggests that a cautious interpretation of the model outputs is required. The model is updated with new data every year.

The species performance measure for the Sandfish fishery are catches remaining in the range 20 – 100 t and catch rate remaining above 25 kg/hour. In 2011, both the catch (56 t) and catch rate (37 kg/hr) measures were met.
The species performance measure for the Redfish fishery are catches remaining in the range 40 – 150 t and catch rate remaining above 60 kg/hour. In 2011, there was no fishing so the performance measures could not be evaluated.

Non-Retained Species

Bycatch species impact: Negligible

No bycatch species are known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: Negligible

There are currently no known interactions with protected in this fishery and given the methods of collection this is likely to remain the case.

Ecosystem Effects

Food chain effects: Negligible

This fishery harvests only a small amount of sandfish and redfish per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant.

In addition, predation on the beche-de-mer is relatively infrequent due to the toxins present in their body tissues. It is highly unlikely these animals are a major diet for higher-order predators, due to these toxins acting as an effective defence system.

Habitat effects: Negligible

Divers collect beche-de-mer as they drift over the bottom; there is minimal impact on the habitat as divers are highly selective in their fishing effort and no fishing gear or lines contact the seabed. The vessels work during the day and anchor at night, usually further inshore where they are protected from the open ocean that is subject to higher seas and wind. Most fishers are mindful of the habitat they choose to anchor over, so they avoid more diverse bottom habitat.

There are some areas where fishers can access beche-de-mer by wading through shallow water mangrove lagoons and estuaries. This is a minor component of the fishery. This method may be applied in areas of the Kimberley that are accessible and prone to extreme tidal movements. Wading usually occurs on soft sandy substrates, with minimal impact on these habitats.

Social Effects

In 2011, two vessels with a total of ten crew worked in the fishery. Additional individuals are employed for the processing of the product. These activities are mostly located in the Northern Territory where the fishing fleet is based.

Economic Effects

Estimated annual value (to fishers) for 2011:

Level 1 - < \$1 million

The estimated annual value for 2011 was \$187,000 based on an average product price of \$10.00/kg for sandfish (gutted and boiled) or \$3.33/kg live weight. This is a farm gate value and supports a substantial processing and value-adding sector.

Fishery Governance

Sandfish catch range: 20 – 100 tonnes

Redfish catch range: 40 – 150 tonnes

Current fishing level of 56 tonnes for Sandfish is within the target range. As no fishing for redfish was undertaken, in 2011 there was no assessment. If the fishery does move to a rotational harvest strategy for redfish, an updated catch range may need to be developed.

New management initiatives (2012/13)

A review of the developing Beche-de-mer fishery is planned for 2013/14.

The species-specific information on catch and effort from the daily logbook, implemented in 2007, has facilitated the

development of species-specific performance indicators and these will be refined as more information arises.

External Factors

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to uncontrolled expansion of fishing of beche-de-mer. Marine park planning has to date restricted this fishery from general use zones of MPAs. However consideration of removal of this restriction is currently underway as all other fisheries have access to general use zones. If successful, this action will likely seem some expansion into previously unfished areas.

BECHE-DE-MER TABLE 1

Catch and effort of Beche-de-mer in Western Australia for the last decade.

Year	¹ Live Wt (t) (all species)	Hours fished (all methods)	Live Wt (t) (Sandfish)	Hours fished (Sandfish)	Live Wt (t) (Redfish)	Hours fished (Redfish)	Live Wt (t) (Teatfish)
2001	90	2,434	88	2,414	2	20	0.2
2002	87	3,235	87	3,235	0		0
2003	122	4,877	121	4,867	1	10	0
2004	81	2,117	81	2,117	0		0.2
2005	78	1,876	75	1,876	0		0
2006	58	2,662	55	2,632	3	30	0.3
2007	113	1,804	26	976	87	828	0
2008 [^]	196 ²	1,544	27	448	169	1096	0
2009	129	1,423	31	701	98	722	0
2010	121	1,053	35	754	86	299	0
2011*	56	1539	56	1539	0	0	0

¹ Sandfish represented 99% of catch until 2006

² Redfish represented 86% of catch in 2008

[^] Diving only method used in recent years

* Sandfish represented 100% of catch by diving (93%) and wading (7%)

BECHE-DE-MER TABLE 2

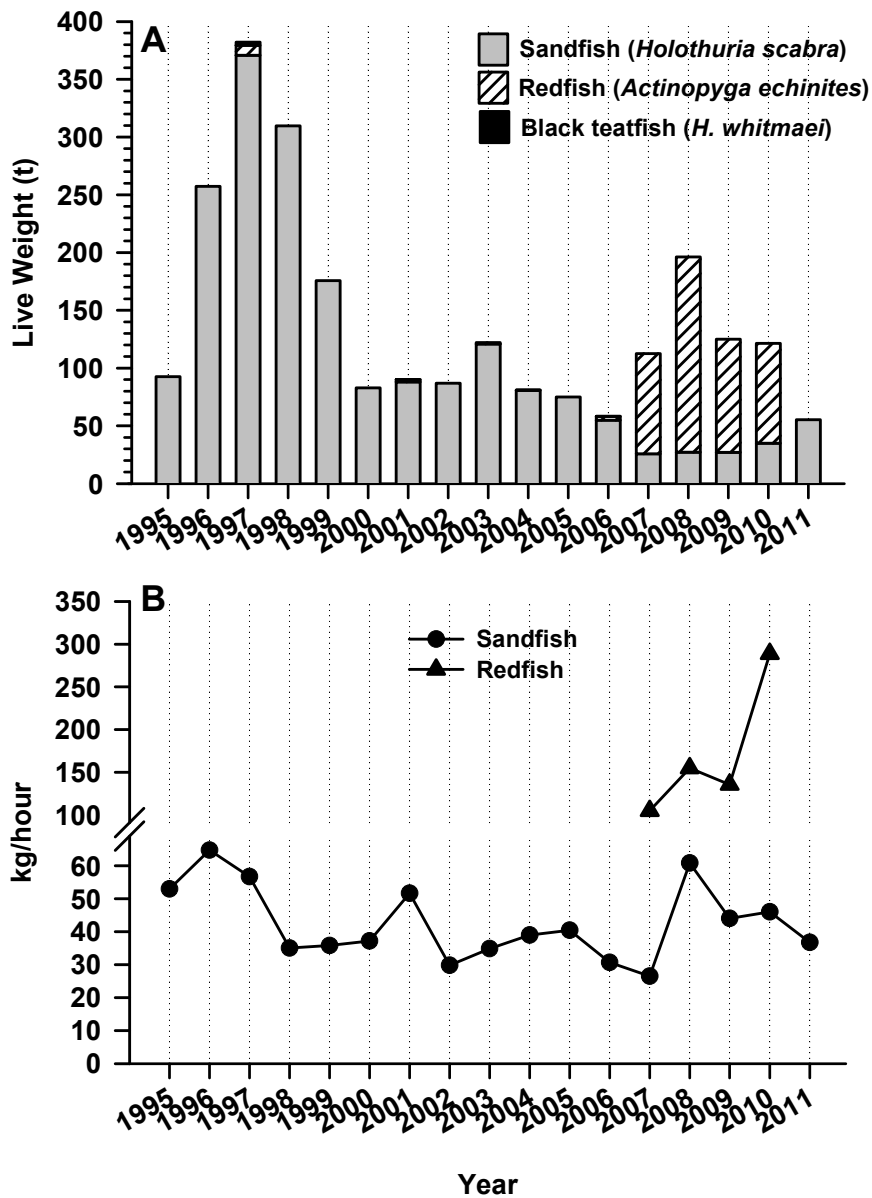
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2011) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	140	44	0.83	969	0.21
Kimberley region (Grid 1425 and 1426)	70	40	0.94	423	0.55

* r – intrinsic rate of increase

k – carrying capacity (Virgin biomass)

q – catchability or fishing power



BECHE-DE-MER FIGURE 1

A) Production (tonnes/live weight) by species, and B) catch rate (kg per crew day) from the Western Australian Beche-de-mer fishery.

North Coast Crab Fishery Status Report

D. Johnston, D. Harris, C. Marsh, C. Syers, R. Green and P. Carter

Main Features			
Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Adequate	Commercial	20 t
Mud crab	Unknown	Recreational	approx 35% of total
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	600 kg
Mud crab	Acceptable	Recreational	Not available for current year

Fishery Description

Blue Swimmer Crab

The blue swimmer crab (*Portunus armatus*) is found along the entire Western Australian (WA) coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth. However, the majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north.

Blue swimmer crabs are targeted using a variety of fishing gear but most commercial crab fishers in WA now use purpose-designed crab traps. Operators in the Pilbara Developing Crab Fishery are only permitted to use 'hourglass' traps. The Onslow and Nickol Bay prawn trawl fisheries also retain crabs as a by-product.

The Pilbara Developing Crab Fishery was established in 2001 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7 of the *Fish Resources Management Act 1994* (FRMA). The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline.

Mud Crab

Four species of mud crab (*Scylla* spp.) have been identified in the Indo-West Pacific region, of which the green mud crab (*Scylla serrata*) and brown mud crab (*Scylla olivacea*) occur in Western Australia (Keenan *et al.*, 1998)¹. The maximum size reported for green mud crabs is between 250 – 280 mm carapace width (CW) (Lloris, 2001)², whereas the maximum size of brown mud crabs is between 135 – 139 mm CW

(Tongdee, 2001)³. An identification brochure outlining minimum legal size limits and defining characteristics between green and brown mud crabs was produced by the Department of Fisheries in 2011 and is widely available to members of the public.

The green mud crab is predominantly found in estuarine habitats in north-western Australia from the Northern Territory border to Shark Bay, but have also been found as far south as the Wilson Inlet at Denmark in years of strong southern coastal current flow (Gopurenko *et al.*, 2003)⁴. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound 200 km northwest of Broome. Brown mud crabs are more tolerant of low salinity than green mud crabs, but less tolerant of lower temperatures. They are also considered to exhibit a strong preference for the intertidal zone, while green mud crabs make regular use of both intertidal and subtidal habitats up to 20 m depth offshore (Hill, 1994⁵, Robertson, 1996⁶).

Mud crabs are fished commercially in the Kimberley region between Broome and Cambridge Gulf near the WA and Northern Territory border, with fishing effort concentrated

³ Tongdee, N. (2001). Size distribution, sex ratio and size at maturity of mud crab (*Scylla* spp.) in Rangong Province, Thailand. *Asian Fisheries Science* 14: 113-120.

⁴ Gopurenko, D., Hughes, J.M., and Bellchambers, L.M. (2003) Colonisation of the south-west Australian coastline by mud crabs: evidence for a recent range expansion or human-induced translocation? *Marine and Freshwater Research*. 54: 833-840.

⁵ Hill, B.J. (1994) Offshore spawning by the portunid crab *Scylla serrata* (Crustacea: Decapoda). *Marine Biology*. 120:3. 379-384.

⁶ Robertson, W.D. (2011) Abundance, population structure and size at maturity of *Scylla serrata* (Forsk.) (Decapoda: Portunidae) in Eastern Cape estuaries, South Africa. *South African Journal of Zoology*. 31:4. 177-185.

¹ Keenan, C.P., Davie, P.J.F., and Mann, D.L. (1998). A revision of the genus *Scylla* de Hann, 1833 (Crustacea: Decapoda: Brachyura: Portunidae). *Raffles Bulletin of Zoology*. 46(1): 217-245.

² Lloris, D. (2001). FAO/SIDS species identification sheet: *Scylla serrata*

NORTH COAST BIOREGION

around Cambridge Gulf, Admiralty Gulf, York Sound and King Sound (see North Coast Crab Figure 1).

Mud crab trap design varies between individual fishers but is usually rectangular or round in shape. The rectangular design generally follows the dimensions of 1000 mm length, 540 mm width and 300 mm height with a mesh size of 50x20x2 mm with 2 openings for crabs to enter the trap. The round trap design is generally 500 mm high; 1000 mm diameter and 50 mm mesh size (knot to knot) with 4 openings for crabs to enter the trap.

There are currently 3 commercial operators and 2 Aboriginal corporations holding exemptions to fish for mud crabs in WA. The fishers generally operate from March to November, with May to September being the most productive months to avoid summer and associated seasonal cyclone weather events. Commercial operators generally fish on a part-time basis with most operating other endorsements including Kimberley Gillnet and Barramundi Managed Fishery Licences and fishing boat charters. Operators tend to fish remote waters for long periods of time in large mother ships, using small dinghies known as doreys to enter mangrove estuaries with crab traps generally checked each daylight high tide.

Governing legislation/fishing authority

Commercial

Blue Swimmer Crab

Fish Traps Prohibition Notice 1994

Exemptions under Section 7 of the *Fish Resources Management Act 1994*

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Mud Crab

Exemptions under Section 7 of the *Fish Resources Management Act 1994*

Notice 539 – Crab Fishing Restrictions (Roebuck Bay) Notice 1991

Notice 194 – Mud Crabs (Scylla sp)

Recreational

Fish Resources Management Act 1994; Fish Resources Management Regulations 1995 and other subsidiary legislation

Consultation process

Commercial

Industry Annual General Meetings are convened by the West Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department. Annual Broome Consultative Forum (Mud crabs)

Recreational

Consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

Boundaries

Blue Swimmer Crab

Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay.

The boundaries of the Onslow Prawn and Nickol Bay Prawn Managed Fisheries which also capture crabs as by-product are described in the relevant status report elsewhere within this document.

Mud Crab

Three operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier Peninsular, north of Broome.

Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.

Management Arrangements

Blue Swimmer Crab

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions. The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. The commercial minimum size of 135 mm carapace width in the Pilbara crab fishery should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

The management arrangements for the Pilbara Developing Crab Fishery are set by conditions on the exemption and are aimed at ensuring the stock and environment are protected. The management measures include gear restrictions, a minimum size limit, spatial closures and reporting requirements. A maximum of 400 pots are permitted in the fishery.

Management controls for the Onslow and Nickol Bay Prawn Managed Fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids). The fleet is composed of trawlers up to 23 metres in length; operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m). The Department of Fisheries' vessel monitoring system (VMS) monitors the activities of all trawlers in these fleets.

Recreational fishing for blue swimmer crabs in WA is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in the waters of the north Coast

bioregion, along with a bag limit of 20 crabs per person with a boat limit of 40 crabs. Restrictions also govern gear types that can be used to take blue swimmer crabs.

Mud Crab

Access to the commercial Mud Crab Fishery has been granted via Instruments of Exemption, issued under Section 7 of the *Fish Resources Management Act 1994*, since 2006. The mud crab fishery is managed under an input control system, primarily through the regulation of vessel and trap numbers (maximum of 1,070 traps), gear restrictions and spatial closures.

Breeding stocks are protected by maintaining minimum size limits (150 mm CW for green mud crab and 120 mm CW for brown mud crabs) well above the size at sexual maturity. These size limits apply to both the recreational and commercial take of the species.

In addition to the minimum size limits, recreational fishers for mud crabs are restricted to a daily bag limit of 5 mud crabs, with a boat limit of 10 mud crabs (except for lower King Sound where the boat limit is 20).

Research Summary

Blue Swimmer Crab

Data for the assessment of blue swimmer crab stocks in the North Coast bioregion is obtained from trap fishers' compulsory monthly catch and effort returns and daily research log books, and trawl fishers' daily logbooks.

Baseline information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade.

Mud Crab

Data for the assessment of mud crab stocks in the North Coast bioregion is obtained from trap fishers' compulsory catch and effort returns and daily logbooks. Relevant research information is sourced from 2 recent FRDC funded projects involving NT Fisheries investigating escape gap sizes of traps (Grubert and Lee, submitted)¹ and environmental correlations with mud crab catches in the Northern Territory (Maynecke *et al.*, 2010)².

Retained Species

Commercial landings (season 2010/11):

Blue swimmer crabs

20 tonnes (19.9 t trap and 0.1 t trawl)

Mud crabs

<1 tonne

Blue Swimmer Crabs

The combined commercial catch of blue swimmer crabs from trap based crab fishers and prawn trawlers operating along the Pilbara coast during 2010/11 was 20 t, a 29% decrease on the 2009/10 catch of 28 t (North Coast Crab Figure 2). The majority of the recorded catch is taken by the trap fishery, with trawlers retaining only 0.1 t of crabs during 2011. This catch accounted for 2% of the state commercial blue swimmer crab catch of 1087 t for 2010/11 (West Coast Blue Swimmer Crab Figure 1).

Mud Crab

The total catch of mud crabs for the North Coast Crab Fishery during 2011 was <1 t and a decrease on the 2010 catch of around 2 t (North Coast Crab Figure 3). This catch accounted for 100 % of the state commercial mud crab catch for 2011. The 2011 catch was also a significant decrease from the 5 year mean of 3800 kg due to a large drop in catch and effort as only one commercial operator fished and only one Aboriginal Corporation fished in the 2011 period. The combination of cyclonic and flooding weather events and difficulty in retaining crew reflects this trend for 2011.

Recreational catch:

Blue Swimmer Crab Pilbara coast

approximately 50% of total

A survey of recreational crabbing was conducted along the Pilbara coast between December 1999 and November 2000. The survey estimated the recreational catch of blue swimmer crabs for the region over the 12-month period to be 22 t, with most of the catch (19 t) taken from Nickol Bay (Williamson *et al.*, 2006)³. This represented the majority of the catch from Nickol Bay in that year, as commercial operations targeting blue swimmer crabs in the area did not begin until the following year. No further surveys quantifying recreational catch have been undertaken since the 2000 survey. If this level of recreational effort has been maintained and the abundance has been consistent, it would provide for about 50% of the total catch based on current commercial catches.

Mud Crab

There is currently no data available for Kimberley recreational catch for 2011. A recreational survey conducted in the Pilbara between December 1999 and November 2000 reported the following recreational catch levels: 18 209 kg green mud crab and 4 655 kg brown mud crab (Williamson *et al.*, 2006¹).

The Department of Fisheries undertook a state wide recreational fishing from boat survey in 2011. The first results of the entire survey are due in late 2012.

¹ Grubert, M.A, and Lee, H.-S. 2012. Improving gear selectivity in Australian mud crab fisheries, Northern Territory Department of Resources, Fishery Report. Submitted.

² Meynecke, J-O., Lee, S-Y., Grubert, M., Brown, I., Montgomery, S., Gribble., Johnston, D. and Gillson, D (2010) Evaluating the Environmental Drivers of Mud Crab (*Scylla serrata*) Catches in Australia. Final Report 2002/012. FRDC and Griffith University.

³ Williamson, Peta C., Sumner, Neil R. & Malseed, Benjamin E. (2006). A 12-month survey of recreational fishing in the Pilbara region of Western Australia during 1999-2000. Fisheries research report (Western Australia. Dept. of Fisheries) no. 153. (61 p.).

NORTH COAST BIOREGION

Fishing effort/access level

Blue Swimmer Crab

Crab trap fishers along the Pilbara coast reported 23,310 trawlifts during 2010/11, a 29% decrease on the 32,700 trawlifts reported for 2009/10.

Mud Crab

Mud Crab fishers along the Kimberley coast reported 784 trawlifts during 2011, a 39% decrease on the 2004 trawlifts reported for 2010 (North Coast Crab Figure 3).

Stock Assessment

Assessment complete:

Blue Swimmer Crab Pilbara - Yes

Mud Crab No

Assessment level and method:

Blue Swimmer Crab

Level 2 - Catch rate/Size Distributions

Breeding stock levels:

Blue Swimmer Crab Pilbara - Adequate

Mud Crab Unknown

Blue Swimmer Crab

The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm carapace width) and significantly reduced the catch of undersize crabs < 120 mm carapace width, without impacting on legal catches. Improved work practices have also reduced the mortality of returned undersize and berried crabs caught in commercial traps to negligible levels.

The minimum legal size at first capture (127 mm carapace width for recreational fishers; 135 mm carapace width for commercial fishers based on industry agreement) for crab fisheries in the North Coast bioregion is set well above the size at first maturity of the resident stocks. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions. The breeding stocks along the Pilbara coast are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over the whole year, whereas spawning is restricted to the late spring and early summer months on the lower West Coast.

Catch rates from the Pilbara trap fishery provides an index of abundance that can be used to assess fishery performance from year-to-year. Blue swimmer crab trap catch rates in the Pilbara Developing Crab Fishery increased steadily during the first three years of exploratory fishing for blue swimmer crabs along the Pilbara coast. This reflected more efficient fishing of stocks in the Pilbara region, as the commercial operators' knowledge of the spatial distribution of resident stocks and localized environmental influences increased over time. The increase in catch rate can also be attributed to improvements to fishing gear and vessels. Favourable environmental conditions led to a significant increase in catch rates (~1.6-1.8 kg/trawlift) from 2004/05 to 2006/07, before returning to longer-term mean catch rates (~0.7-1.0 kg/trawlift).

The Pilbara Developing Crab Fishery recorded a mean catch rate for 2010/11 of 0.8 kg/trawlift – a slight increase on the catch rate of 0.7 kg/trawlift from the previous year.

Mud Crab

Historically catch and effort within the fishery rose steadily from 1100 kg in 2003 to 6300 kg in 2009. Catch per unit effort increased between 2003 and 2005 with greater knowledge of the fishery. The highest recorded catch peaked at 9300 kg in 2006; however this was attributed to the extensive exploratory efforts of a single fisher and therefore did not represent the efforts of the entire fishery for that year. The majority of commercial crabbing has occurred in the areas of Cambridge Gulf, Admiralty Gulf, York Sound and King Sound.

The minimum legal size at first capture is 150 mm carapace width (CW) for green mud crab (*Scylla serrata*) and 120mm CW for brown mud crab (*Scylla olivacea*). This is set well above the size at first maturity of 90-110mm CW for green and 86-89mm CW for brown mud crab fisheries in the North Coast bioregion.

Non-Retained Species

Bycatch species impact Negligible

Blue Swimmer Crab

The shift from using gillnets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks.

Discarded bycatch from trawl fisheries that retain crabs as a by-product is dealt with in those sections of this report specific to the trawl fisheries.

Mud Crab

Mud crab traps are purpose built to effectively target larger (legal sized) mud crabs. The overall trap design and large mesh size allows sub legal mud crabs and non-targeted bycatch species opportunity to escape the trap, preventing them from being retained. The gear needs to be pulled regularly, and undersized and berried crabs must be returned to the water.

Protected species interaction Negligible

Blue Swimmer Crab

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

Mud Crab

As mud crab traps are purpose built to target mud crab species and are set for relatively short periods of time, the possibility of causing harm to threatened and protected species is minimal.

Ecosystem Effects**Food chain effects****Low****Blue Swimmer Crab**

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually, secondary food chain effects are likely to be minimal in these fisheries.

Mud Crab

As the retained commercial catch of mud crabs is low, the commercial fishery represents a small proportion of the available biomass. Therefore secondary chain effects would not be likely to be significant within the surrounding ecosystem of the fishery.

Habitat effects**Negligible****Blue Swimmer Crab**

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the sea bottom occurring during trap retrieval. Sand and associated biota does not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macro-benthos.

Although seagrasses are occasionally uprooted and brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Mud Crab

Trap fishing in the shallow waters of associated mangrove tidal creeks and near shore embayments result in limited habitat disturbance. The large mesh size prevents capture of benthic organisms and only minor dragging of traps on the sea floor occurring in trap retrieval. The sheltered shallow mangrove environment is protected from wind and waves where the majority of traps are deployed, resulting in minimal habitat damage.

Social Effects**Blue Swimmer Crab**

During 2010/11, two people were employed as skippers and crew on vessels fishing for blue swimmer crabs along the Pilbara coast. Additional employment for several workers has been created in Point Samson through the development of post-harvest processing of the crab catch.

Mud Crab

Historically the mud crab fishery has had a high community value and a low commercial value. Commercial fishers travel vast distances due to the remoteness of their operations and stay in the vicinity for several weeks before returning to unload catch. In this scenario crabs are frozen and generally sold to local markets although live product may also be sold at premium prices.

During the 2011 season, this fishery employed 1 commercial operator and 1 aboriginal corporation. The combination of unusual weather including seasonal flooding and cyclone activity coupled with difficulty with retaining crew resulted in this lower than normal fishing level.

Economic Effects**Estimated annual value (to fishers)****Level 1 - < \$1 million****Blue Swimmer Crab**

Average beach prices for trap caught blue swimmer crabs in the North coast fisheries for the year were around \$5-\$6/kg. The frozen crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps.

The crab catch from the Pilbara region was sold through local and interstate markets.

Fishery Governance**Target catch (or effort) range:****Blue Swimmer Crab Pilbara - Under Development****Mud Crab****N/A****Blue Swimmer Crab**

A review of these blue swimmer crab fisheries is being undertaken and target catch ranges will be set.

Current fishing (or effort) level:**Blue Swimmer Crab****Pilbara - N/A****Mud Crab****N/A****Blue Swimmer Crab**

While the Pilbara Developing Crab Trap Fishery has undergone a steady expansion since exploratory fishing for blue swimmer crab stocks between Onslow and Port Hedland began in 2001, effort levels in the fishery are considered acceptable. The large area covered by the fishery and the remote nature of much of this coastline provides significant logistical and financial challenges in returning the harvested catch to market in an acceptable time period. Improvements to fishing gear and vessels, along with a substantial increase in the understanding of localised environmental influences such as tide and wind, has allowed commercial fishers to maintain catch levels with reduced effort. Fishing effort in this region is further limited by very hot weather experienced during the summer months, which generally restricts fishing effort to between April and November.

Because of the logistical and financial difficulty in fishing this area, one licensee has not reapplied to fish under an exemption since the 2007/08 fishing season. Consequently, the number of traps in the Pilbara trap fishery has reduced from 600 down to 400.

NORTH COAST BIOREGION

New management initiatives

Blue Swimmer Crab (2011/12)

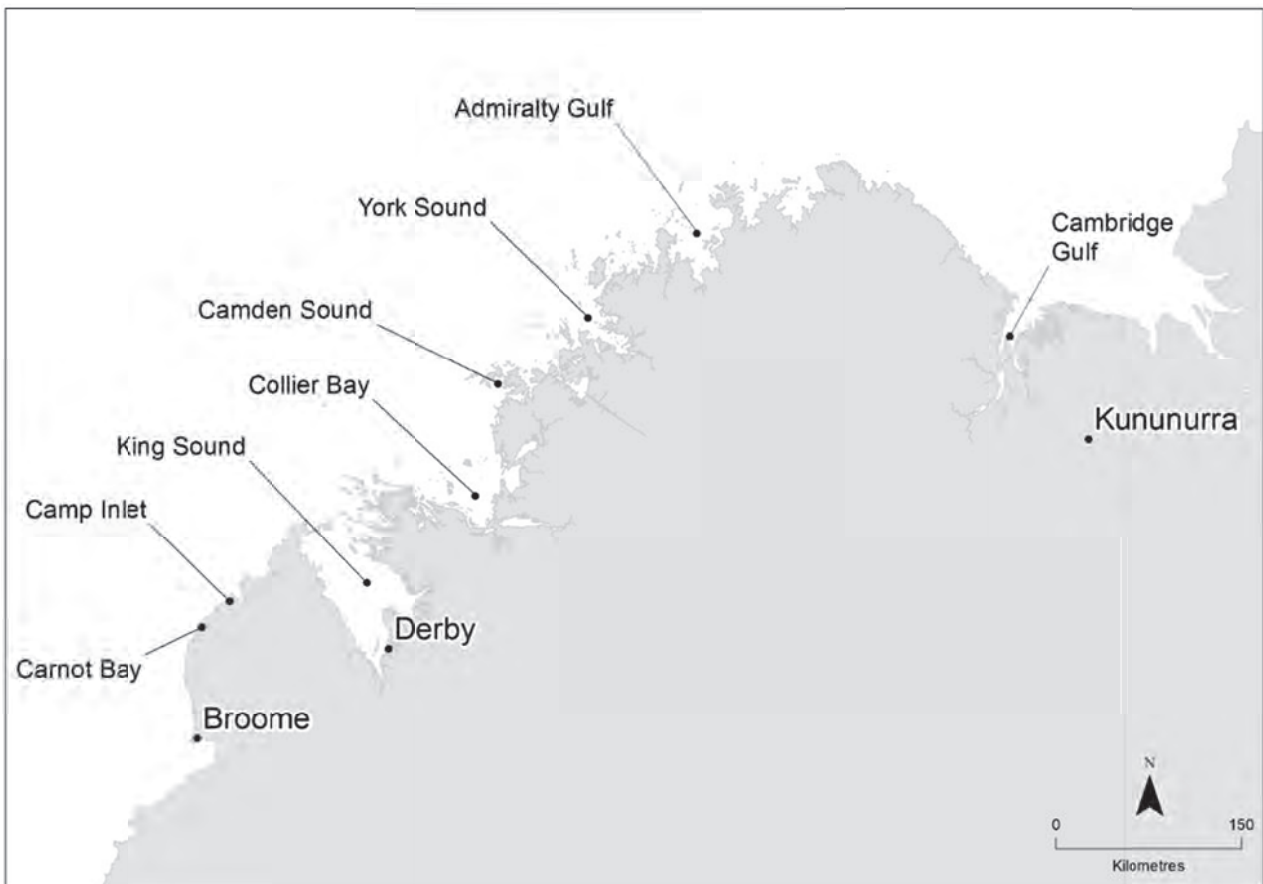
The Department proposes to bring the Pilbara Crab DNF under formal management arrangements in the near future.

Mud Crab (2011/12)

The Department proposes to bring the Mud Crab Fishery under formal management arrangements in the near future.

External Factors

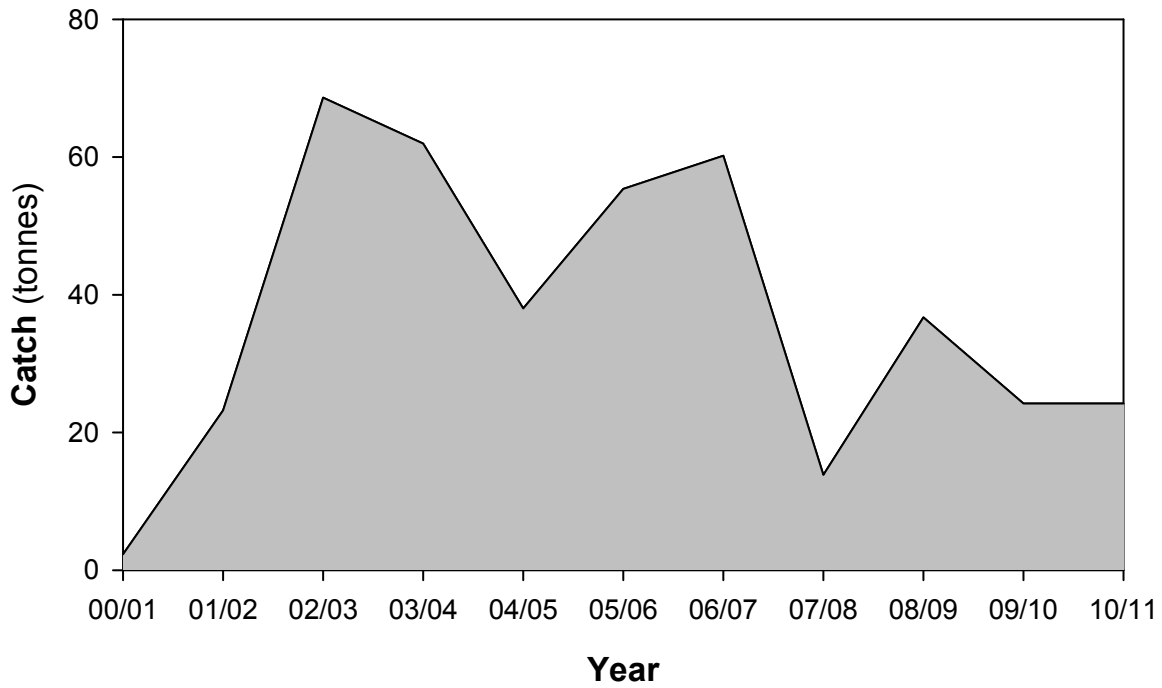
Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of these variations are not fully understood, it is considered most likely due to environmental influences on spawning success and larval survival through to recruitment. The relationship between environmental factors, recruitment and catch is being further evaluated as data becomes available.



NORTH COAST CRAB FIGURE 1

Areas fished for mud crab along the Kimberley coast of Western Australia.

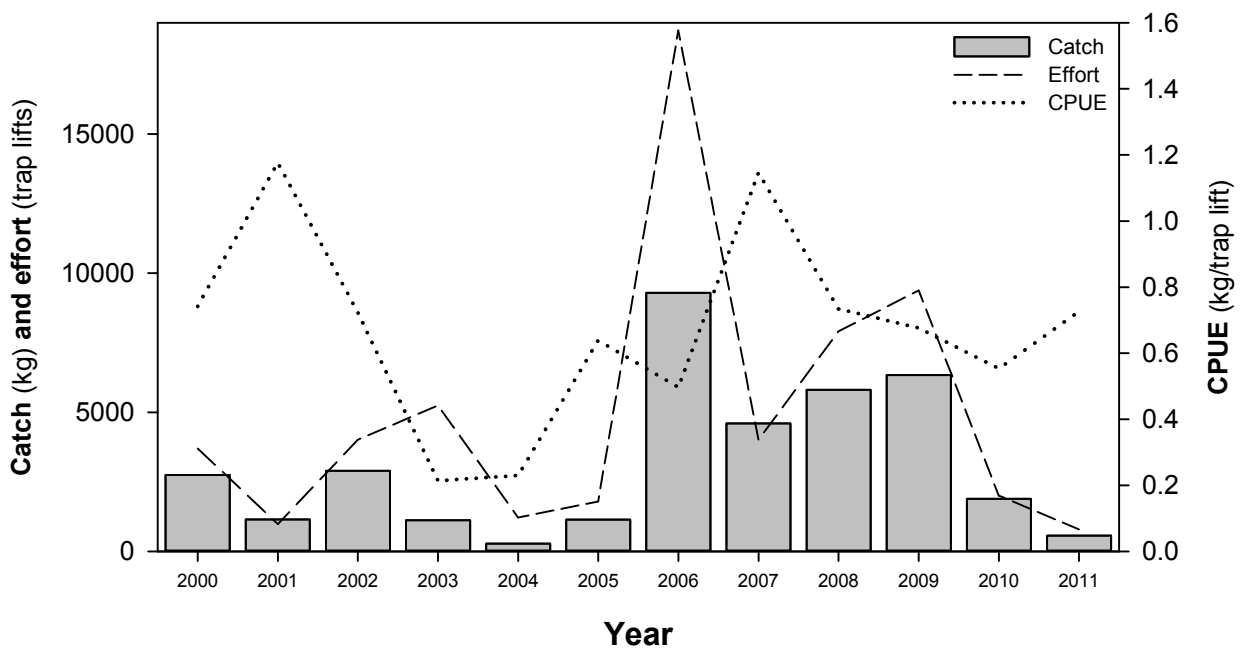
Blue Swimmer Crab - Commercial Catch History
Pilbara Coast



NORTH COAST CRAB FIGURE 2

Commercial catch history for the blue swimmer crab (*Portunus armatus*) in the North Coast bioregion since 2000/01.

Mud Crab - Trap Catch and Effort
State catch



NORTH COAST CRAB FIGURE 3

Annual catch history for the Western Australian commercial mud crab fishery since 2000.

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the north coast bioregion is dominated by the production of South Sea pearls from the silver lip pearl oyster *Pinctada maxima*. This industry sector utilises both wild-caught and hatchery-reared oysters to produce cultured pearls. The wild-stock fishery is reported in the North Coast bioregion section of this volume.

The Department of Fisheries also has a major role in the management and regulation of pearl hatcheries, seeding activities and pearl oyster farm leases.

A Memorandum of Understanding (MOU) between the Western Australian and Northern Territory fisheries ministers, signed in June 2006, recognises that WA and the NT comprise the entire Australian south-sea pearling industry and that product from both jurisdictions supplies the same market.

The operator of a fish farm producing barramundi (*Lates calcarifer*) in Cone Bay is successfully increasing production following approval by the Environmental Protection Authority (EPA) to increase output to 2,000 tonnes per annum. The operator is planning to gradually increase its production capability to 5,000 tonnes per annum, subject to receiving the requisite environmental approval.

A demonstration project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass has started near Karratha. The company is planning for significant increases in scale and production capability in the future.

To assist in addressing the regulatory and approvals issues concerning aquaculture development in WA, the Department of Fisheries has received Government funding of \$1.85 million over 2½ years to establish two aquaculture zones in the Kimberley and Mid West regions. Through this project, the Department of Fisheries will secure strategic environmental approvals for the zones from the EPA, thereby streamlining the approvals processes for commercial projects within zoned areas and providing an “investment ready” platform for prospective investors.

The Department of Fisheries manages the operations of the Broome Tropical Aquaculture Park, which provides the basic resources and facilities for supporting aquaculture development and training.

An indigenous project at One Arm Point operates a marine hatchery that focuses on a variety of ornamental and edible marine species.

COMPLIANCE AND COMMUNITY EDUCATION

The North Coast is one of the largest bioregions in WA – stretching from Onslow to the Western Australia/Northern Territory border with over 2600 kilometres of coastline.

The North Coast Bioregion has many biodiversity rich areas including the Rowley Shoals, Montebello Islands, Barrow Islands and hundreds of islands and atolls. These areas attract many people – especially for fishing.

Tourism is a major part of the coastal towns in the North Coast with over 600,000 additional people visiting the area each year. The transient population usually increases in the cooler months from May to October including international, interstate and intrastate tourists.

Many of the towns in this bioregion support mining communities where the majority of the population are fly in / fly out. Surveys have shown that a large proportion of mining community and tourists take part in fishing while visiting the bioregion.

Three district offices located in Kununurra, Broome and Karratha provide compliance and education across the region with eleven permanent Fisheries and Marine Officers and one Community Education officer. An additional two officer Recreational Mobile Patrols operates in the area throughout the year. Compliance is delivered to several sectors including commercial and recreational fisheries, pearling, aquaculture, fish habitat and bio-security.

The North Coast Region is sparsely populated in most areas with much of the terrain remote and difficult to access. Remote patrols are undertaken for up to two weeks at a time to get to these areas. Specialised equipment is required for patrols including four wheel drive vehicles and a variety of vessels for inshore coastal and inland waters, when offshore patrols are conducted a 23 metre vessel is utilised.

A range of compliance duties are carried out in the bioregion including investigations, catch, licence, gear, processor, retail and transport inspections. These are carried out through roadside checks, land & sea patrols and aerial surveillance.

FMOs not only spend time on compliance but also dedicate time to community education by maintaining a presence at a variety of expos, fishing competitions and community fairs. Annual fairs are held throughout the bioregion with the Department represented every year at most events.

The Community Education Officer develops programs and coordinates delivery of education activities to school-aged children and awareness raising activities with the broader community. In-school and school holiday programs are the main method of reaching students in both the Pilbara and the Kimberley, while attendance at shows and local events target the broader community. An increased emphasis has been placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Activities during 2010/11

During 2010/11, the North Coast bioregion's FMOs delivered a total of 4,920 officer hours of active compliance patrol time (North Coast Compliance Table 1). – a significant

increase (2345 hours) from the previous year (North Coast Compliance Figure 1) due to the impact of the Northern Region Recreational Mobile Patrol. FMOs also achieved 13585 personal compliance contacts with the fishers and non-fishers across the recreational and commercial sectors.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2010/11. This resulted in 9 infringement warnings, 13 infringement notices being issued and 7 matters resulting in prosecution action.

Compliance inspections were also carried out on Pearl oyster fishing and seeding operations, during transport of Pearl oysters and at various Pearl oyster lease sites. Considerable travel time is required to reach many of the lease sites, due to their remote locations.

In the recreational sector 149 infringement warnings were issued, 190 infringement notices and 33 matters resulted in prosecution action.

Initiatives in 2011/12

The Department's office in Kununurra will continue to carry out Patrols with staff from other agencies such as Department of Environment and Conservation and the Department of Transport. This will greatly enhance the ability of the Department to conduct education and compliance activities in the East Kimberley.

The Northern Region Mobile Patrol, comprising of two FMO's will continue to focus entirely on recreational fisheries compliance and education throughout the Northern Region.

A newly established Fremantle based Statewide Mobile Patrol Unit will be based in the Pilbara District from July to September and will focus on recreational fishers operating in the area.

The North Coast bioregions FMOs will continue to use a risk assessment based approach to fisheries compliance to ensure areas and activities of a high risk of non-compliance are targeted.

FMOs will continue to assist with ongoing checks of bio-security of vessels entering the states' waters for introduced marine pests.

An additional Community Education Officer for the region (with a focus on the Pilbara) will see increased education and communication opportunities and initiatives.

Improved engagement with short and long term visitors to the Pilbara and the Kimberley through a targeted education program.

Improved engagement with the resource sector in the Pilbara through targeted educational programs and improved access to information and increased education in remote community schools.

NORTH COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the North Coast bioregion during the 2010/11 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	4,920 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	154
Infringement warnings	9
Infringement notices	13
Prosecutions	7
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	13,092
Infringement warnings	149
Infringement notices	190
Prosecutions	33
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	493
Fishwatch reports***	18
VMS (Vessel Days)****	7,136

* Pearling contacts are excluded from these totals and detailed in North Coast Compliance Table 2.

** Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational.

The "other fishing related contacts within the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by *PV Walcott*. Contacts made by PVs *Hamelin* and *Houtman* are included in West Coast Compliance Table 1.

*** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors.

**** VMS (Vessel Days) represents the number of vessel days recorded in this bioregion. That is, a count for each day that each vessel was polled within the bioregion.

NORTH COAST COMPLIANCE TABLE 2

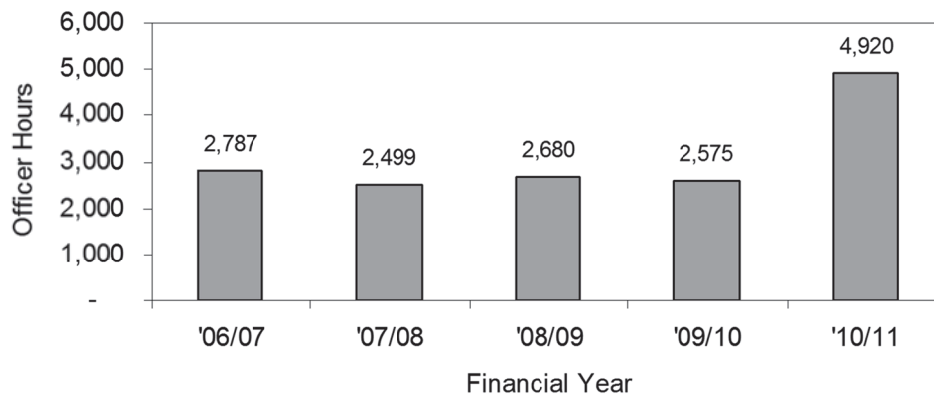
This table gives summary statistics for pearling compliance in all bioregions in the 2010/11 fishing season.

Total compliance hours*	244 Officer Hours
Field contacts by Pearling Officers	32
Letters of Warning issued**	0
Prosecutions	1

* Includes all time spent on compliance-related tasks by District Staff, e.g. investigations, prosecutions, etc. but does not include pearling activities by PV Walcott.

** No legislative capacity to issue infringement notices

North Coast Bioregion Compliance Patrol Hours



NORTH COAST COMPLIANCE FIGURE 1*

This figure gives the “On Patrol” officer hours showing the level of compliance patrol activity delivered to the North Coast bioregion over the previous five years. The 2009/10 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

*Does not include “on-patrol” hours delivered by PV Walcott (4,688 in 2010/11).

The total on-patrol hours for each of the Department’s 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV Houtman* and *PV Hamelin* in West Coast.