

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 Currents 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 Coast 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 intertidal 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. Nearshore 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 the Dampier Peninsular. 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 aquaculture development is provided by the Department of Fisheries' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster 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* (see North Coast Ecosystem Management Figure 2), and closures to fishing under section 43 of the Fish Resources Management Act 1994 at Point Samson and the wreck of the Kunmunya Samson II (Delambre Reef). The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries has participated in the marine conservation reserve planning process in this region. This has resulted in the recent establishment of the Lalang-garram 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 further marine protected areas at Eighty Mile Beach, Roebuck Bay and the Horizontal Falls. The Department continues to work closely with relevant agencies and stakeholders to develop strategies to minimize environmental impacts in the marine environment. This includes participation in the Kimberley Science and Conservation Strategy developed with the Department of Parks and Wildlife (DPAW) and collaboration on relevant WAMSI Kimberley Marine Research Program (KMRP) projects.

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 Bioregion 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 extent of the impact 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 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

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

Protected species (direct impact – capture or interaction);
 Benthic habitats; and
 External impacts.

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 is currently achieved through the Fish

Resources Management Act 1994 and the Biosecurity and Agriculture Management Act 2007.

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 Lalang-garram Camden Sound Marine Park (LGCSMP). This will focus on developing research and monitoring projects that provide information on the key ecological assets within the bioregion and contribute to the key management strategies of the LGCSMP management plan. Further initiatives are being developed as part of the broader Kimberly Science and Conservation strategy.

The Marine Biosecurity Research and Monitoring group have implemented a series of biosecurity related projects during 2012 – 2013. 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
Kimberley Nearshore	Estuarine	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.
	Marine	LOW	The current level of removal of all retained species is considered to have only minor impacts on the trophic structure.
Pilbara Nearshore	Estuarine	LOW (non-fishing)	See Kimberley Estuarine above.
	Marine	LOW	The current level of removal of all retained species is considered to have only minor impacts on the trophic structure.
Kimberley Inshore (shelf)	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 minor risk that the ecosystem will be altered measurably. Hall and Wise (2010) found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact.
Pilbara Inshore (shelf)	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 regional-level community structure to an unacceptable level. Hall and Wise (2010) found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact.
Offshore Oceanic Shoals	Marine	LOW (non-fishing)	There is a number of specific oil and gas related offshore developments that are proposed in this region, particularly around Scott Reef. At the overall ecosystem level, however, there is only a minor risk that the ecosystem will be altered measurably.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Northern Pelagic	Marine	LOW	<p>Aside from shipping traffic, there are few other anthropogenic impacts to this system.</p> <p>A single fishery operates in the pelagic component of the North Coast Bioregion. Hall and Wise (2010) found no change in community structure of commercially captured finfish over the past 30 years consistent with a significant trophic impact.</p>

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine/ Nearshore	MODERATE	The barramundi and threadfin salmon stocks are considered to be at acceptable levels.
	Inshore (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 in determining 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	Estuarine/ Nearshore	LOW	There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas.
	Inshore (shelf)	MODERATE	There are a number of separate prawn stocks and fisheries within this bioregion that each has 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	Nearshore	LOW	The North Coast Trochus Fishery in King Sound is an indigenous fishery targeting the commercially important gastropod shell <i>Tectus niloticus</i> , commonly known as trochus. It is a hand collection fishery open to nominated fishers from the community. No fishing took place in 2012. The pearl oyster fishery only targets a very small section of the pearl oyster stock both spatially and within the available size range. Recent catches have been well below the quota levels due to low market demand but are beginning to increase again.
Echinoderm	Nearshore	LOW	Bêche-de-mer, also known as 'sea cucumbers' or trepang, are commercially harvested echinoderms (sea slugs) processed and sold for medicinal purposes in Asia. The majority of the effort has been expended in the Kimberly region, although there have been several years with substantial effort directed into the Pilbara region.

Protected species

Protected species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Reptiles	LOW	<p>Sea snakes and occasionally turtles are encountered in trawl catches. Both of these species are typically returned to the sea alive. Grids are now compulsory on trawl nets, which has largely eliminated the capture of any turtle or other large animal.</p> <p>Crocodiles are occasionally captured in nearshore/ freshwater fisheries' nets and most often are released alive.</p>
	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 trialed.

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Protected species	Species	Risk	Status and Current Activities
	Sea/Shore Birds	LOW	Anecdotal information from Lake Argyle fishers suggests that interactions with birds are very low. Additionally, the fishery is closed from 1 November to 31 December each year, during a high-use period for protected migratory birds.
	Elasmobranchs	MODERATE	The sawfish (Pristidae), spartooth shark (<i>Glyphis glyphis</i>) or the northern river shark (<i>Glyphis garricki</i>) are captured in small numbers by net fishing and trawlers in some areas of the Kimberley region. The area of these fisheries in which sawfish are vulnerable to capture is small relative to the total range of each species, suggesting limited impacts on each population. However, elasmobranchs grow and reproduce slowly, and even low levels of fishing mortality may be unsustainable.
Protected 'Fish' Species	Syngnathids and Solenostomids	LOW	Sea horses and pipefish are occasionally captured in trawl nets and fish/crab traps. The areas of each fishery in which syngnathids and solenostomids are vulnerable to capture is small relative to the total distribution of the species, which includes waters inshore of the fishery and fishery closed areas, as well as structured habitats where trawling does not occur.
	Other Fish	LOW	Recent video observations indicate that the potato cod is present in high numbers at discrete locations within the Kimberley region where the NDSF operates. Potato cod (<i>Epinephelus tukula</i>), a totally protected species, rarely enter fish traps due to their large size and girth limiting their capacity to pass through the entrance funnel into fish traps.

Benthic habitat

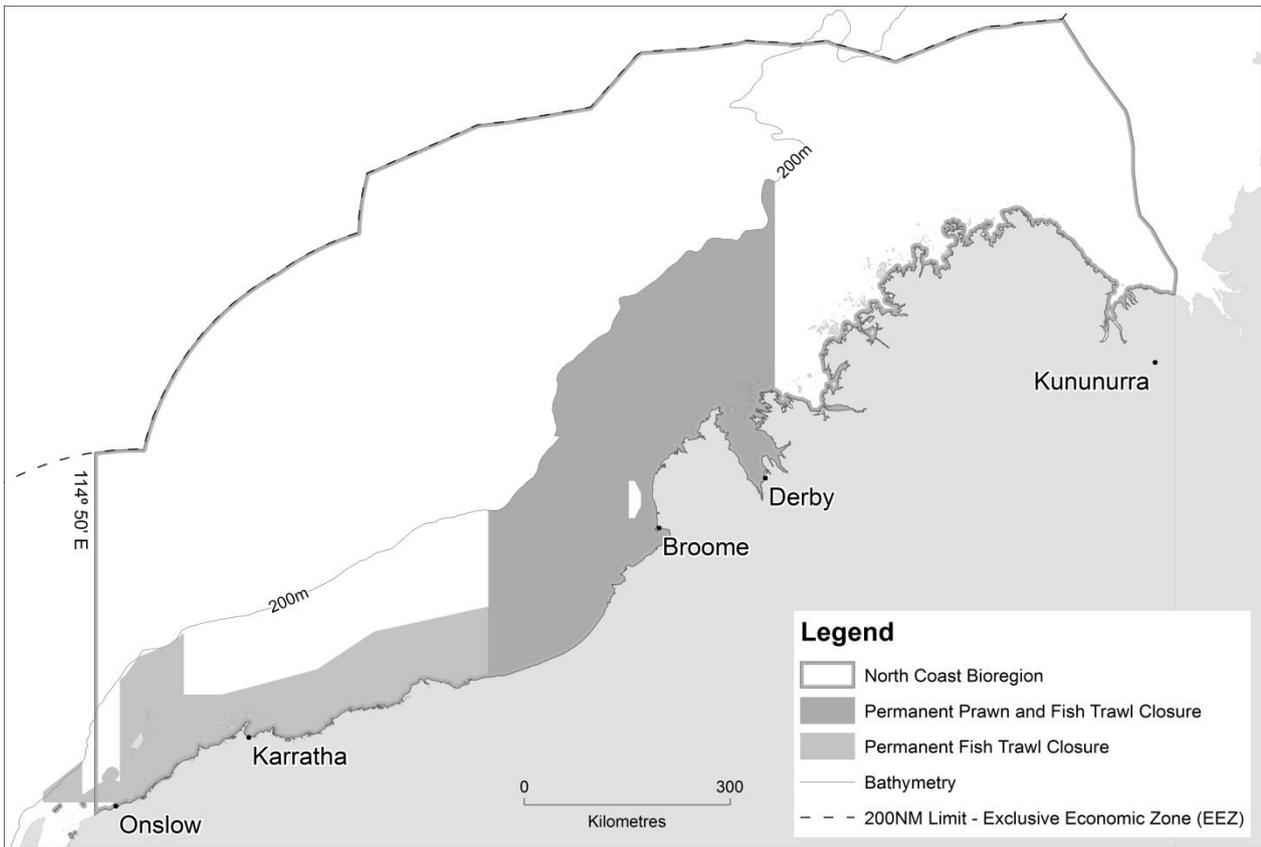
Benthic Habitat	Aquatic Zone	Category	Risk	Status and Current Activities
Kimberley Nearshore	Estuarine	Sand/Mud Mangroves	LOW (Non-fishing)	The main risks to nearshore habitats come from oil and gas resource development and the expansion of port facilities, plus periodic cyclones.
	Marine	Sand/Mud Sponge Reef Mangroves	LOW	The main fishing activities within the nearshore environment are hand collection fisheries, which actively avoid damaging benthic habitats in the fishing grounds.
Pilbara Nearshore	Estuarine	Sand/Mud Mangroves	LOW (Non-fishing)	See Kimberley Estuarine above.
	Marine	Sand/Mud Sponge Seagrass Reef	LOW	The majority of fishing activities in the Pilbara take place over mud and sand habitats. Prawn trawl activities are considered to have the highest impact of the methods used within the ecosystem; however, the spatial extent of trawling activities is small, and there are a variety of measures in place to manage any habitat impacts.
Kimberley Inshore (shelf)	Marine	Sand/Mud Sponge Reef	LOW	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 in the future as part of the proposed Camden Sound Marine Park monitoring.

Benthic Habitat	Aquatic Zone	Category	Risk	Status and Current Activities
Pilbara Inshore (shelf)	Marine	Sand/Mud Sponge Seagrass Reef	MODERATE (fishing) LOW (non-fishing)	Although fish trawling occurs in these areas, trawl activities are 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. The most likely potential impacts to the habitat in this area are from oil and gas infrastructure development and operation.
Offshore Oceanic Shoals	Marine	Sand/Mud Reef	LOW (non-fishing)	The main threat to benthic habitats in this ecosystem is from oil and gas development at Scott Reef. A small amount of line fishing also occurs around these offshore shoals and reefs and is likely to have a negligible impact on the benthic habitat.

External Drivers (NON FISHING)

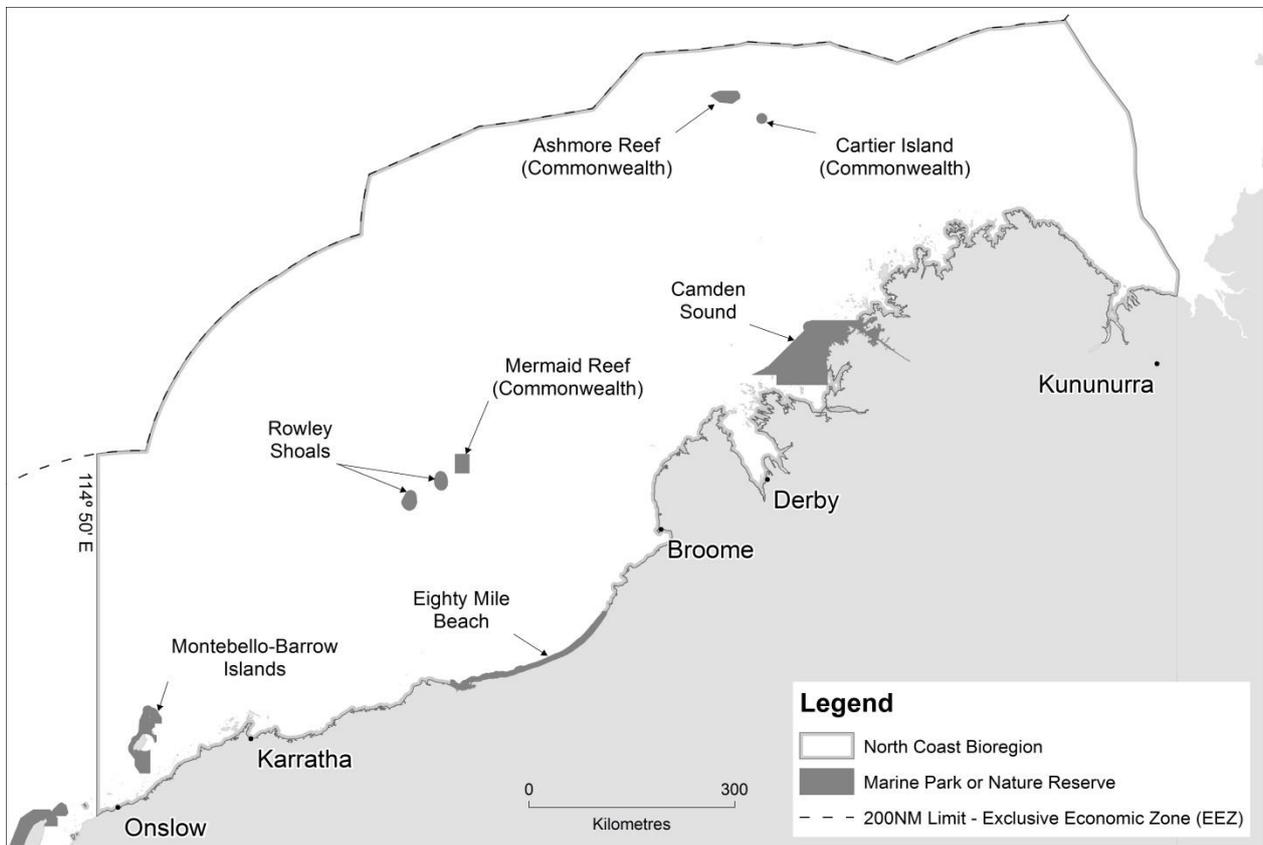
External Drivers	Risk	Status and Current Activities
Introduced Pests and Diseases	HIGH	The extremely high level of international shipping that operates in this region poses a high risk that an introduced pest may be introduced. The Department has implemented a targeted IMP monitoring and inspection program. For more information please refer to External Factors.
Climate	LOW	This area is predicted to have relatively minor impacts from climate change, especially in the coming decade compared to more southerly locations. A number of research projects to examine potential impacts are planned.
Oil and gas development	LOW	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 low risk that the ecosystem will be altered measurably. Some of the risks identified (e.g. increased turbidity) are being examined under WAMSI 2 projects. In addition, State and Commonwealth marine parks, including totally protected zones, are currently in place (State) or will be in place by 2014.

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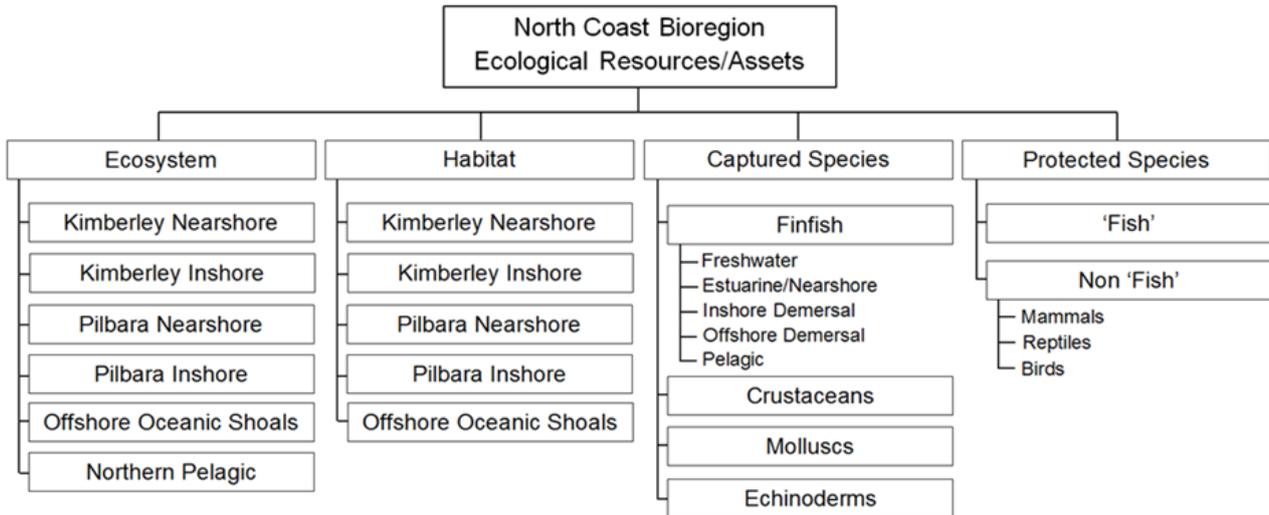
NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

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 and Monitoring group continue to implement a series of biosecurity related projects initially developed in 2010 in two ports in the North Coast Bioregion. The aim is to detect the early 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 is to be successful. Large-scale, nationally approved surveys of Dampier and Port Hedland ports were completed in early 2013. 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 the Marine Biosecurity Research and Monitoring group have developed complementary monitoring to occur every alternate year to

National monitoring. These surveys are scheduled for mid 2014. 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 and Monitoring group, with financial and *in-kind* assistance from Dampier and Port Hedland Port Authorities and stakeholders, is running an Early Warning System program 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 N. Blay

Main Features

Status		Current Landings	
Stock level	Adequate	Onslow:	nil
		Nickol Bay:	129 t
Fishing level	Acceptable	Broome:	12 t
		Kimberley:	329 t

Fishery Description

There four prawn fisheries that operate in the North Coast Bioregion include the Onslow (OPMF), Nickol Bay (NBPMF), Broome (BPMF) and Kimberley (KPMF) Prawn Managed Fisheries. These are all otter trawl fisheries and extend 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 OPMF and NBPMF 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 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 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 Management

Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), which is 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).

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. Fish Escape Devices are mandatory in all trawl nets. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats.

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 2012 season officially opened on 13 April and closed on 12 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Areas 1, 2, 3	13 April – 12 October
Fortescue SMFG	29 May – 30 September
Ashburton SMFG	13 May – 11 July
Weld Island SFMG	13 May– 31 August
Mangrove Island SFMG	13 May –12th October

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 2012 season opened on 15 March and closed on 22 October with subsidiary openings and closings of SMFG's. The specific SMFG openings were as follows:

Nickol Bay	29 May – 30 September
(Day fishing only 29 May – 18 June)	
Extended Nickol Bay SMFG	29 May –22 October
Depuch SMFG	29 May – 30 September
De Grey SMFG	29 May – 30 September

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 25 May and officially closed on 25 October, providing for 153 fishing nights. Two boats fished in the BPMF fishery this season for a limited time then left the fishery. 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 2012.

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, 45 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. There are permanent inshore closures and 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 2012 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 Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) 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.

In the OPMF a field-based consultative process is normally undertaken whereby industry and the Department's 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 2012 no commercial fishing was undertaken because of resource ventures in the region. The installation of the pipeline into the hinterland from platforms at sea and the construction of wharf facilities increased uncertainty of fishing viability in Area 1 the most productive area in this fishery. Area 3 was fished by one boat from the NBPMF, which has access to that part of the Onslow fishery.

For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana 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. Insufficient effort has occurred in this fishery since 2008 precluding the use of this analysis.

Retained Species

Commercial production (season 2012):

Onslow:	Nil tonnes
Nickol Bay:	129 tonnes
Broome:	12 tonnes
Kimberley:	329 tonnes

Landings

OPMF: No commercial trawling occurred by the dedicated Onslow licenced fishing boats therefore, no landings of major penaeids or byproduct for the 2012 season were recorded (Northern Prawn Figure 5).

NBPMF: The total recorded landings of major penaeids for the 2012 season were 129.4t, comprising: 129 t of banana prawns (124 t from the Nickol Bay fishery, and 5 t from Onslow, Area 3), and no recorded landings of king and endeavour prawns and a very low amount of tiger prawns (approximately 10kgs) (Table 1). The recorded landings of banana prawns in 2012 from Nickol Bay (124 t) was lower than the predicted catch of 165 t and slightly below the predicted catch range (130 to 200 t). (Northern Prawn Figure 6).

BPMF: Recorded landings for target species were very low at 12 t for king prawns and 4 t of coral prawns. No byproduct species was recorded in 2012 (Northern Prawn Figure 7).

KPMF: The total recorded landings in the KPMF were 329 t, comprising 323 t of banana prawns, 4 t of tiger prawns and 2 t of endeavour prawns (Northern Prawn Figure 8). Banana prawn landings were the highest since 2004 and within their target catch range (200-450 t) and slightly above the projected catch range (210 to 315 t) calculated using the relationship between summer rainfall and annual landings. Both tiger and endeavour prawns were below their target catch ranges. Fishing occurred in both fishing periods for 2012 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: No boats fished in 2012

NBPMF: Six boats fished during the 2012 season for an aggregated total of 186 boat days. This is a relatively low total effort and within the expected effort levels reflecting the moderate banana prawn abundance this season.

BPMF: A total of twenty nine nights of fishing effort was expended by two boats in 2012.

KPMF: Fifteen boats fished during 2012 for an aggregated total of 362 boat days. This is an increase compared to the 200 boat days fished in the 2011 season reflecting the economic conditions and targeting banana prawns at high

catch rates. Boats left the fishery when banana prawn catch rates declined hence the low catches of other prawn species. The total days was well below the 1500 aggregated days allocated to fish and similar to 2008 to 2011.

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 (2013):

NBPMF: **150 t banana prawns**

KPMF: **290 t banana prawns**

For the prawn stocks in the North coast region 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 recent series of low annual landings of prawns is still a feature in many of these northern fisheries and 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: No commercial fishing was undertaken in 2012, this was due to disturbance to the main fishing grounds in Area 1. This included construction of facilities on the hinterland for the delivery of gas via a pipeline from the offshore gas platforms, wharf construction and general boat movement in the area making fishing operations difficult. Since there was no effort or catch of tiger prawns in this part of the fishery adequate breeding stock would remain. This also applies for the king prawn stock. The dredging for the wharf facility and inshore disturbance for the construction of the pipeline facility is likely to cause short term loss of some nursery habitat and may change the hydrology for prawn movement in the immediate area. This disturbance may cause some loss of seagrass/algal habitats and may impact juvenile tiger prawns in the short term.

NBPMF: The landing of banana prawns 124 t overall (129 t overall) in 2012 was below the target catch range and slightly below the predicted catch range. All other species, tiger, king and endeavour prawn landings were well 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 2012 and March 2013 (at Roebourne) was 234 mm and the predicted catch for 2013 is around 150 t with a range of 120 –180 t of banana prawns.

BPMF: The very low fishing effort that occurred was reflected in the low king prawn landings of 12 t. While no stock assessment was completed in 2012, the king prawn catch rates of 44 kg/hr were the highest seen since 1998, but reflect the very low catch and effort levels. Because of the low effort only part of the fishery was exploited to its potential total catch. Since the king prawn catch rates have returned to historical levels, there has been interest from Licensees to consider fishing in this fishery in 2013.

KPMF: Banana prawns were within the target catch range (200 to 450 t) and the highest since 2004 despite the relatively low level of effort. However both tiger and endeavour prawns were very low and below their target ranges which is 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 good 2012 catch was expected given the high level of rainfall. This may be in part due to the slightly increased level of fishing effort due to the increased number of boats operating overall compared to the last three years. The predicted catch of banana prawns in 2013 is 290 t, with a range of 230 to 350 t.

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 2012 the breeding stock indicators in the OPMF (catches within specified ranges, as set out in the 'Fishery Governance' section) were not able to be measured because no fishing effort was applied or catch taken in this fishery.

The breeding stock indicator for banana prawns in the NBPMF was met and the landings were within the target catch range. Banana prawns were slightly below the projected range. There were no recorded king or endeavour prawn landings, therefore, they were below the target ranges. The tiger prawns landings were negligible and below the target range. This is likely to be a result of limited targeting of these species.

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 prawns were met as the landings were within the target range but slightly above the upper end of the projected range. Tiger and endeavour prawns were below the target range. This may be due to low levels of effort expended on these species as their behavior is quite different to that of the aggregating behavior of the banana prawns and generally are taken in the latter part of the season thus more effort or time on the fish grounds is required.

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: **Nil**
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.

OPMF: Nil

NBMF: Three sea snakes were reported as caught and released alive and no turtle captures were recorded.

BPMF: Three turtles were reported as captured but their status was not reported. Thirty sea snakes were reported of which 19 were released alive, 5 were dead and 6 reported as unknown status.

KPMF: One green turtle was reported as captured and the status was unknown. Thirty five sea snakes were reported as captured and 27 were returned to the sea alive whilst 1 was reported as dead and 7 status unknown. Four Saw fish were reported as captured, all with unknown return status.

Ecosystem Effects

Food chain effects: **Low**

For all the northern prawn fisheries and in particular the OPMF with no fishing 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:

OPMF, BPMF: **Negligible**
NBPMF, KPMF: **Low**

In 2012 the area fished in the three northern fisheries where fishing took place 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. Because there was no fishing in the OPMF the habitat effects was changed from low to negligible.

Social Effects

Estimated employment in these fisheries for 2012 was 45 to 65 including skippers and other crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for 2012:

OPMF/NBPF/BPMF:

Level 2 - \$1 - 5 million (\$1.5 million)

KPMF: Level 2 - \$1 - 5 million (\$3.1 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.

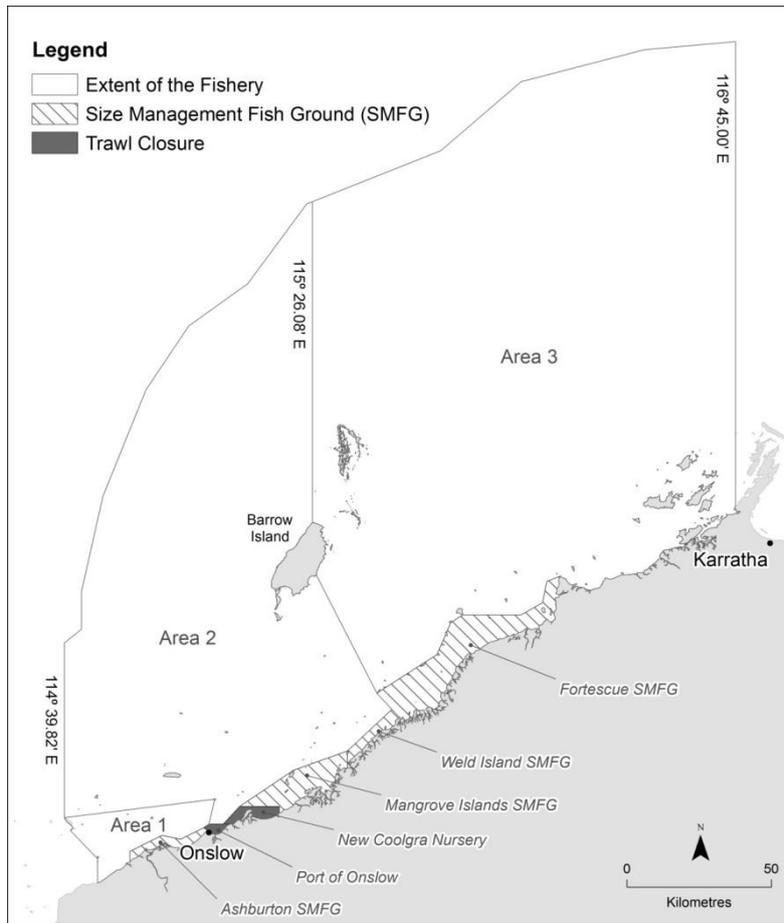
New management initiatives (2013): None

External Factors

The resource industry developments in the OPMF during 2012 have created uncertainty about the access to prawn abundance in traditionally high catching fish grounds and overall viability of operations therefore no fishing took place in 2012.

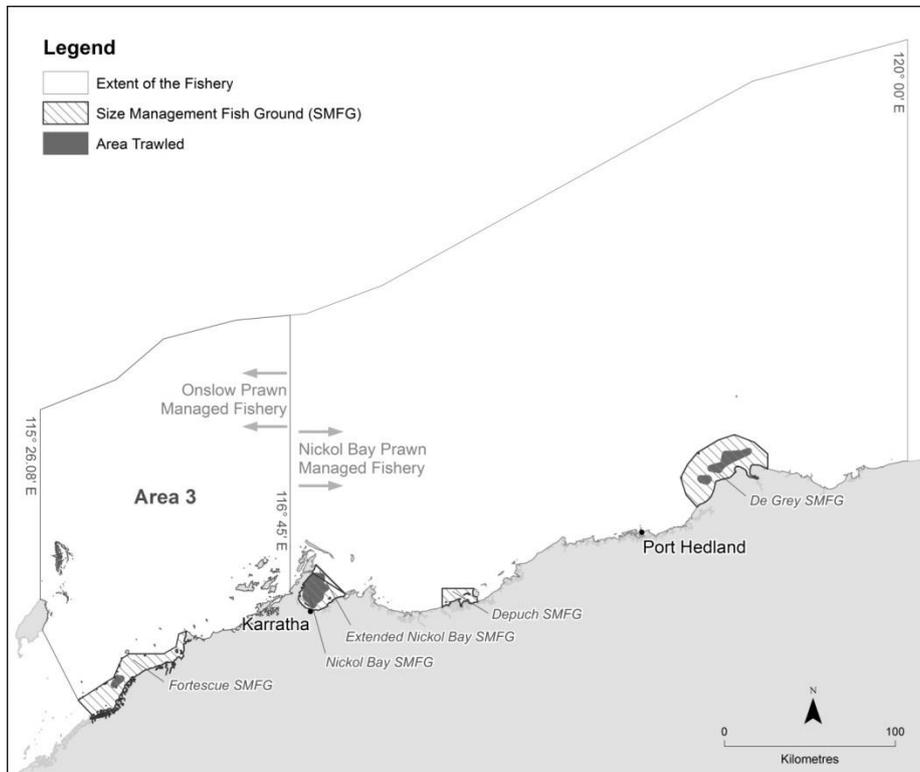
Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River. Due to high costs of fishing and low prawn prices, some boats in these fisheries are choosing 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.



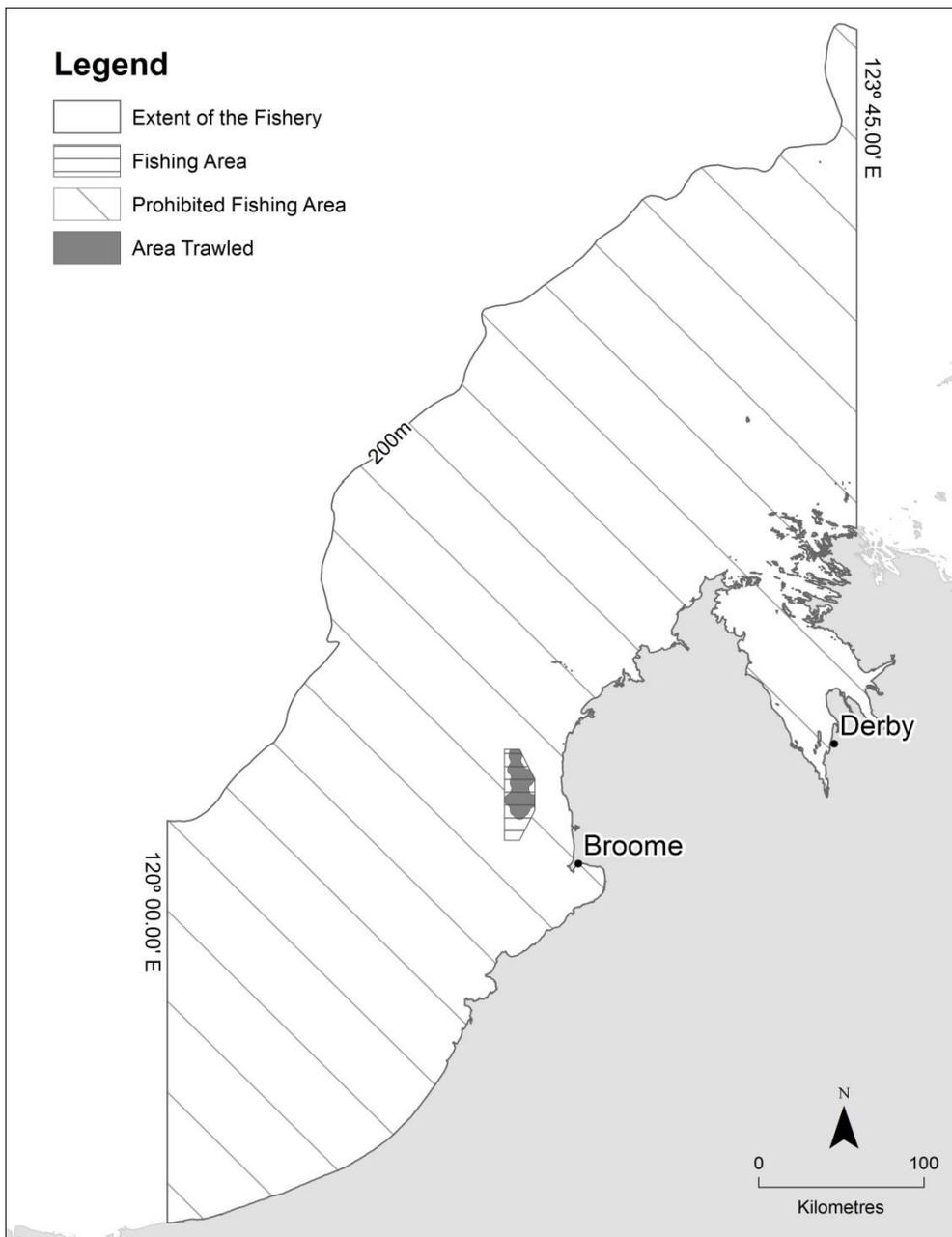
NORTHERN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds. No fishing took place in 2012.



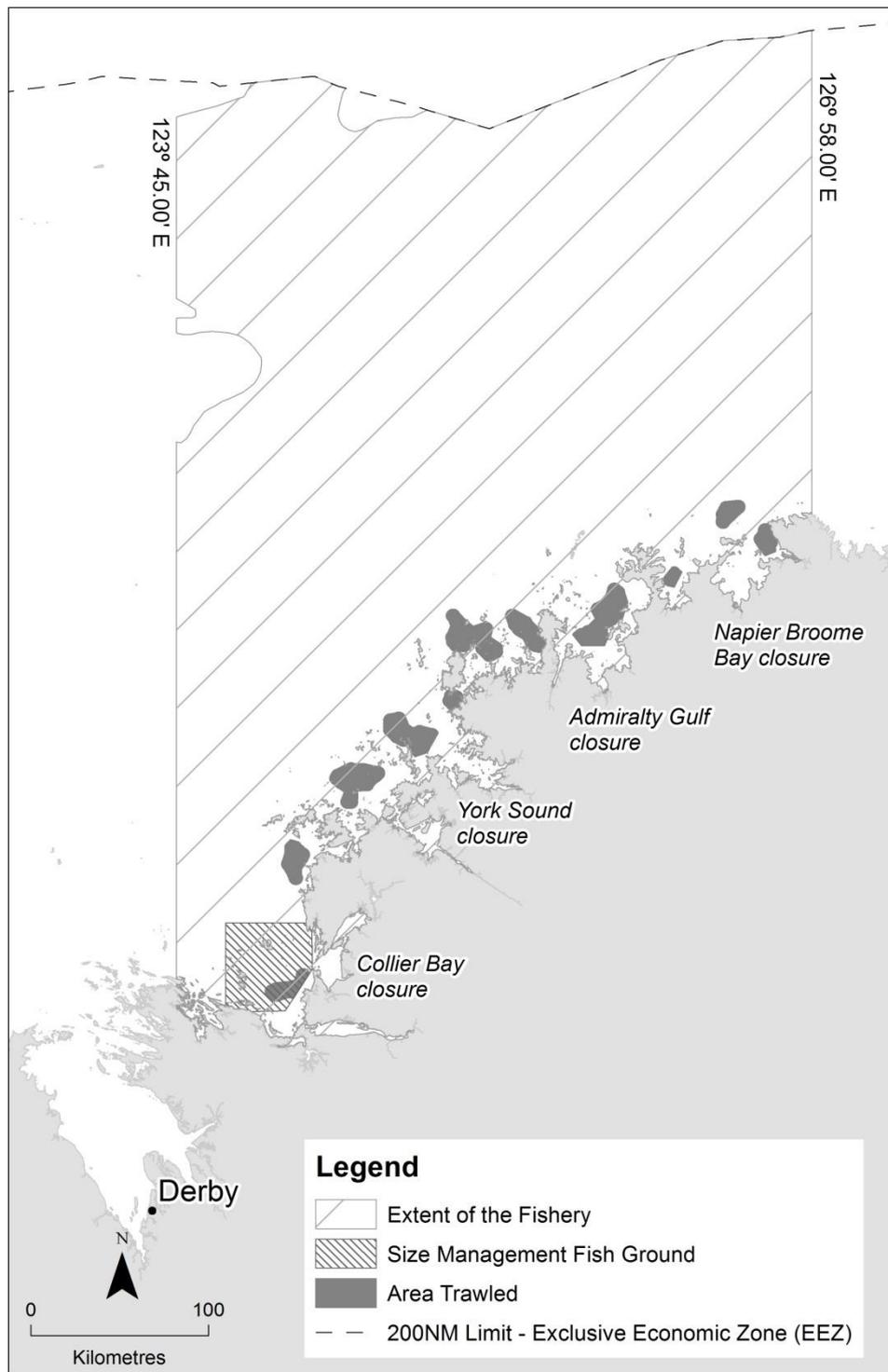
NORTHERN PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2012.



NORTHERN PRAWN FIGURE 3

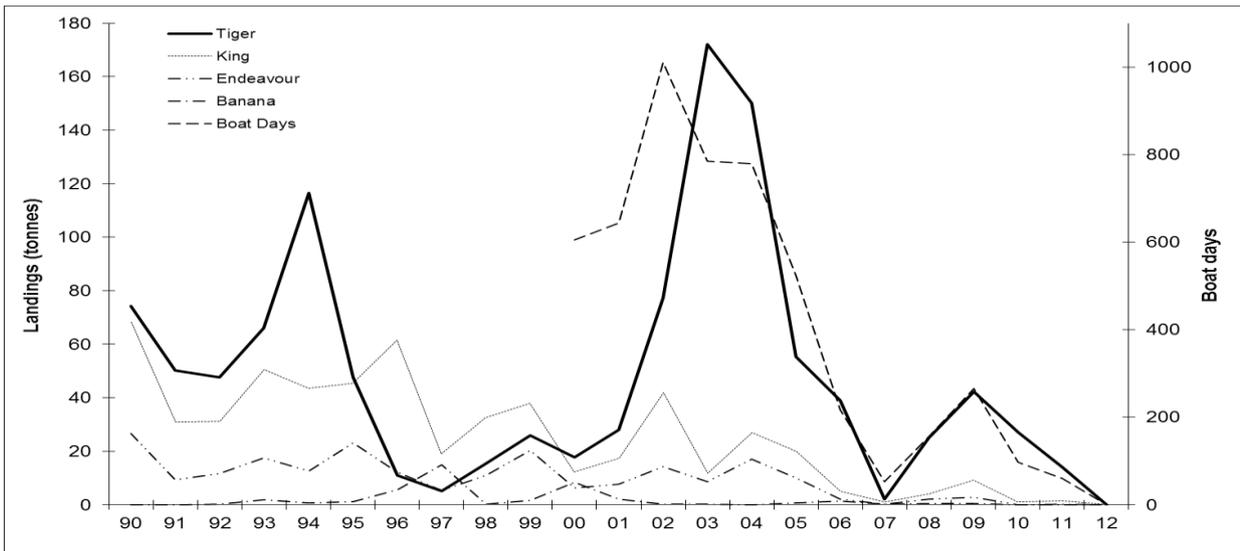
Boundaries of the Broome Prawn Managed Fishery indicating area trawled in 2012.



NORTHERN PRAWN FIGURE 4

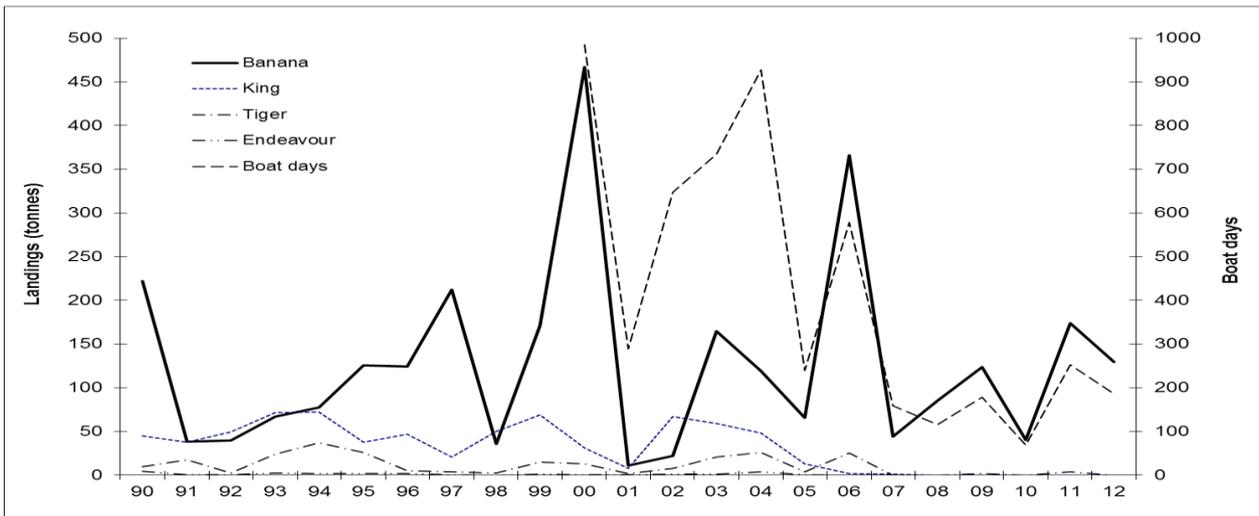
Areas fished in the Kimberley Prawn Managed Fishery in 2012, Size Management Fish Grounds and the inshore trawl closures.

NORTH COAST BIOREGION



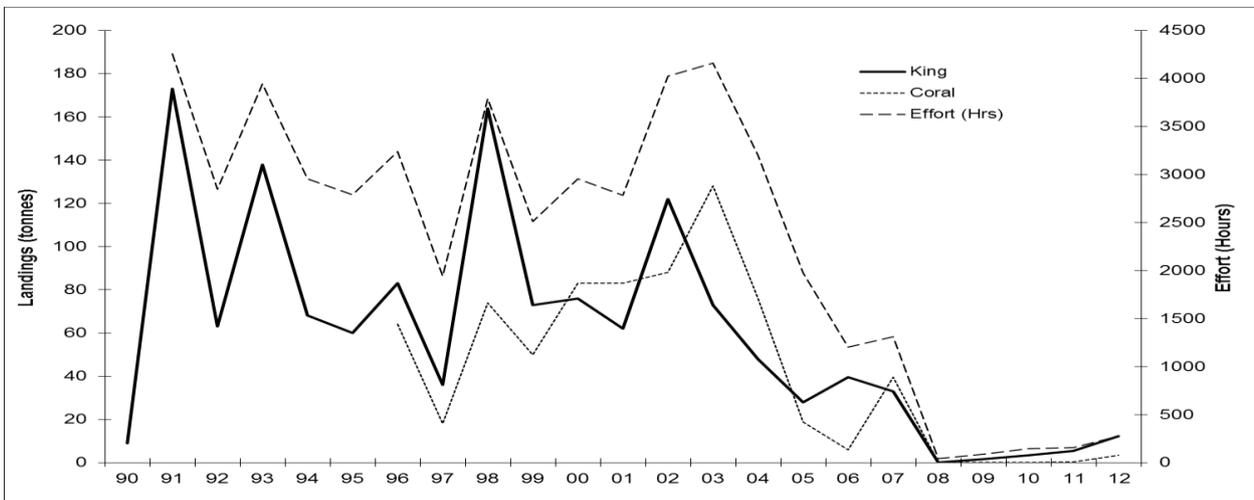
NORTHERN PRAWN FIGURE 5

Annual landings and number of boat days (from 2000) for the Onslow Prawn Managed Fishery, 1990 – 2012.



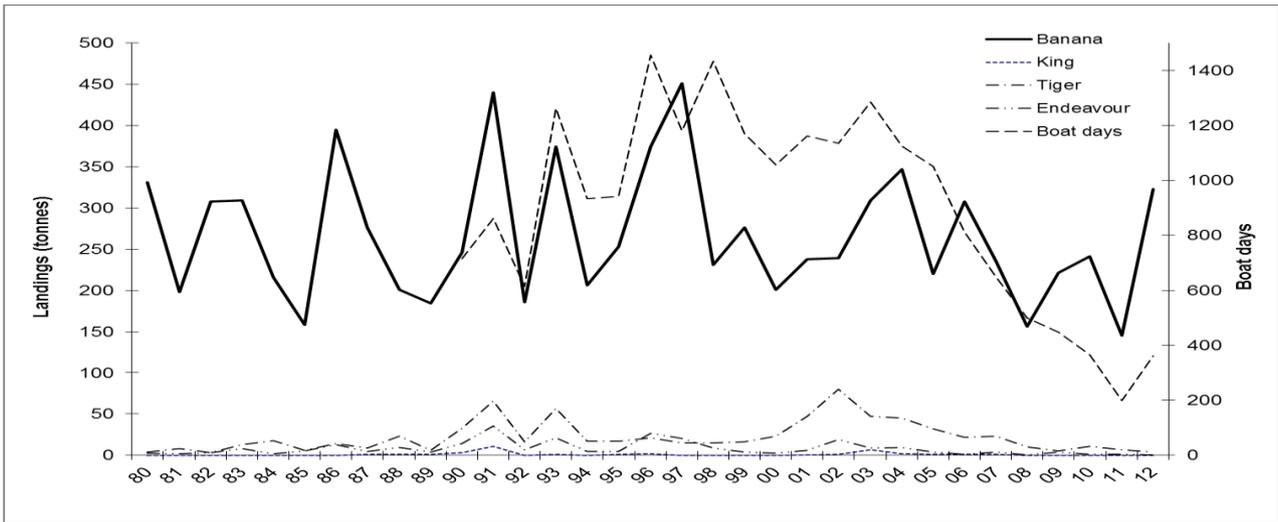
NORTHERN PRAWN FIGURE 6

Annual landings and boat days (from 2000) for the Nickol Bay Prawn Managed Fishery, 1990 – 2012.



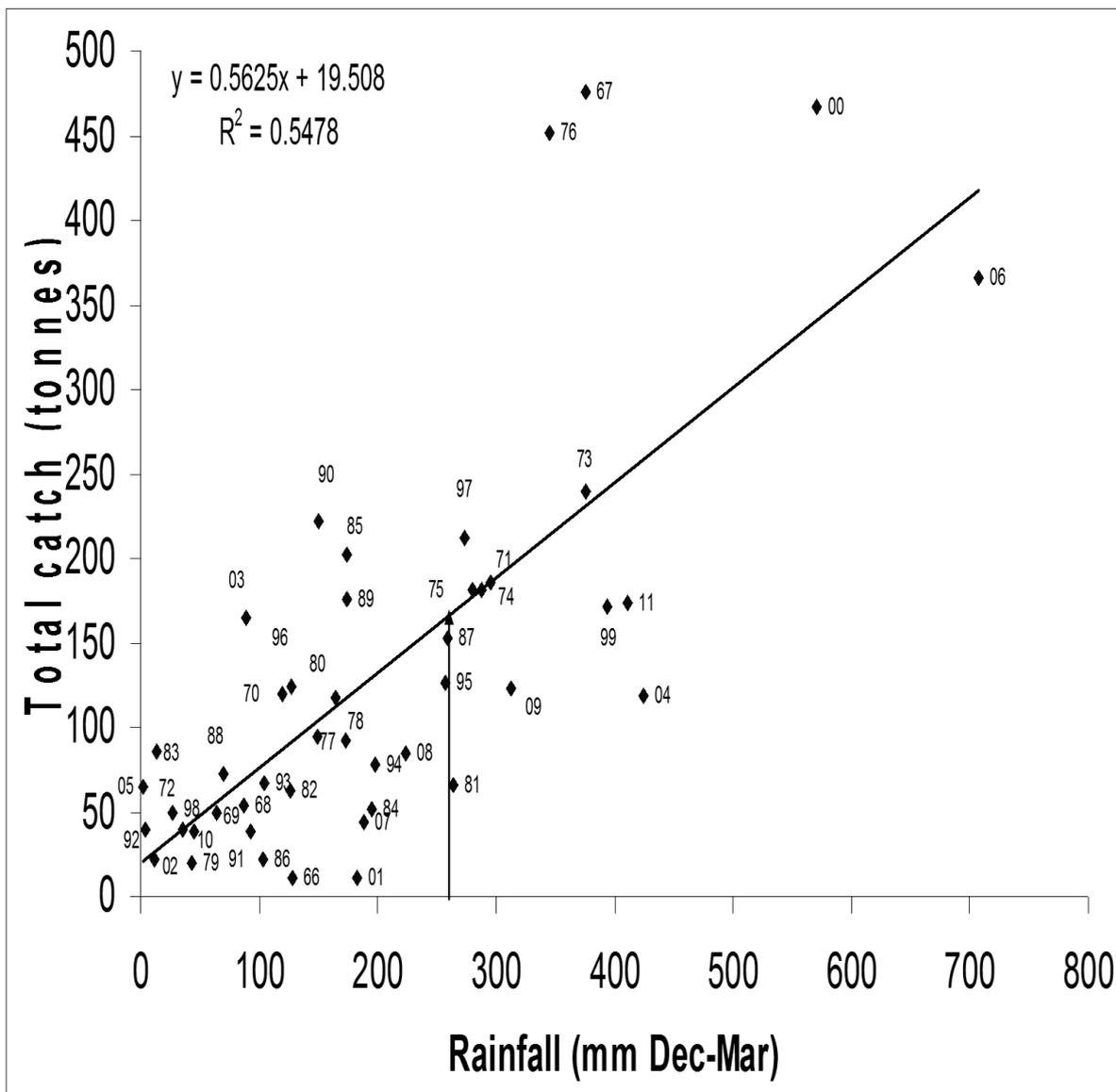
NORTHERN PRAWN FIGURE 7

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2012.



NORTHERN PRAWN FIGURE 8

Annual landings and number of boat days (from 1990) for the Kimberley Prawn Managed Fishery, 1980 – 2012.



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, C. Skepper, G. Mitsopoulos, A. Thomson, R. Marriott and P. Carter

Main Features

Status		Current Landings	
Stock levels	Acceptable	Total	91.0 t
		Barramundi	39.7 t
Fishing Levels	Acceptable	Threadfin	46.2 t
		Recreational	20% of total (last estimate 2012)
		Charter	< 7 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 end 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 (Kimberley Gillnet Figure 1).

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 Western Australian Fishing Industry Council (WAFIC), who are also responsible for statutory management plan consultation under a Service Level Agreement with the Department.

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

Commercial

The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47' south latitude' (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 (see Kimberley Gillnet Figure 1). 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).

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

Fish species in the North Coast Bioregion are assigned bag and size limits according to their aquatic environment (ecological suite) and risk to sustainability 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) to ensure that breeding stock levels are maintained. These bag and size limits have been revised and new simpler rules that apply across most bioregions will be effective in 2013. These new rules include the following: barramundi (individual daily bag limit and possession limit of 2 fish, minimum legal length (MLL) of 550 mm and a maximum size limit of 800 mm); black jewfish (individual daily bag limit of 2 fish, MLL 700 mm); king threadfin (individual daily bag limit of 2 fish, MLL 450 mm); other threadfin species (individual daily bag limit of 4 fish) and tripletail (individual daily bag limit of 2 fish, MLL 300 mm).

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 fisheries' management officers.

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 by

Welch *et al.* (2010)³ and will be considered in future monitoring and assessment programs. Estimates of recreational boat and shore based catches were assessed in 1999/2000 (Williamson *et al.* 2006)⁴ and an integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013)⁵.

Retained Species

Commercial landings (season 2012):

All species	91.0 tonnes
Barramundi	39.7 tonnes
Threadfin	46.2 tonnes

The principal species landed are barramundi and two species of threadfin (king threadfin and blue threadfin). 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 (Family Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays. Sawfish (Family 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 2012 was 91t (Kimberley Gillnet Figure 2). The total landings of barramundi from the KGBF were 39.7 t for 2012 (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 3), an increase on the reported catch of 28.5 t in 2011. The 2012 landings of threadfin from the KGBF were 46.2 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), lower than that reported in 2011 (74.2 t) and represent the lowest catch level reported from the fishery over the last decade (Kimberley Gillnet Table 1). The composition of the KGBF catch in 2012 is summarised in Kimberley Gillnet Table 2.

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. 172 pp.

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. 132 pp.

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., 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. 180 pp.

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, 61 pp.

5 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

Recreational catch estimate (last estimate

2011/12): 20% of total catch

The recreational catches from boat-based fishers in 2011/12 were estimated to be approximately 8.4 t of barramundi and approximately 7.0 t of threadfin.

The estimate that the recreational catch in 2011/12 was 20% of the total catch is not directly comparable to the 1999/2000 survey results (Williamson *et al.* 2006).

Estimates of the recreational catch by boat-based fishers for barramundi will be underestimated as shore-based fishers and boat-based fishers that fished only in freshwater were out of scope of the 2011/12 survey.

The reported charter vessel catches for the North Coast Bioregion in 2012 were estimated to be approximately 4.8 t of barramundi and approximately 1.4 t of threadfin.

As such, there is an estimated annual harvest of 13.2 t of barramundi (recreational + charter) reported in the North Coast Bioregion. In addition, there is an estimated annual harvest of 8.4 t of all threadfin (recreational + charter) reported in the North Coast Bioregion.

Even though these data underestimate the recreational catch, the recreational catch (i.e. recreational + charter) can be estimated at around 20% of the total (commercial and recreational) barramundi and threadfin catch in these areas in 2012. Separately, the recreational catch of barramundi can be estimated at around 25% of the total (commercial and recreational) catch in these areas in 2012; whereas the recreational catch of threadfin can be estimated at around 15% of the total (commercial and recreational) catch in these areas in 2012.

Fishing effort/access level

Commercial

The effort reported in the fishery this year is kg per block day. The effort used in the fishery is currently being reviewed. Fishing practices vary across the industry and are not uniform. For example, some fishers actively fish there nets for a few hours while others leave there nets in the water for up to 24 hours. Furthermore, reporting practices are inconsistent across time. It is anticipated that effective effort in the fishery, once validated, will reflect the total length of net set and the time that net is set in the water. During 2012, the total effort across the fishery was 511 block days, a decrease on the 2011 effort figure of 598 block days and considerably below the effort reported from 2008 to 2010 (a range of 800-935 block days). This decrease in effort is linked to one vessel not operating in 2012, thus reducing the overall effort in the fishery and in particular the effort expended in Roebuck Bay. There is considerable latent effort in the KGBF.

Recreational

A summary of the key findings of the integrated survey of boat-based recreational fishing in regards to Barramundi, Blue and King threadfin by Ryan *et al.* (2013) are provided below.

- Recreational catches of Barramundi by RFBL holders aged five years or older occurred in the North Coast Bioregion. The majority of the boat-based recreational catch of barramundi was released or discarded (72%).

The majority of the catch was taken in estuary habitats (64%), but also in freshwater (21%) and nearshore areas (16%). Barramundi were harvested throughout the year, with higher catches observed in winter (38%), spring (29%) and autumn (20%). All the barramundi catch was taken by line-fishing.

- All recreational catches of Blue and King threadfin by RFBL holders aged five years or older occurred in the North Coast Bioregion. Similar proportions of the boat-based recreational catch of Blue threadfin were retained (54%) and released (46%). Catches were taken predominantly from nearshore habitat (86%), but also estuarine habitats (14%). Blue threadfin were harvested throughout the year, with higher catches observed in winter (71%) compared with spring (6%), summer (3%) and autumn (20%). All catches were taken by line fishing.
- The majority of the boat-based recreational catch of King threadfin was retained (66%). Catches were taken from estuary (51%) and nearshore (49%) habitats. King threadfin were harvested throughout the year, with higher catches observed in autumn (45%) and spring (42%) compared with winter (4%) and summer (9%). All catches were taken by line fishing.

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 increased in 2012 due to an increase in catch and also effort levels along the Kimberley Coast and in the Cambridge Gulf area. Fishing effort in the Broome Coast and King Sound areas was substantially lower than that reported in recent years. The level of catch of threadfin was much reduced in 2012 due to a decrease in effort levels in the Broome Coast fishing area.

The commercial catch rates for barramundi in the KGBF increased in 2012 (77.7 kg/block day) to the highest level reported since 1990 (Kimberley Gillnet Figure 3). The catch rate for threadfin in 2012 (178.1 kg/block day) across the fishery was slightly lower than that reported in 2011 (184.7 kg/block day; Kimberley Gillnet Figure 4). The catch rate for threadfin in the Broome Coast area was similar between 2011 (205.1 kg/block day) and 2012 (204.1 kg/block day) despite effort (block days) being almost 50% less than that reported in 2011.

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 (planned for 2015/16). 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. In 2012, protected species interactions were reported for both crocodiles and sawfish.

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 poses a minimal risk 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 and is typically mud flat areas.

Social Effects

Commercial

During 2012, six vessels fished in the KGBF with an average crew level of approximately 2.7 people, with an estimate of at least 16 people directly employed in the fishery. There was additional employment through local processors and 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 2011-12:

Level 1 - < \$1 Million

The value of the North Coast Nearshore and Estuarine Fishery was 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 2011-2012 financial year.

The KGBF principally targets the high-value species barramundi and threadfin. The fishery's score value in 2011-12 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 fishery 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 32-45 tonnes

Current Fishing (or Effort) Level: Acceptable

The target catch range for barramundi (32–45 t) represents a confidence interval that describes the general range of total catches during a stable time period for this fishery, 1989 through to 1999. This interval was calculated using the standard deviation of the observed catches over this period. For most years, the level of barramundi catch is within the target catch range. The barramundi catch in 2001 and from 2008-2010 was above the target range, as a result of increased effort levels in different areas of the fishery. In only 2 years (2007 and 2011) was the barramundi catch below the target catch range. This reduced catch was associated with reduced effort levels in the fishery. The 2012 catch is within the target range. However, there is no risk to the sustainability of the stocks.

A review of the fishery is planned for 2015/16 and will include reviews and updates of 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.

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

New management initiatives (2012/13)

The KGBF management plan was amended in June 2012 to modernise the fishery management arrangements. The next management review of the fishery is due after the 2015 /16 financial year.

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.

The KGBF is planned to undergo MSC pre-assessment in late 2013.

KIMBERLEY GILLNET TABLE 1

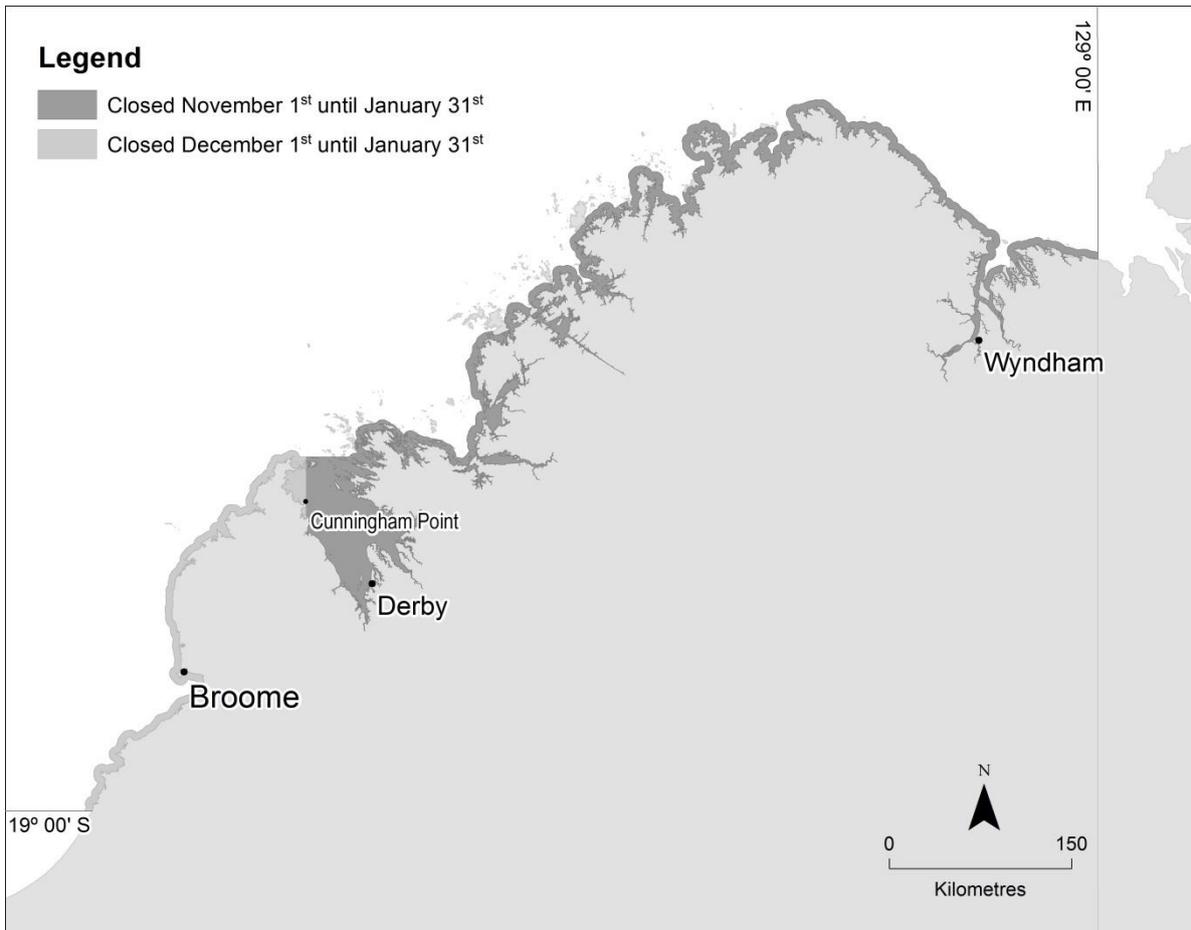
Annual catches of the major target species by the KGBF from 2000-2012.

Species	Kimberley Gillnet Annual Catch (tonnes)												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	39.7
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	46.2
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	91.0

KIMBERLEY GILLNET TABLE 2

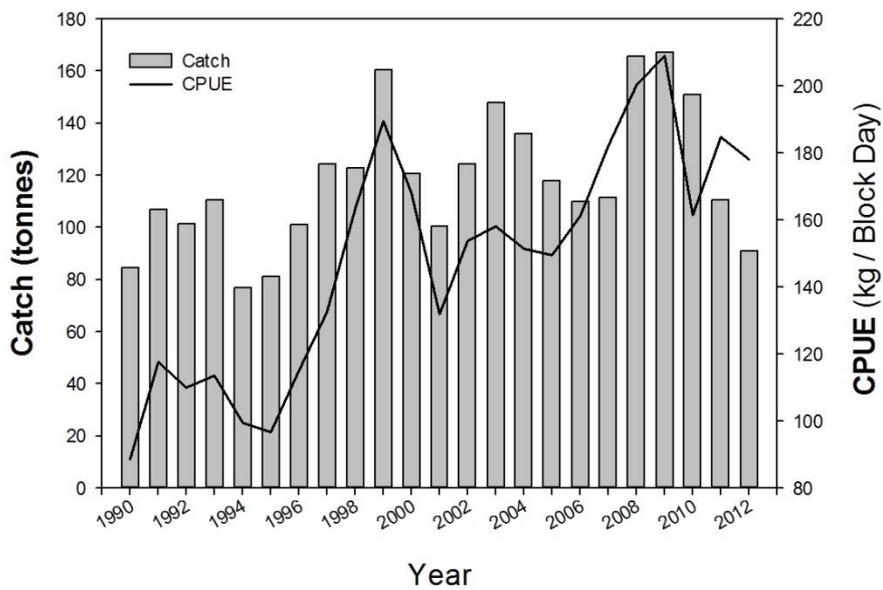
Summary of the reported catch (t) in the KGBF in 2012 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	46.2	50.7
Barramundi	39.7	43.6
Tripletail	0.7	0.8
Black jewfish	1.5	1.6
Sharks and rays	0.9	1.0
Other fish	2.0	2.2
Total	91.0	100



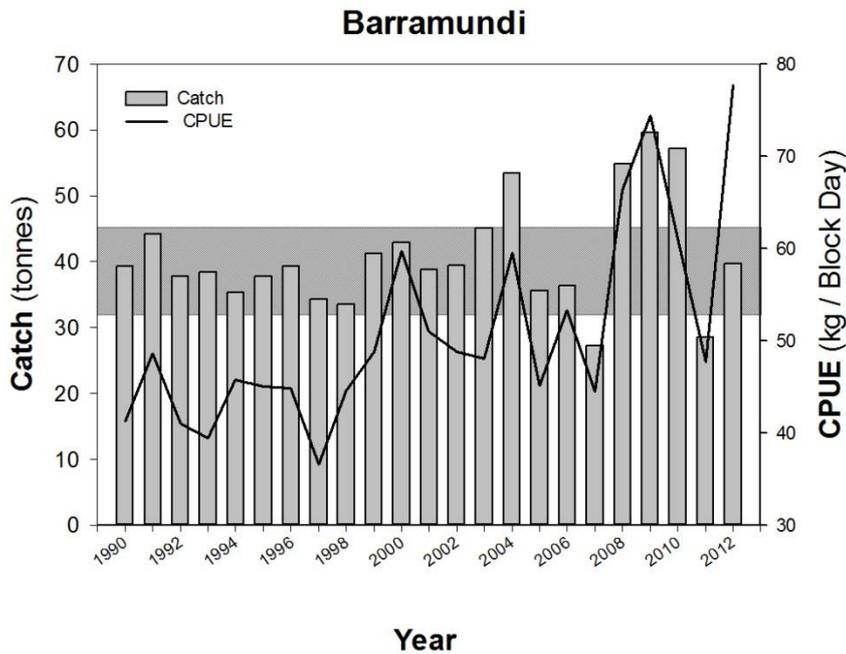
KIMBERLEY GILLNET FIGURE 1

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



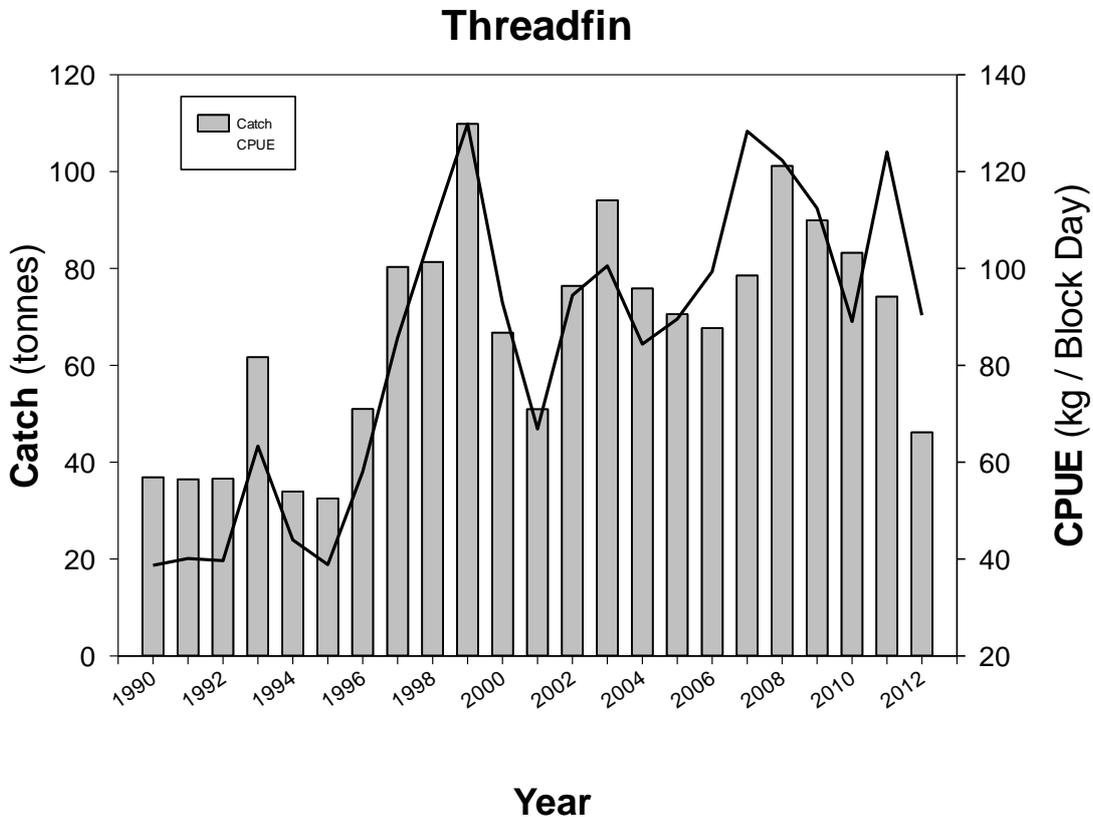
KIMBERLEY GILLNET FIGURE 2

The annual total catch and catch per unit effort (CPUE, kg block day⁻¹), from all areas of the KGBF including sharks and rays over the period 1990 to 2012.



KIMBERLEY GILLNET FIGURE 3

The annual catch and catch per unit effort (CPUE, kg block day⁻¹) for barramundi from the KGBF over the period 1990 to 2012. The upper and lower bounds of the target commercial catch range for barramundi are shown by the shaded catch area between 32 and 45 tonnes.



KIMBERLEY GILLNET FIGURE 4

The annual catch and catch per unit effort (CPUE, kg block day⁻¹) for threadfin from the KGBF over the period 1990 to 2012.

North Coast Demersal Fisheries Status Report

S.J. Newman, C. Wakefield, C. Skepper, D. Boddington and P. Dobson

Main Features

Status

Pilbara:

Stock level Adequate

Fishing Level

Trawl Fishery Acceptable

Trap Fishery Acceptable

Line Fishery Acceptable

Kimberley:

Stock level Adequate

Fishing Level Acceptable

Current Landings

Total North Coast Demersal landings 2,913 t

Recreational (top 10 demersal) 77 t (~3% of total)

Pilbara:

Total 1,806 t

Red emperor 122 t

Rankin cod 82 t

Bluespotted emperor 210 t

Pilbara Fish Trawl Fishery 1,312 t

Pilbara Fish Trap 416 t

Pilbara Line 77 t

Charter ~24.3 t (1.4% of total)

Kimberley (NDSF):

Total 1,107 t

Red emperor 134 t

Goldband snapper 487 t

Charter ~11.8 t (1.1% 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) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number it also includes some deeper offshore species, e.g. ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus*)

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

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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.

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

Commercial

Pilbara

The Pilbara Fish Trawl Interim Managed 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 1). The fishery is further divided into two fishing areas; an inshore sector (Area 1) and an offshore sector (Area 2; see North Coast Figure 1). Under a voluntary industry agreement (soon to be formalised in the *Northern Demersal Scalefish Managed Fishery Management Plan 2000*), 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 1).

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 trawl 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.

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's Environment Department, 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 exempt from export controls under the List of Exempt Native Species until November 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. 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. In 2012 an Exemption provided 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 additional access to Zones A and C will be provided in the 2013 licensing period via units of entitlement on Area 2 Managed Fishery Licences.

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 2012, 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 2012, 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 2012, 9 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 iconic 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 statutory 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 as reported in statutory logbooks and time spent in each management area derived from VMS pollings) 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

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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 involved an ecological assessment of the demersal fish assemblages and habitat characteristics across trap, trawl and targeted fisheries closed (Area 3) management areas. The results of that survey are currently being collated.

An intense six month independent observer program designed to monitor bycatch and interactions with endangered, threatened and protected species was completed in December 2012 in order to meet a specific set of conditions from SEWPaC within the current WTO for the Fishery. The outcomes of the observer program will be reported in a Fisheries Research Report in 2013.

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 ca. 5 years using an age-based stock assessment model where applicable to assess the status of two indicator species, red emperor and goldband snapper, based on age-composition data collected in previous years. The next assessment (nominally due in 2014) will incorporate age composition data collected during 2012 from two surveys conducted on board industry vessels. Age composition data were collected from both fixed and random sites within the fished areas of Zone B of Area 2 of the NDSF. 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. 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 2012):

Pilbara Fish Trawl	1,312 tonnes
Pilbara Fish Trap	416 tonnes
Pilbara Line	77 tonnes
Kimberley (NDSF)	1,107 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 2012 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 an annual average catch of close to 2,500 t during the period 1995 – 2004 to an average of 1,182 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 six consecutive years, with 1,312 t landed in 2012 (North Coast Table 2). These lower annual catches are considered to be a response to the effort reductions imposed on the trawl fishery since 2008.

The catches of the major target species landed by the trawl fishery were generally higher in 2012 than the previous year, i.e. crimson snapper 182 t (130 t in 2011), bluespotted emperor 151 t (152 t in 2011), rosy threadfin bream 102 t (79 t in 2011), brownstripe snapper 90 t (63 t in 2011), goldband snapper 75 t (56 t in 2011), red emperor 62 t (54 t in 2011), saddletail snapper 52 t (43 t in 2011), spangled emperor 15 t (18 t in 2011) and Rankin cod 16 t (12 t in 2011). The total retained byproduct was 17 t (18 t in 2011) and included bugs, cuttlefish, and squid (North Coast Table 2).

The total annual catch taken by the Pilbara trap fishery has remained relatively consistent since 2004 averaging 451 t per year and remaining within the target catch range of 400-500 t (North Coast Tables 1 and 2). The total catch of 416 t in 2012 was slightly lower than the 2011 catch (North Coast Table 2). The major species taken by the trap fishery in 2012 were Rankin cod 64 t (60 t in 2011), red emperor 60 t (62 t in 2011), bluespotted emperor 59 t (71 t in 2011), goldband snapper 56 t (74 t in 2010), and crimson snapper 39 t (49 t in 2011).

The total annual catch of scalefish taken by the line fishery is historically much lower than that taken annually by the trawl and trap fisheries (North Coast Tables 1 and 2). In 2012, the total annual catch for the line fishery was 77 t, which was lower than that taken in 2011 but within 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 2012, the ruby snapper catch was 26 t (30 t in 2011) and the goldband snapper catch was 9 t (20 t in 2011) (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 need to be considered in any future assessment or development of a harvest strategy.

Kimberley

After the initial development period from 1990 to 1992, the catch of the NDSF reached the first peak in catch (> 900 t) in 1996 before declining to levels of about 500 t in 2003 (North Coast Figure 3). The total catch began to increase again in 2003, and the past five years have the highest recorded catches (> 1,000 t) since the inception of the fishery. The total catch in 2012 of 1,107 t is the second highest catch recorded during this period, with the Zone B catch (934 t) the highest ever recorded from this sector of the fishery. Catches in Zone A of the fishery remained relatively high (172 t), although they have continued to decline slowly since the peak catch in 2010 of 201 t (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 2012 is similar to that reported in 2011, with goldband snapper dominating the landed catch. The landed catch of goldband snapper in 2012 was similar to that reported in 2011 (487 t). Catch levels of goldband snapper have remained high since the peak goldband snapper catch of 523 t that was reported in 2010. The last three 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 2012 was 134 t. Although the catch of red emperor in 2012 was slightly higher than the landed catch reported in 2011 (128 t), recent catches of red emperor have shown an overall declining trend since 2005. The cods/groupers catch in 2012 (170 t) was higher than that reported in 2011 (155 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 increased from 41 t in 2011 to 52 t in 2012 (North Coast Table 7).

The catch rate of red emperor in Zone B in 2012 increased slightly, although the catch rate is low when compared to catch rates for this species reported from 2005-08 (North Coast Figure 4). The catch rates for goldband snapper in Zone B decreased slightly, but remained within the higher range reported since 2008. These high levels of catch rate (2008–2011) have followed the sharp increase in catch rates for goldband snapper from 2006 (North Coast Figure 5). The catch rate for the cod/grouper complex in Zone B in 2012 increased significantly, and is the highest recorded for this species complex. This continues a period of generally increasing catch rates for this species complex since 2005, with particularly high levels of catch rate since 2010 (North Coast Figure 6).

The 2012 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 threshold level (20% increase in average catch of the previous 4 years).

Recreational catch estimate (season 2012):

Pilbara	~3%
Kimberley	~3%

North Coast Bioregion

An integrated survey of boat-based recreational fishing in WA was conducted during 2011/12 (Ryan *et al.* 2013¹). Estimates from this survey are not directly comparable to the survey conducted in 1999/2000 (Williamson *et al.* 2006²).

1 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. 2013. An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

2 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

A total of 153 finfish species were taken in the North Coast Bioregion (both Pilbara and Kimberley; Ryan *et al.* 2013). The most common were: stripey snapper (14%), grass emperor (12%), spangled emperor (9%), barcheek coral trout (4%), and barramundi, blackspot tuskfish, blackspotted rockcod, blue tuskfish, golden trevally and Spanish mackerel (3% each). These 10 species accounted for 57% of the total catch (by numbers). There is little overlap with the main species landed by recreational fishers and those landed by the commercial fisheries covered in this report.

An estimated annual harvest of 76.9 t was reported for the top 10 demersal species in the North Coast Bioregion (Ryan *et al.* 2013). In terms of estimated harvest, the dominant demersal species were grass emperor (16.1 t), spangled emperor (14.8 t), barcheek coral trout (11.2 t) and red emperor (9.3 t). Even though the catch estimate of the top 10 demersal species is an underestimate of the total recreational catch, the total demersal recreational catch can be estimated to be at least ~3% of the combined (commercial and recreational) demersal scalefish catch in the North Coast Bioregion in 2012. In addition, the red emperor recreational catch can be estimated to be ~4% of the combined (commercial and recreational) red emperor catch in the North Coast Bioregion in 2012.

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 reported charter vessel catch of demersal scalefish in the waters of the Pilbara demersal fisheries in 2012 was estimated to be 24.3 t (red emperor – 3.3 t; Rankin cod – 7.6 t; spangled emperor – 2.3 t). The Pilbara charter vessel catch is estimated to be ca. 1.4% of the Pilbara commercial catch of demersal fish.

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 waters of the Kimberley demersal fishery in 2012 was estimated to be 11.8 t (grass emperor – 3.5 t; golden snapper – 3.0 t; goldspotted/blackspotted rockcod – 1.6 t). The Kimberley charter vessel catch is estimated to be ca. 1.1% of the Kimberley commercial catch of demersal fish.

Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is concentrated in the Broome sector of Area 1, which is closed to commercial fishing on demersal species. The magnitude of recreational fishing

catch in offshore areas 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 of these species taken from nearshore and inshore demersal waters of the NDSF.

Fishing effort/access level

Pilbara

Fishing effort utilisation by the trawl and trap sectors of the commercial fishery are monitored using VMS. Fishing effort for the trawl fishery is also recorded as the net bottom time (hours) in statutory logbooks. Information on fishing effort (days) for the trap and line fisheries are recorded in monthly catch and effort returns (North Coast Table 3).

The trawl fleet had the equivalent of three full-time vessels in the 2011/12 season. The percentage of allocated hours used by the trawl fleet during the 2011/12 season were 83% in Area 1, 110% in Area 2 (noting that vessels can exceed their entitlement within an area by 48hr as long as overall entitlement is not exceeded), 82% in Area 4 and 64% 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 2012, trap fishers were allocated 5,456 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 98% of the units used as calculated from the VMS.

In 2012, line fishers reported operating for 328 days, compared with 376 days in 2011.

Kimberley

The nine fish trap vessels that fished in the NDSF in 2012 reported using between 20 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 2012. Effort across all zones of the fishery in 2012 was 1,059 days (North Coast Table 8).

The total effort allocated in Zone B in 2012 was 986 standard fishing days (i.e. using 20 traps per day) (North Coast Table 8). The number of standard fishing days (SFDs) recorded in Zone B using VMS data was 896 SFD's (90%). That is, 10% of effort allocated to Zone B in 2012 was not used. A total of 616 standard fishing days was allocated to Zone A in 2012. The number of SFDs recorded using VMS data was 162 (163 SFDs in 2011), indicating that ~74% remained unutilised in Zone A at the end of the season. The effort expended in Zone C in 2012 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 -2009)

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 ca. 2004 to 2008 (North Coast Figure 2). From 2009-2011, the catch rates of the shorter lived indicator species (bluespotted emperor and brownstripe snapper) and total catch increased each year. The trends in catch rates of these shorter lived species from 2011

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.

to 2012 varied with rates increasing or similar between years in Areas 1, 2 and 5 for brownstripe snapper and areas 4 and 5 for bluespotted emperor, but decreasing in the other trawl managed areas. Catch rates for the total retained catch in 2012 remained stable relative to recent years in Areas 2, 4 and 5, but decreased in Area 1. The trends in catch rates for longer lived indicator species (red emperor, Rankin cod and goldband snapper) were inconsistent between species, with increasing or stable catch rate trends for Rankin cod in all trawl areas but decreasing trends for red emperor particularly in Areas 2, 4 and 5 (North Coast Figure 2).

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 2009 based on age data up to 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 trends in catch rates of all indicator species and the total catch from ca. 2004-2008, and; 2) fishing mortality estimates that exceeded limit reference 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 historic levels of effort for the trawl fishery since the individual transferable effort system was introduced in 1998. It has been four 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 that increases in catch rates will be evident 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.

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 2009 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 2009. Age composition data for the next assessment was collected during 2012. The next assessment of the fishery is due in 2014.

Catch Rates

The catch rate (or catch per unit of effort, CPUE) presented in this status report is a nominal catch rate statistic calculated as the annual mean of the landed catches divided by corresponding units of fishing effort expended within Zone B of the fishery, which is the traditional core area fishing activity. Effort is adjusted for gear type used (based on standard fishing days). Nominal CPUE from data recorded on monthly catch and effort returns (1998-2008) were calculated as the sum of landed catches divided by total standard fishing days reported by each vessel in each month. Nominal CPUE from data recorded on daily trip returns (from 2010 onwards) were calculated as the landed catch divided by the total standard fishing days reported for each trip. For the 2009 reporting year, since some vessels had not yet switched to reporting their catch and effort on daily trip returns, the annual mean CPUE was calculated as the mean of monthly and trip CPUEs weighted by effort. A study is currently underway to use statistical catch rate standardisation methods in order to produce a more informative index of abundance for these stocks by correcting for factors such as spatial, seasonal and fishing power effects on CPUE.

Nominal catch rates for Zone B only are presented in North Coast Figures 4-6, as this area represents the historical core

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fishing area of the NDSF prior to zoning in 2006. During 2012, Zone B catch rates for the indicator species were 125 kg/std day for red emperor, 507 kg/std day for goldband snapper and 198 kg/std day for cods/groupers. Catch rates for red emperor were slightly above those reported in 2011 (119 kg/std day), while the catch rate for cods/groupers increased significantly from 150 kg/std day in 2011. The catch rate for goldband snapper declined from 544 kg/std day reported in 2011.

While the 2012 catch of cods/groupers from all zones exceeded the average of the previous four years, it did not exceed the ESD trigger point of a 20% increase in catch above the average of the past four years. The 2012 catches of red emperor and goldband snapper were both 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. A study is currently underway to use statistical catch rate standardisation methods in order to produce a more informative index of abundance for these stocks by correcting for factors such as spatial, seasonal and fishing power effects on CPUE. Results will be made available with the next stock assessment advice.

Age Structured Model

The spawning biomass of the key target species in the NDSF was last estimated by an age-structured stock assessment model using age data collected prior to 2007, which indicated the spawning biomass was above the international target 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 ahead of the next assessment.

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 at acceptable levels. Zone A of the fishery continues to receive increasing levels

of effort and catch. There is currently only 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 2012. Therefore, there is currently a very low risk to the sustainability of the fishery resources in this zone.

NDSF: The annual 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 2012, the catches of goldband were equivalent to 2011. The 2012 level of catch of cods/groupers was above 2011 and the average of the previous four years, but this did not exceed the trigger point. The 2012 red emperor catch was above that taken in 2011, but below the average of the preceding four years. Combined with the spawning biomass for both red emperor and goldband snapper having been assessed as greater than 40% of virgin biomass in 2009, all species/groups are considered to currently have adequate breeding stock levels.

Non-Retained Species

Bycatch species impact:

Pilbara

Low - Moderate

Kimberley

Low

Pilbara

Species of teleosts caught as bycatch by the trawl fishery are typically small bodied and/or short lived. Such species are considered less vulnerable compared to longer-lived teleost species based on their population production potential. Thus, the indicator species used in the weight-of-evidence stock assessments for the Pilbara demersal scalefish resources are considered to provide an adequate indication for similar or less vulnerable retained and bycatch species. In 2010, an ecological assessment of fish assemblages and habitat characteristics in trap, trawl and a 12 year targeted fishery closed area was undertaken. The results of this study are being collated.

An intense six month observer program was completed in the last half of 2012 that investigated catch rates and subsurface expulsion rates in trawl nets. This program used dual-lens above water and subsurface within-net, secure camera systems to achieve a high level of observer coverage on all trawl vessels operating in the Pilbara fishery (n = 3). The observer coverage rates of 85.2% of trawl catches above water (n = 1,916 trawls observed), and 71.7% of day trawls (n = 774 trawls observed) and 53.9% day trawl hours (n = 1,013 h observed) below water, was unprecedented. About two thirds of all chondrichthyans were expelled from escape hatches during trawling, with the majority expelled relatively quickly (< 10 min). This resulted in more than half of the trawl catches containing no chondrichthyan bycatch (51.4%).

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 **Low - Moderate**
Kimberley **Negligible**

Pilbara

The Pilbara Fish Trawl Fishery (PFTF) has a long history of developing and adopting mitigation measures that have resulted in very low capture rates of endangered, threatened and protected (ETP) megafauna, i.e. dolphins, turtles, sea snakes and sawfish. However, there has been uncertainty over the potential for unaccounted mortality of ETP megafauna from subsurface expulsion through escape hatches in the trawl nets (particularly air breathing species). To examine this issue, all trawl operations in the fishery (n = 3) were fitted with dual-lens above water and subsurface within-net, secure camera systems. This resulted in a high level of observer coverage from June to December 2012 that far exceeded that stipulated in the Bycatch Action Plan (22%) and levels achieved from previous studies from the PFTF. Capture rates of ETP megafauna were very low, despite very high levels of attendance and depredation in and around trawl nets by bottlenose dolphins (> 75% of trawls). All observed catches of ETP species were reported in statutory logbooks and these catch rates were consistent with previous data since exclusion grids were mandated in March 2006. Therefore, there was no evidence to suggest that captures of ETP species were being unreported by commercial fishers. The subsurface expulsion of megafauna in poor condition was extremely rare (only one dolphin was observed from over 1,000 trawl hours of within-net observations) and thus reporting rates in statutory logbooks are likely to be close to census. Extensive subsurface observations determined that current mitigation strategies are highly effective for sea snakes and turtles, and that further mitigation strategies in the forward sections of trawl nets would likely be more effective for dolphins and sawfish. The very low rates of mortalities of these ETP megafauna by the PFTF were considered to pose a negligible risk to their sustainability based on their wide distributions, high mobility and life history strategies. The outcomes of this observer program are to be reported in a Fisheries Research Report in 2013.

The reporting of interactions 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 in and around trawl nets during > 75% of trawls (FRR Report) their capture is very rare (~0.005 trawl-1 in 2011, reported by in statutory logbooks).

Based on estimates from independent observers, exclusion devices that were made compulsory in fish trawl nets in March 2006 reducing the incidental catch of dolphins by 64% and turtles by 97%. Subsequently, dolphin mortalities reported in statutory logbooks have reduced to less than 25 per year since 2006 (North Coast Table 5) and this rate has been independently verified.

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, can be 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 Pilbara Fish Trawl Interim Managed Fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by foreign vessels. Previous 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 continental shelf. At the present levels of catch and effort by the fish trawl, fish trap, and line fisheries, the broader effect on the trophic levels and community structure of the North West Shelf is considered to be at an acceptable level. 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 Interim Managed Fishery, which is restricted to less than 5% of the North West Shelf (North Coast Figure 1). Area 3 and the waters inside the 50 m isobath 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 and the effective area trawled within the managed areas has been greatly reduced, it is likely that the trawl fishery imposes a moderate risk to the small amount of habitat in the Areas open to trawling (5% of NWS) but a negligible risk to the total habitat in the North West Shelf.

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

Nine vessels fished in the 2012 fishing season, with approximately three crew per vessel, at least 27 people were directly employed in the NDSF. Approximately half the fish from this fishery are supplied to Perth metropolitan markets, while the other half is supplied to east coast metropolitan markets.

Economic Effects

Estimated annual value (to fishers) for 2011-12:

Pilbara	Level 3 - \$5 - 10 million
Kimberley	Level 3 - \$5 - 10 million

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

Pilbara

The fish trawl demersal scalefish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its value is estimated to be Level 2 – \$1-5 million. For social amenity some of the species 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 by valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was estimated to have an economic value of \$1-5 million and the social amenity is also Level 2. For the line fishery the economic value is Level 1 < \$1 million and social amenity is minimal because there is no recreational fishing for these offshore species and no specific broader community interests.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor resulting in an economic value of \$5-10 million. The social amenity value is that this is an important asset locally.

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 five 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 (2012) 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 2012. The line catch was also within the acceptable catch range in 2012.

Kimberley

For the 2012 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 2012 catches were 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, only the 2012 catch of the cods/groupers complex was above the average of the previous four years, but did not exceed the ESD performance measure. Both the goldband snapper and 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 following assessment of the next representative age sample.

New management initiatives (2012/13)

Pilbara

The Pilbara Fish Trawl Interim Managed Fishery Management Plan cessation date was recently extended to 30 June 2016. The extension was provided to allow for the results of the observer program to be analysed and published (as a Fisheries Research Report in 2013) and to assess the long-term future of the Pilbara Fish Trawl Interim Managed Fishery, including consideration of moving the Fishery to “managed” Fishery status.

Kimberley

In 2013 the industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF will be incorporated into the management plan. The Department continues to address the findings of the Prescott Review ahead of the next Level 5 assessment.

All commercial fisheries in the North Coast Bioregion will undergo MSC pre-assessment in late 2013.

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.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2012 (catches rounded to the nearest tonne).

Species		Trawl catch		Trap catch		Line catch		Total catch tonnes
		tonnes	%	tonnes	%	tonnes	%	
Bluespotted emperor	<i>Lethrinus punctulatus</i>	151	72%	59	28%	-	-	210
Crimson snapper	<i>Lutjanus erythropterus</i>	182	81%	39	17%	4	2%	225
Rosy threadfin bream	<i>Nemipterus furcosus</i>	102	99%	1	< 1%	-	-	103
Brownstripe emperor	<i>Lutjanus vitta</i>	90	83%	19	17%	-	-	109
Goldband snapper	<i>Pristipomoides multidens</i>	75	53%	56	40%	9	6%	139
Red emperor	<i>Lutjanus sebae</i>	62	51%	60	49%	1	1%	122
Saddletail snapper	<i>Lutjanus malabaricus</i>	52	73%	15	22%	3	5%	71
Spangled emperor	<i>Lethrinus nebulosus</i>	15	35%	17	42%	9	23%	42
Frypan snapper	<i>Argyrops spinifer</i>	31	93%	2	6%	< 1	1%	33
Rankin cod	<i>Epinephelus multinotatus</i>	16	20%	64	78%	2	2%	82
Ruby snapper	<i>Etelis carbunculus</i>	-	-	-	-	26	100%	26
Other demersal scalefish		537	83%	85	13%	23	4%	645
All demersal scalefish		1,312	73%	416	23%	77	4%	1,806

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			Total	Byproduct*
	Line	Trap	Trawl		Trawl
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
2012	77	416	1,312	1,806	17

* Byproduct 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)
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
2012	328	441	707	10,269

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 bycatch of protected species by skippers in the Pilbara trawl fishery in 2012.

	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	5	24	29
Pipefish	8	16	24
Green sawfish	17	10	37
Narrow sawfish	31	10	41
Seahorses	2	10	12
Sea-snakes	116	15	131
Turtles	0	0	0

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

NORTH COAST TABLE 6

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

Species	NDSF annual catch (tonnes)							
	2005	2006	2007	2008	2009	2010	2011	2012
Goldband snapper (<i>Pristipomoides</i> spp.)	429	331	405	457	485	524	487	487
Red emperor (<i>Lutjanus sebae</i>)	192	164	179	173	156	142	128	134
Saddletail snapper (<i>Lutjanus malabaricus</i>)	92	78	99	104	108	126	87	100
Spangled emperor (<i>Lethrinus nebulosus</i>)	21	27	15	17	23	30	20	25
Cod/grouper (Epinephelidae)	110	127	126	149	142	153	155	170
Other species	78	62	107	102	132	144	161	191
Total demersal scalefish catch	922	789	933	1002	1046	1117	1037	1107

NORTH COAST TABLE 7

Catches of major target and byproduct species or species groups by zone in the NDSF in 2011 and 2012.

Species	NDSF annual catch (tonnes)			
	2011		2012	
	Zone A & C	Zone B	Zone A & C	Zone B
Goldband snapper (<i>Pristipomoides</i> spp.)	13.1	473.7	17.2	470.2
Red emperor (<i>Lutjanus sebae</i>)	38.8	88.8	32.8	100.9
Saddletail snapper (<i>Lutjanus malabaricus</i>)	12.5	74.8	11.6	88.8
Spangled emperor (<i>Lethrinus nebulosus</i>)	1.9	17.8	1.3	24.0
Rankin cod (<i>Epinephelus multinotatus</i>)	17.8	23.4	18.3	33.9
Other Cods/groupers (Epinephelidae)	25.2	88.9	23.1	94.6
Other species	78.7	81.9	70.3	120.3
Total demersal scalefish catch	188	849	175	933

NORTH COAST TABLE 8

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since 2001.

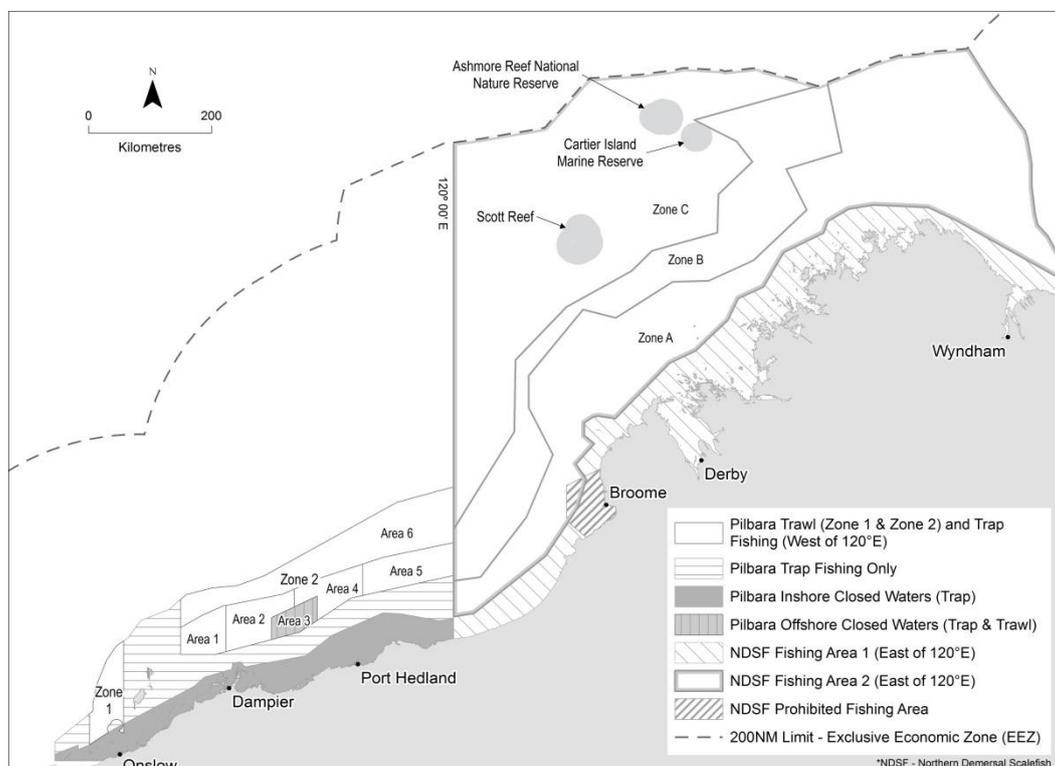
Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	1,144	0	0	801	1,193	801
2007	1,144*	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	1038*	0	0	1,116	1,178#	1,116
2011	986*	0	0	1,037	1,042#	1,037
2012	986*	0	0	1,107	1,059#	1,107

(* = TAE is for B Zone only; # = total effort is from all zones; 2012 Estimated Catch: Zone A = 172 t, Zone B = 933 t; 2012 Estimated Effort: Zone A = 162 SFDs, Zone B = 896 SFDs)

NORTH COAST TABLE 9

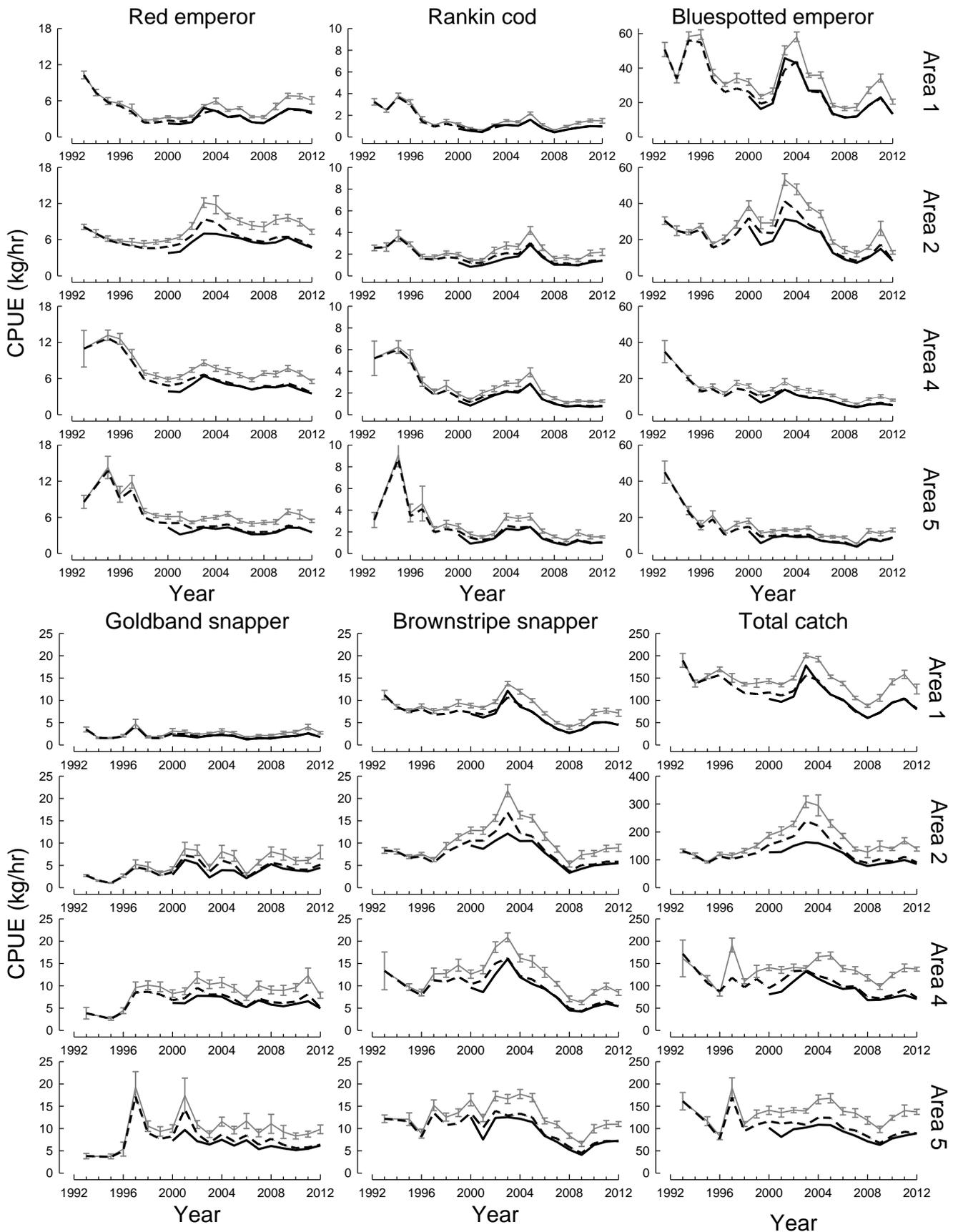
Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast Bioregion in 2012.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch tonnes
	tonnes	%	tonnes	%	
Red emperor	122	48%	133.7	52%	255.7
Saddletail snapper	71	41%	100.3	59%	171.3
Crimson snapper	225	82%	49.6	18%	274.6
Brownstripe snapper	109	96%	4.9	4%	113.9
Goldband snapper	139	22%	487.4	78%	626.4
Spangled emperor	42	62%	25.3	38%	67.3
Bluespotted emperor	210	80%	54.0	20%	264
Rankin cod	82	61%	52.2	39%	134.2
Frypan snapper	33	97%	< 1	3%	34
Rosy threadfin bream	103	99%	< 1	1%	104
Other demersal scalefish	645	76%	199	24%	844
Total all demersal scalefish	1,806	62%	1,107	38%	2,913



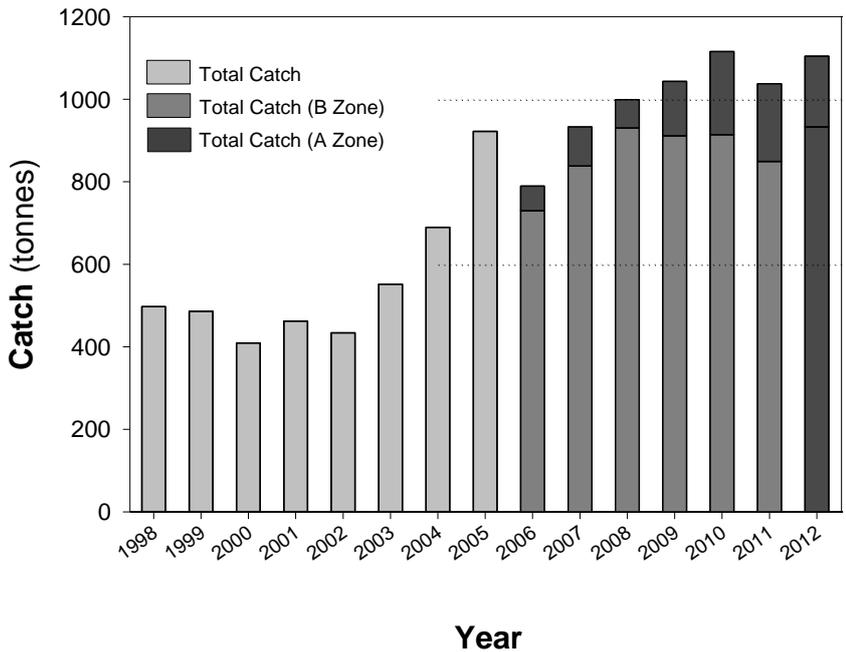
NORTH COAST FIGURE 1

Demersal scalefish fisheries of the North Coast Bioregion of Western Australia. In the Pilbara subregion: 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. In the Kimberley subregion: Zones A, B and C lie in Area 2 of the NDSF.



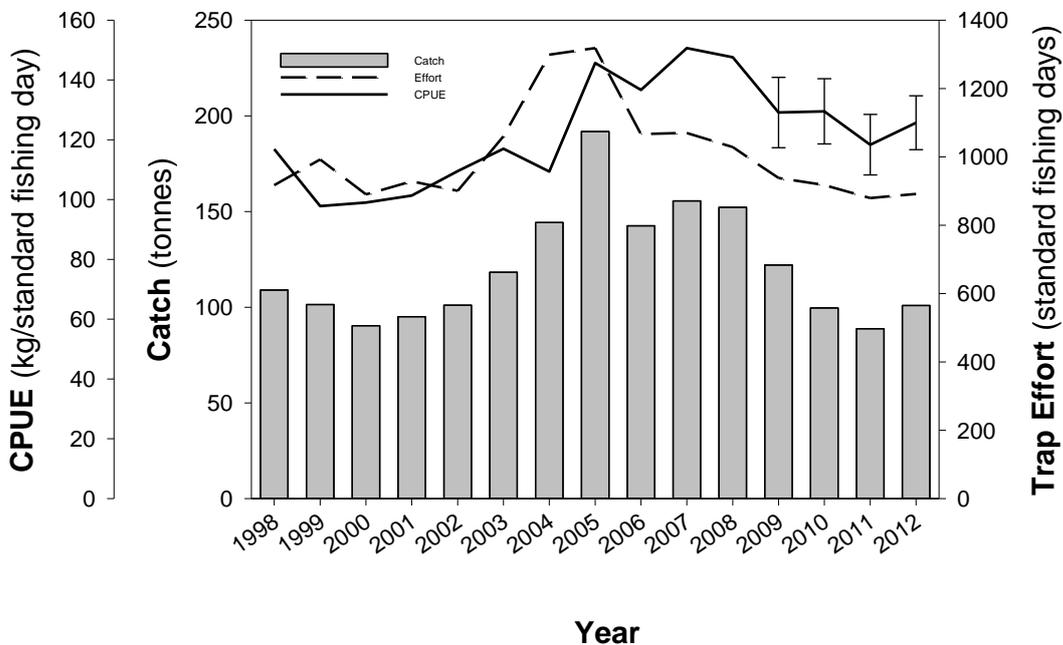
NORTH COAST FIGURE 2

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 1993–2012. The solid grey line is nominal catch rate (± 1 se) with trawl time as the effort measure, the dashed black 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).



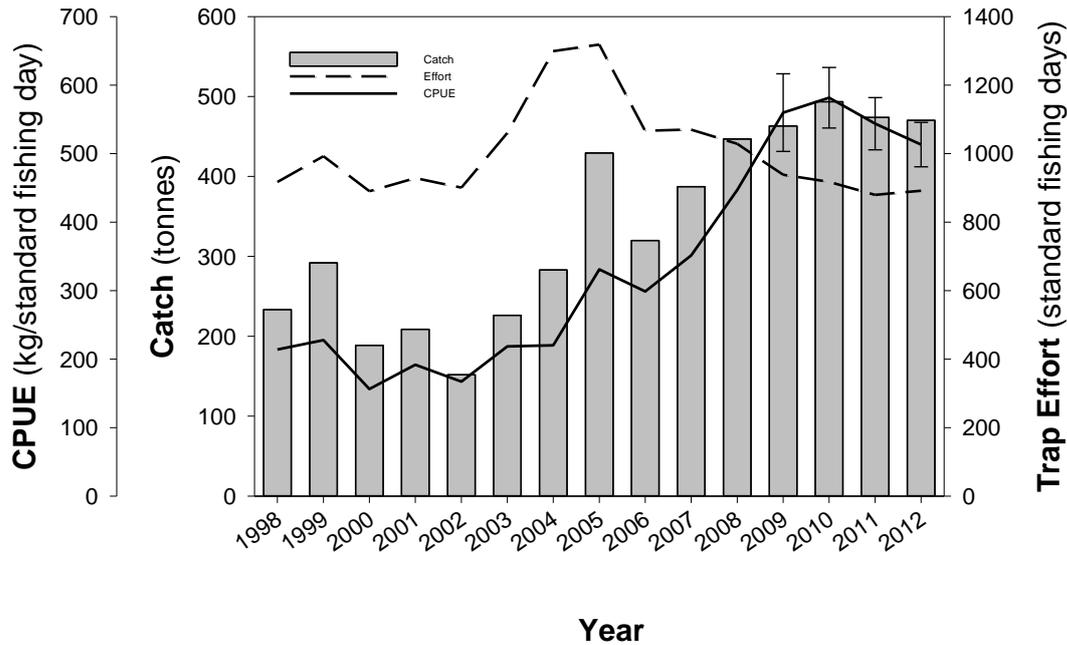
NORTH COAST FIGURE 3

Catch levels of demersal finfish in the NDSF by line and trap from 1998–2012. Note that prior to 2006 the NDSF was not differentiated in zones. Since 2006 catches are reported separately by zones within Area 2 of the fishery. The dashed lines represent the acceptable catch range of 600-1000 tonnes for the fishery.



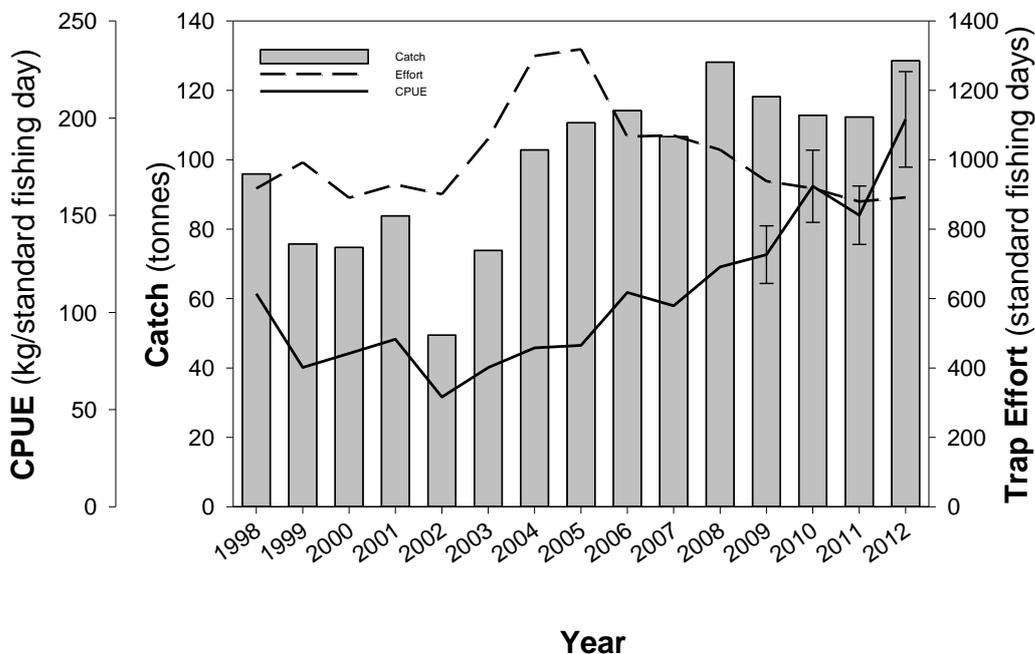
NORTH COAST FIGURE 4

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2012 (2006-2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010-12).



NORTH COAST FIGURE 5

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2012 (2006-2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010-12).



NORTH COAST FIGURE 6

Catch, effort and catch per unit of effort of the cod/grouper complex in the NDSF by trap, 1998–2012 (2006-2012 for Zone B only, catches represent total landings in B Zone, whereas effort and catch rate (CPUE) are determined from commercial vessel activity only). The catch rate (CPUE) presented here is a nominal catch rate that is calculated as the mean of monthly fleet catches divided by effort adjusted for gear type within Zone B of the fishery only, except for data from daily trip returns, where catch rates are calculated as the mean of all catch rates attained during separate fishing trips. Standard error bars illustrate variability in CPUE from the two sources of catch returns in 2009, and variability in trip CPUE data from daily log books (2010-12).

Mackerel Managed Fishery Report: Statistics Only

B. Molony, E. Lai and S. Walters

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 trolling, 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

The Fishery became fully managed on 1 January 2012, formalising the interim management arrangements. The Mackerel Managed Fishery (MMF) operates under an Individual Transferable Quota (ITQ) system which includes the setting of 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 licensing period (1 January to 31 December) is limited to the quantity of mackerel determined by the Director General. The TACC for each Area of the Fishery for 2012 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 licences 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.

Licence holders may only fish for mackerel by trolling or handline. There are currently 49 licences in the Fishery with 15, 15 and 19 licences in Areas 1, 2 and 3 (respectively), with the combined quota allocations being consolidated onto 14 boats operating within the fishery.

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 2012)

Spanish mackerel	318.1 tonnes
Grey mackerel	11.9 tonnes
Other mackerel	0.4 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 2012 season estimated at 318.1 t which is similar to the levels that have been taken in this fishery (averaging about 300 t) since quotas were introduced in 2006 (Spanish Mackerel Figure 2).

A total of 12.3 tonnes of other species of mackerel were landed in the 2012 season, including 11.9 t of grey mackerel. The catch of grey mackerel in 2012 was of a similar magnitude to grey mackerel catches by the fishery since 2006 but well below the TAC and the historical high catches of 'other mackerel' recorded in the late 1980s and 1990s.

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

Recreational

Estimates of recreational catches of Spanish mackerel were generated from data collected in the integrated survey of boat-based recreational fishing in WA conducted during 2011/12. Estimates are available at the level of individual Bioregions (Spanish Mackerel Table 1). A total of 68.1 t of Spanish mackerel were landed by recreational boat-based fishers in 2011/12, with most (26.2 t) landed in the North Coast Bioregion. An additional 61.2 t were captured and subsequently released. Recreational anglers also reported much lower catches of other mackerel, including blue mackerel (*Scomber australasicus*), grey mackerel

(*Scomberomorus semifasciatus*), school mackerel (*Scomberomorus queenslandicus*), shark mackerel (*Grammatorcynus bicarinatus*), spotted mackerel (*Scomberomorus munroi*) and wahoo (*Acanthocybium solandri*). Recreational anglers also reported small amounts of unidentified mackerel.

Reported annual catches of Spanish mackerel by recreational charter boats are relatively minor.

Fishery Governance

Target commercial catch range :

246 – 410 tonnes

The total catch in 2012 of 318.1 t was within the acceptable catch range for the Fishery. The reported catch from the Kimberley Area of 180.3 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, with the 2012 catch of 88.0 t (acceptable catch range 80 – 126 t) the highest catch since 2005. Catches from the Gascoyne/West Coast Area in 2012 were 49.8 t, below the acceptable range of 56 – 79 t but similar to the range of catches from this Area since 2004.

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

Fishing effort throughout the Fishery has been relatively stable since 2006 following reductions due to management changes. The increasing trend in catch rates for the two main (Northern and Pilbara) fishery areas, with Area 1 (Kimberley)

now at near record levels, indicates a relatively high abundance of Spanish mackerel in this management Area (Spanish Mackerel Figure 3). Catch rates in the Pilbara Area were also high in 2012 and were stable for the Gascoyne /West Coast Area.

As the minimum legal size for Spanish mackerel is 900 mm total length which is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. Therefore the status of the Spanish mackerel spawning stock is measured using the catch rates for each areas of the Fishery. With area based catch rates either increasing or stable this suggests that the overall spawning stock is increasing.

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 (2013)

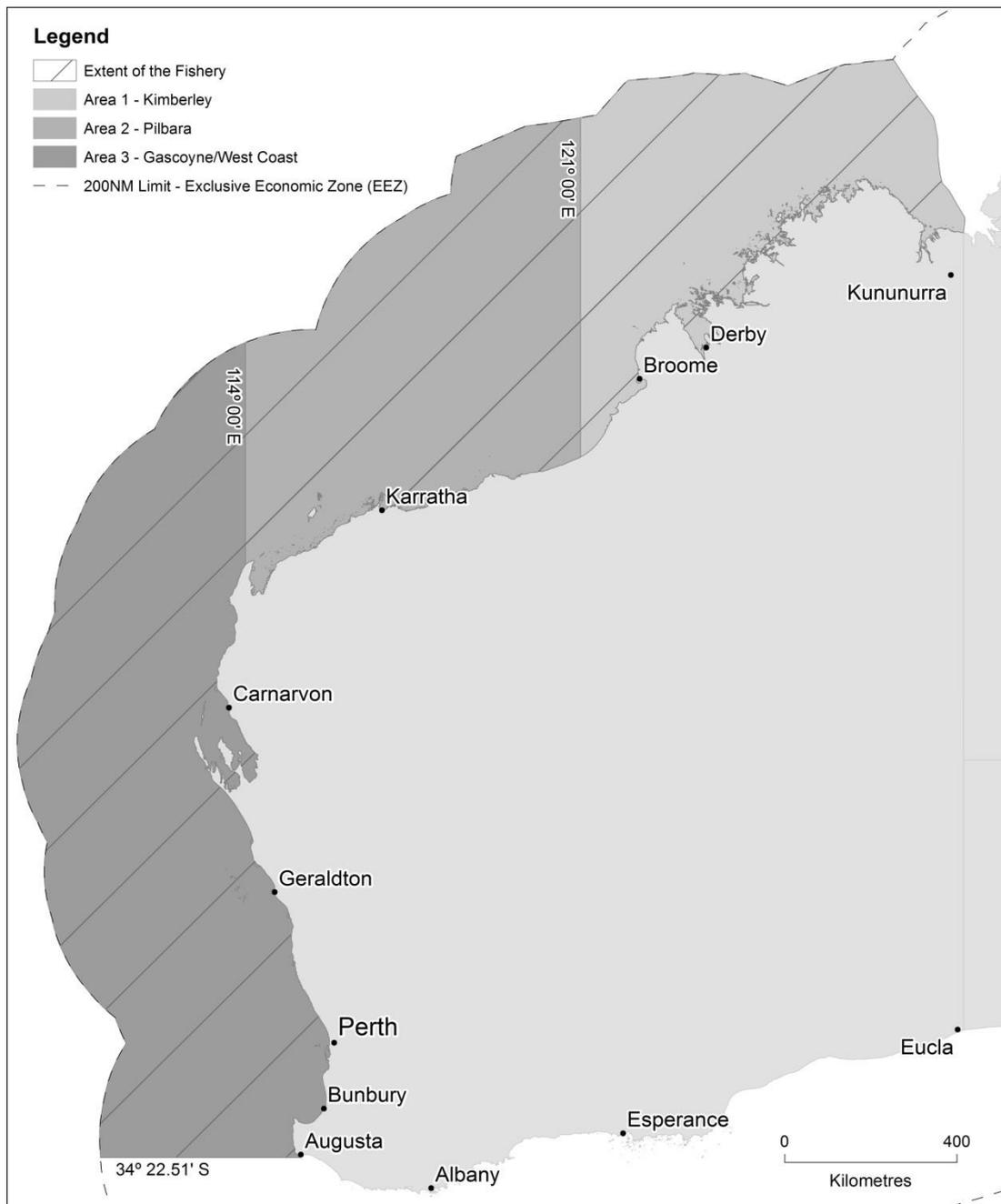
A review of the acceptable catch ranges and TACCs for the Fishery will be undertaken during 2013 with any changes being introduced in 2014. It is anticipated that a formal harvest strategy will be developed for the fishery in the future to assist in monitoring the fisheries performance and reviewing TACCs.

An operator's guide is also being developed for licence holders and skippers to enhance their understanding of the management arrangements for the Fishery.

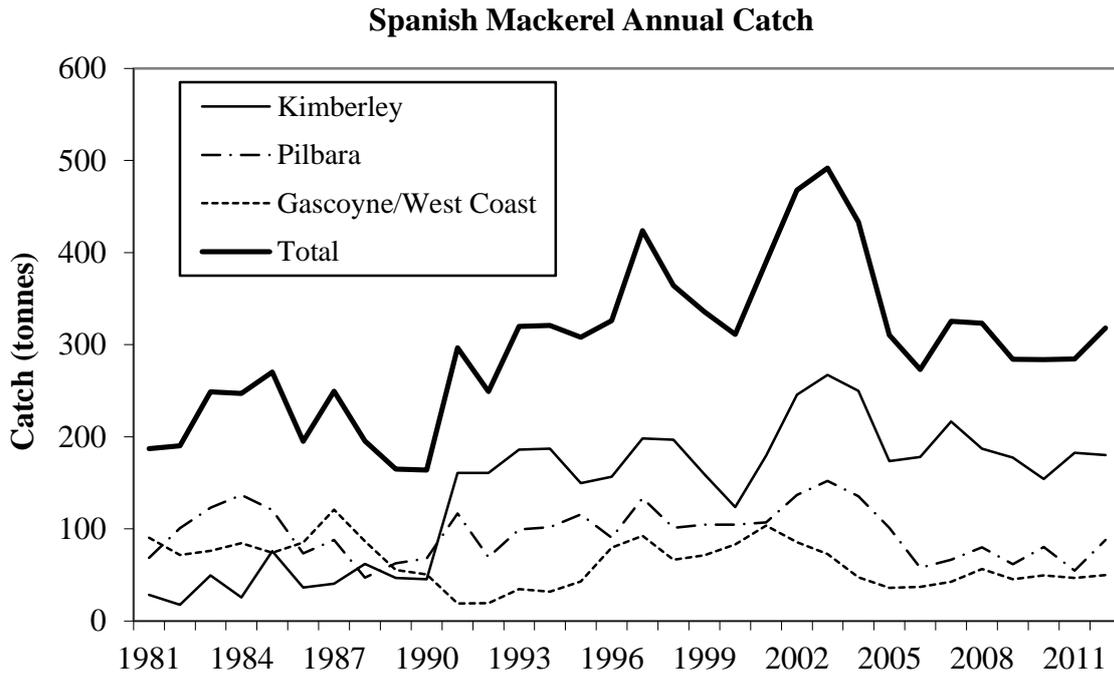
SPANISH MACKEREL TABLE 1

Recreational boat-based catch estimates (in tonnes, t) of Spanish mackerel in Western Australia 2011/12. Estimates are based on an average weight of a Spanish mackerel of 6.9 kg. No Spanish mackerel were reported from the South Coast Bioregion during 2011/12.

Bioregion	Retained catch (std. error)	Released catch (std. error)	Total catch (std. error)
North Coast	26.2 t (3.66 t)	30.8 t (6.58 t)	57.0 t (8.59 t)
Gascoyne Coast	21.3 t (2.80 t)	24.0 t (4.81 t)	45.2 t (6.61 t)
West Coast	20.7 t (3.02 t)	6.3 t (1.46 t)	27.0 t (3.81 t)
Statewide (total)	68.1 t (9.47 t)	61.2 t (12.84 t)	129.3 t (19.01 t)

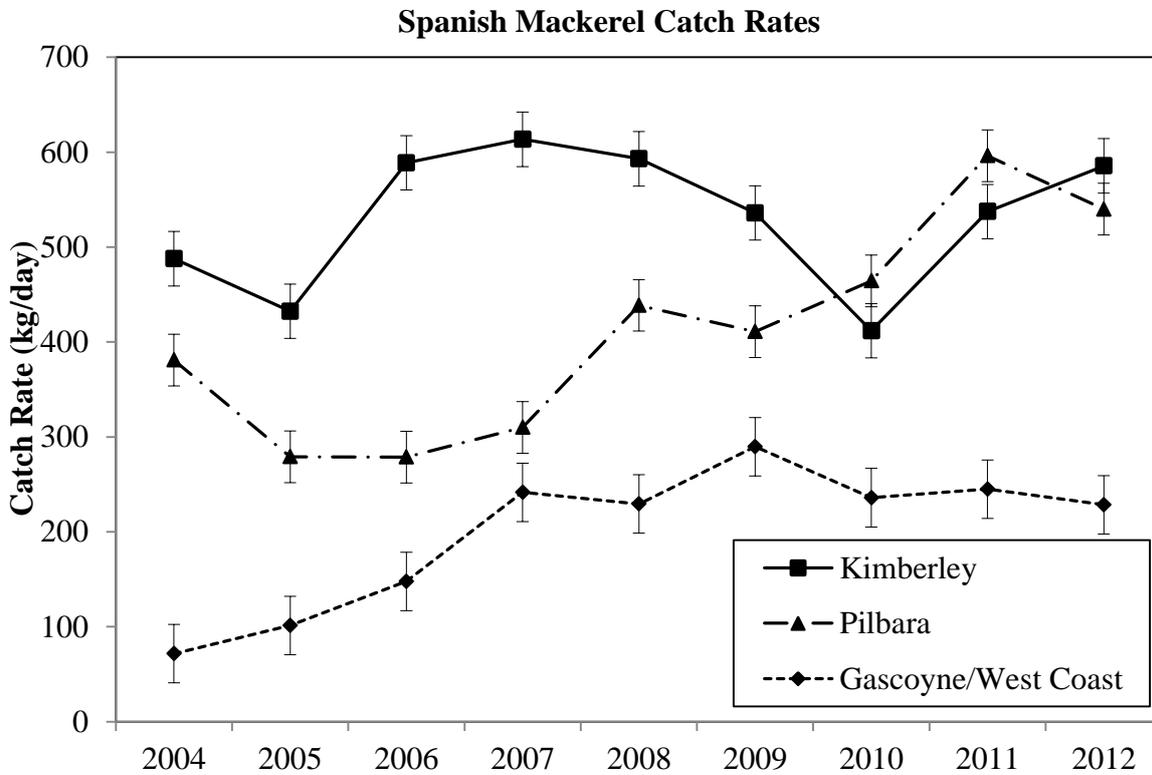


MACKEREL MANAGED FISHERY FIGURE 1
Map of the extent of the Mackerel Managed Fishery.



SPANISH MACKEREL FIGURE 2

Annual catches of Spanish mackerel in Western Australia, 1979–2012. Note: quota management was introduced in 2006.



SPANISH MACKEREL FIGURE 3

Annualised catch rates of Spanish mackerel in Western Australia derived from daily logbooks, 2004–2012.

Northern Shark Fisheries Status Report: Statistics Only

B Molony, R. McAuley and F. Rowland

Fishery Description

Commercial

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. The two fisheries have been considered as a single fishery for reporting purposes given confidentiality concerns resulting from the small number of operators in the Fishery. However, there has been no reported fishing activity in the northern shark fisheries since 2008/09. Since fishing commenced in 1994, the northern shark fisheries have targeted various species, including sandbar (*Carcharhinus plumbeus*), blacktip (*Carcharhinus* spp., at least two species), tiger (*Galeocerdo cuvier*), hammerhead (Family: Sphyrnidae) and lemon sharks (*Negaprion acutidens*). The primary fishing method employed in these fisheries was demersal longlining with a relatively small amount of pelagic gillnetting in the JANSF.

Recreational

Recreational fishers target similar species mainly using line fishing methods.

Boundaries

Commercial

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).

Recreational

The recreational fishery operates throughout the North Coast Bioregion from the WA/NT border to 114°06'E.

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 Western Australia under an arrangement agreed through the Offshore Constitutional Settlement. 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 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. This resulted in zoning of the WANCSF into three separate areas with different levels of access, including an indefinite closure to protect the breeding stock of sandbar sharks that support the southern fishery (see Temperate Demersal Gillnet and Demersal Longline Fishery Status Report).

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 be legally exported. For more detailed information on the Fishery see previous State of the Fisheries and Aquatic Resources Northern Shark Fisheries Status Reports.

The Department of Fisheries is currently reviewing future options for managing the WANCSF and is working with the Commonwealth Government to determine management arrangements for the JANSF.

Landings and Effort (Season 2011/12)

Commercial landings (season 2011/12)

Northern Shark Fisheries: 0 tonnes

Other Commercial Fisheries: 1 tonne

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

Recreational catch estimate:

283 (+/- 128) Individual sharks retained (2011/12)

Relatively few sharks were retained by the recreational fishery in the North Coast Bioregion, as estimated by the integrated survey of boat-based recreational fishing in WA during 2011/12. Approximately 93% of all sharks were released.

Commercial Fishing effort/access level

There was no reported fishing effort in the northern shark fisheries in 2011/12.

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: Recovering

Blacktip sharks: (Adequate, based

on assessment of the NT component only)

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

Fishery Governance

Target catch range:

Sandbar sharks: 0 - 20 tonnes

Current fishing (or effort) level:

Effort: Acceptable (2011/12)

Sandbar shark catch: Acceptable (2011/12)

There has been no reported fishing effort in the northern shark fisheries since 2008/09 including in 2011/12.

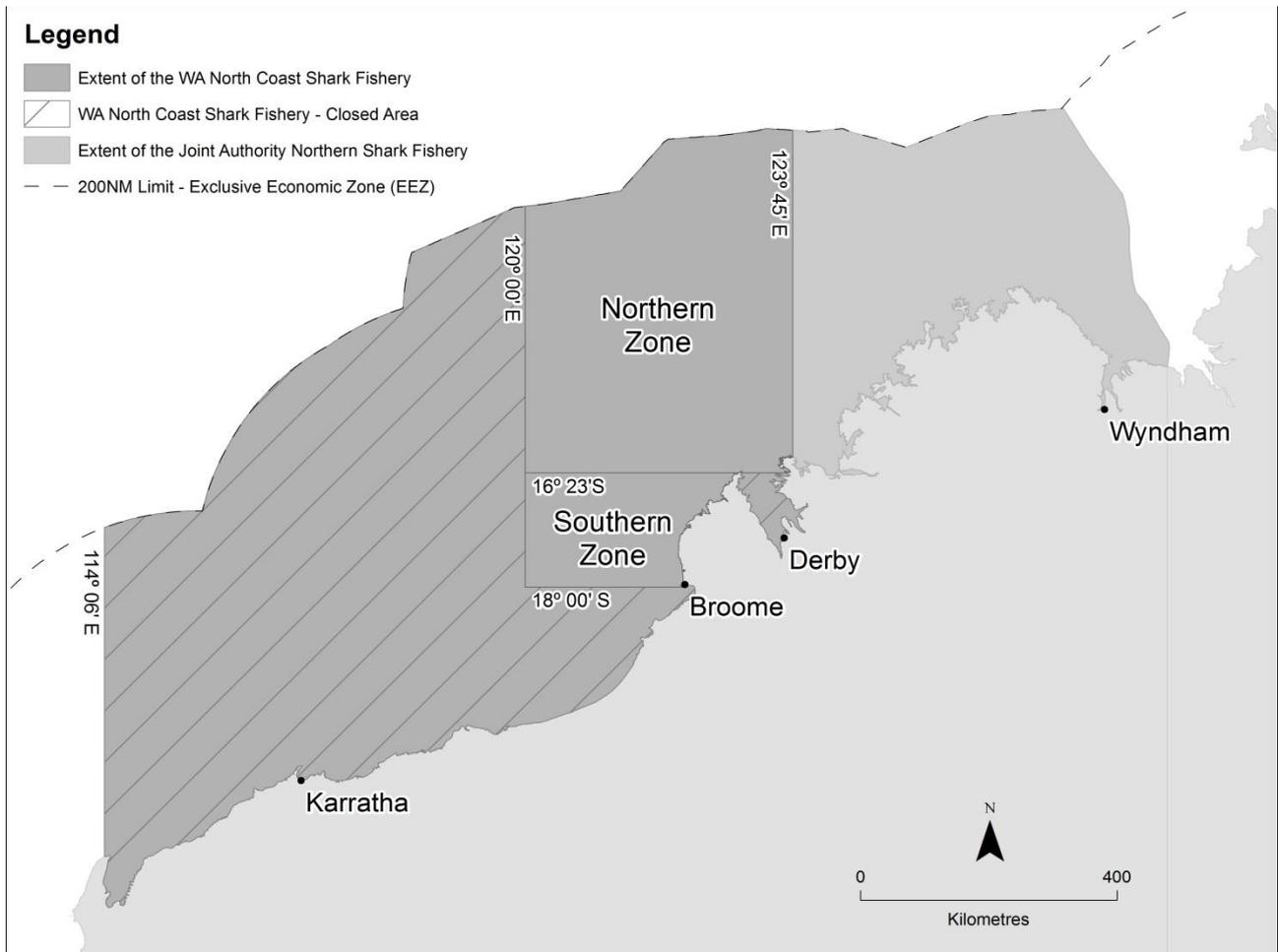
New management initiatives (2011/12)

Future management arrangements for the JANSF and the WANCSF are the subject of continuing discussion between the State and Commonwealth Governments. A recent NT assessment (2012) of blacktip sharks (multiple species) suggested that the stock status was acceptable. However, the applicability of these results for the Western Australian blacktip stocks is not clear due to uncertainties around historic and recent catch levels, poor species identification

and significant declines in catch rates observed for some species in the late 1990s and mid 2000s. The relevance of the NT assessment will be resolved in 2014.

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 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 Temperate Demersal Gillnet and Longline Fisheries Status Report).



NORTHERN SHARK FIGURE 1

Management boundaries of the WA northern shark fisheries.

Pearl Oyster Managed Fishery Status Report

A. Hart and D. Murphy, and S. Walters

Main Features

Status		Current Landings	
Stock level	Adequate	Commercial Pearl Oyster Catch	
Fishing level	Acceptable	Shell numbers (All Zones)	685,888 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 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. This zone has not been fished since 2008.

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

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.

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). Hatchery production is also controlled by ITQs; currently there are 350 hatchery ITQ units allocated amongst 14 pearling licensees, however this restriction is currently under review.

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 in each management area. Between 2008 and 2011 it was set at historically high levels (3,500 shell in 2011) in Zone 2&3 due to increased stock abundance. The wild stock quota unit for Zone 2/3 for the 2012 season was reduced to 1,400 shell, as a result of stock levels returning from record high 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 which is under trial for seasons 2012-2013.

Historically the legal size limit has been 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate (e.g. in Exmouth Gulf in Zone 1). The catch of pearl oysters is divided up into two size classes; "culture" shell, between 100 and 175 mm, and "MOP" shell, which are greater than 170 mm.

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.

Research summary

Current stock assessment research is focused on 5 main areas: (1) catch and effort statistics, (2) monitoring an index of settlement for predicting future years catch levels, (3) stock and habitat surveys using length frequency data and diver observations, (4) development of decision rules for determining the TAC; and (5) investigating 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 2012):

685,888 shell

In 2012, catch was only taken in Zone 2/3 and the number of wild-caught pearl oyster shell was 685,888 comprised of 556,567 culture shells and 129,321 MOP shells (Pearl Figure 2). The TAC for culture shells was 639,800, thus 87% of the TAC was caught. In comparison, 765,000 culture shells were caught in 2011. The reduced catch in 2012 was due to a lower quota as a result of the abundance returning to more normal levels. The take of 129,000 shells for MOP, which are large oysters (>175 mm shell length), represents a 300% increase over the 30,949 MOP caught in 2011 (Pearl Figure 2).

There has been no fishing in Zone 1 since 2008.

Fishing effort/access level

Total effort was 17,396 dive hours (Pearl Figure 2), an increase of 20% from the 2011 effort of 14,361 hours and the highest effort level since the early 1990s. Of this total effort, 15,589 hours was focused on culture shell fishing, and the remaining 1,807 hours was applied to MOP fishing.

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 2012 fishing season based on catch and effort statistics, settlement analysis (53,000 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (13,000 shells measured), shell discard rates by size and location, population dive 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 2013 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:

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 2012, CPUE was 36 shells per dive hour, a decline of 35% from 2011 (55 shells per dive hour; Pearl Figure 3). The decline over the past two years indicates that stock levels are returning to normal levels after record high levels in 2008 - 2011.

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 range to set the quota for forthcoming years. A very high 0+ spat abundance detected in the Zone 2 fishery in 2005 was confirmed in the 1+ spat 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 (Pearl Figure 3), but CPUE has now returned to normal levels as a result of spat settlements returning to normal levels.

Using the catch prediction system, the culture catch quota for 2013 was reduced to a unit value of 1,200 shells (TAC = 548,400) which is a 14% reduction in the 2012 TAC of 639,800 shell. Fishers were also given a MOP quota of 163 shell per unit to further explore the potential of the MOP fishery, resulting in a total quota of 1,363 shells per unit.

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

Breeding stock: Under average growth and mortality and recent levels of TAC, 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. Despite the fishery trialling a minimum size of 100 mm for 3 years, the basis for quota setting remains the abundance within the 120-165 mm size class.

Animals that survived this 'gauntlet' were effectively protected from the age of 6 to 7 years onward, and could have lived for another 15 to 20 years. With very low natural mortalities, this results in a large broodstock being built-up over time. The fishery is trialling the capture of a conservative level of MOP shell which should not make a significant impact on the breeding stock. In Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004, 2009 – 2012.

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 2012. 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 36 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 has demonstrated 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 in 2012 was five.

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 Total Industry value for 2012

Level 5 - > \$20 million (\$79 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 byproducts in 2012 was considered to be approximately \$79 million, which is slightly lower than 2011, in which it was around \$93 million.

Fishery Governance

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

The target effort range relates to the time required to achieve the TAC (culture shell only) in the pearl oyster fishery of 694,800 oysters in 2012 (639,800 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 15,589 dive hours of effort, which was within the target range. Zone 1 of the pearl oyster fishery was not fished in 2012.

Current effort level: **Acceptable**

Overall fishery effort level is acceptable.

New management initiatives (2013)

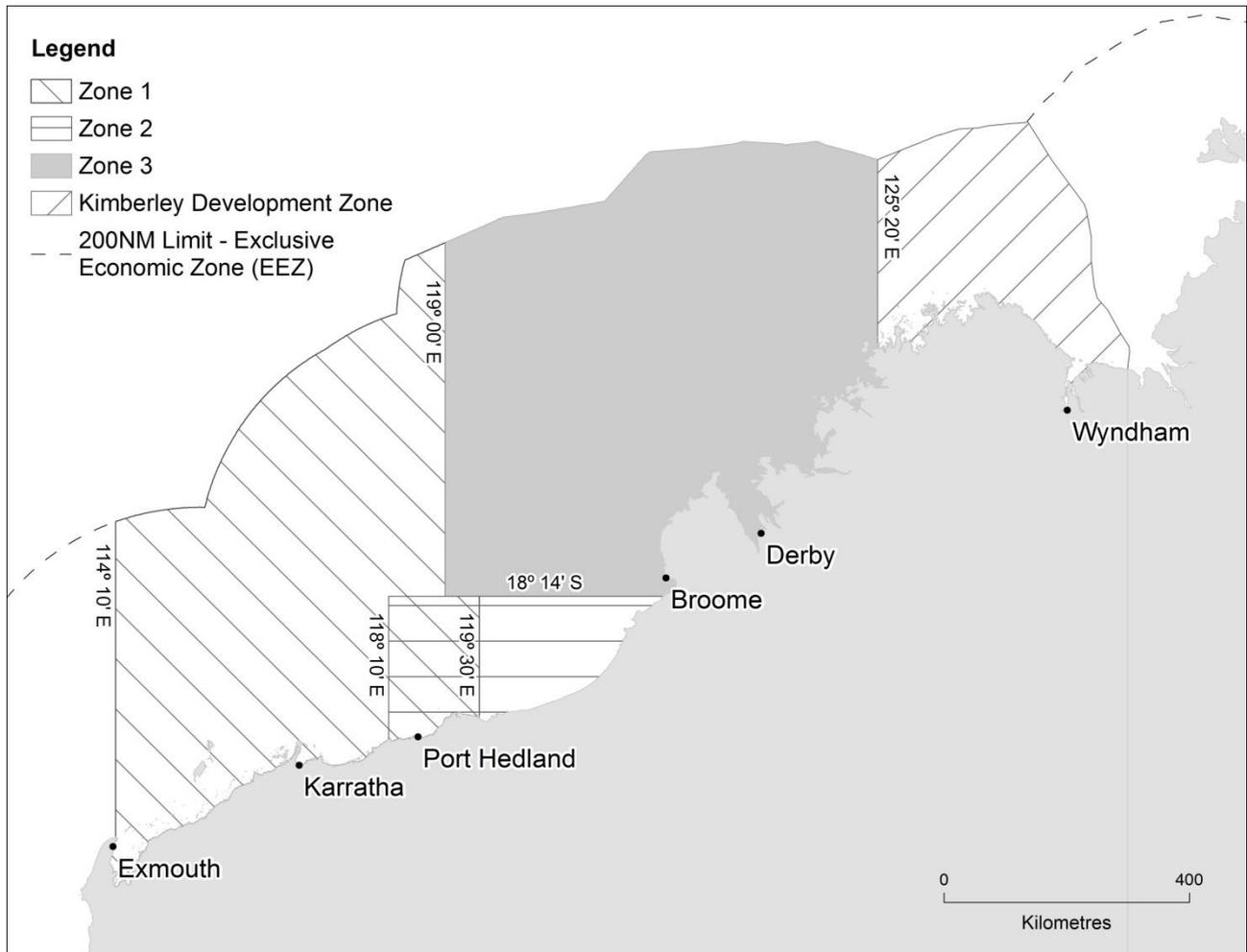
DoF has approved a two-year trial (2012/2013) for industry to take smaller shell legally, 100-120 mm, and to harvest MOP. The request to take smaller shell was put forward by industry to evaluate the economics for their business model. DoF advised that there were no sustainability issues, under a fixed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

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 2013. 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.

driver of the high abundance in 2008-2011. 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. Future signs for 2013 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.

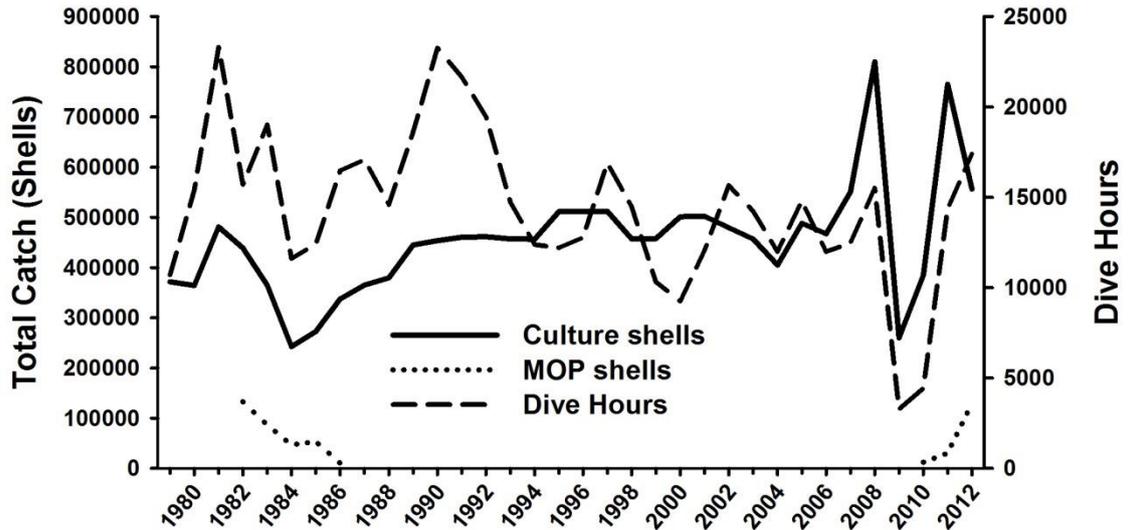
External Factors

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



PEARL FIGURE 1
Distribution of pearl oyster stocks and fishing zones in Western Australia.

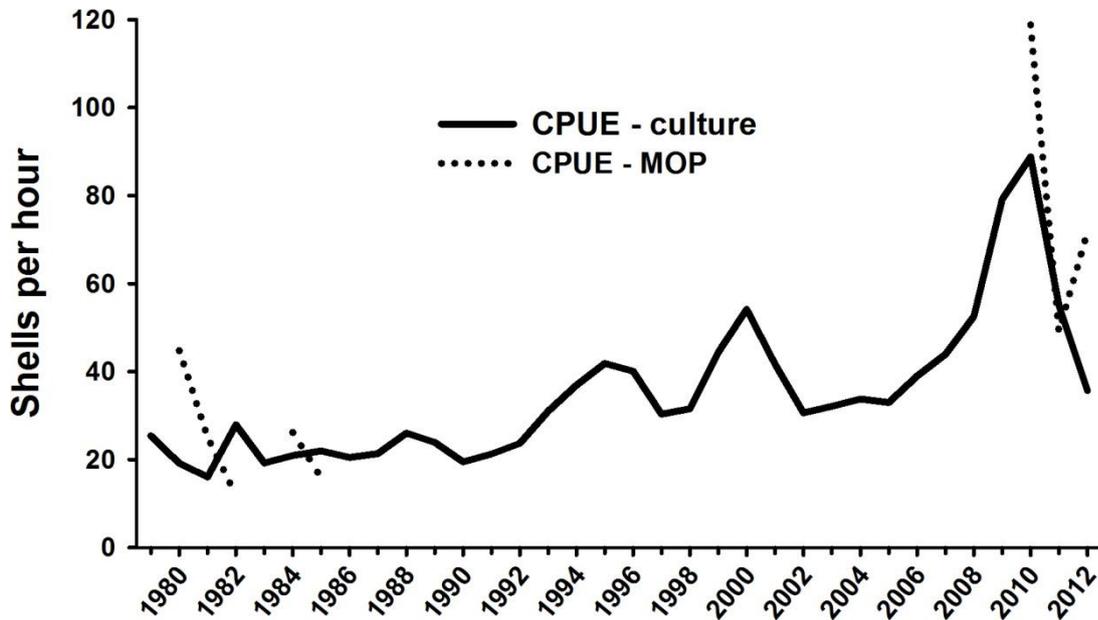
Zone 2/3 Catch And Effort



PEARL FIGURE 2

Pearl shell catch and effort – Broome area (Zone 2/3)

Zone 2/3 CPUE



PEARL FIGURE 3

Pearl shell catch per unit effort (CPUE) in the Zone 2/3 fishery.

Beche-de-mer Fishery Status Report

A. Hart, D. Murphy and K. Green

Main Features

Status

Stock level	Acceptable
Fishing level	Acceptable

Current Landings

Holothuria scabra – Sandfish 13 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*). An additional species (deepwater redfish - *Actinopyga echinites*) was also targeted during 2007-2010.

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 Western 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 logbook 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 2012):

13 tonnes (live weight)

Landings

In 2012 the total *beche-de-mer* catch was 13 t live weight (*Beche-de-mer* Table 1), a decrease of 77% over last year’s catch of 56 t and the lowest catch in 18 years, due to nil catch from the newly developing redfish fishery, and reduced effort focused on the traditional sandfish fishery.

On a species-specific level, the 13 t catch was made up of (100%) *Holothuria scabra* (*Beche-de-mer* Figure 1), being 63 % lower than the 2010 catch of 35 t. This is the second year in the last 6 years that *Actinopyga echinites* has not been

NORTH COAST BIOREGION

caught and represents an effort reduction on this new target species. Industry has advised they are adopting a rotational fishing strategy with *A. echinites*, with 2011 and 2012 being a rest period.

Fishing effort/access level

Only 1 of 6 licensed vessels fished for *beche-de-mer* in 2012, 1 vessel less than 2007 to 2011.

Total effort for sandfish was 413 hours fished – about 73% lower than in 2011 and approximately 61% below the average of the last 7 years for sandfish fishing only (*Beche-de-mer* Table 1). The effort comprising of 47 hours wading and 366 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 2012) was 31 kg/hour, this is 15% below last year's catch rate of 37 kg/hour and close to the average of the last 10 years, being 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 2012, the catch (13 t) was not met but catch rate (31 kg/hr) was 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 2012, there was no fishing for this species 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

species 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 2012, one vessel with a total of four 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 2012:

Level 1 - < \$1 million

The estimated annual value for 2012 was \$42,290 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 13 tonnes for Sandfish are not within the target ranges due to reduced effort in the fishery and no fishing in the newly developed Deepwater Redfish fishery.

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.

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 see some expansion into previously unfished areas. Currently, lack of experienced fishers and suitable vessels is restricting catch to low levels. This situation is expected to change within the next two years.

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

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	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
2012	13	413	13	413	0	0	0

BECHE-DE-MER TABLE 2

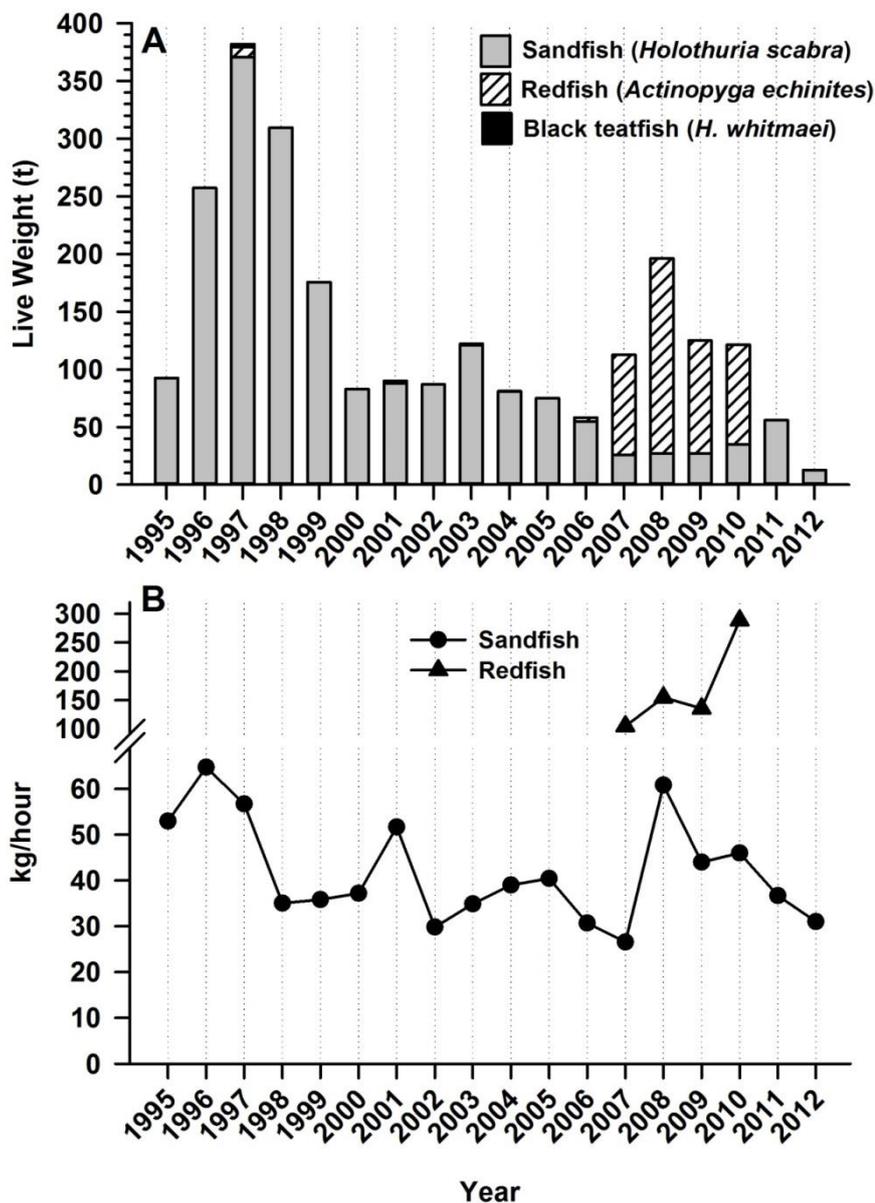
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2012) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	143	40	0.84	966	0.21
Kimberley region (Grid 1425 and 1426)	70	34	0.95	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 and P. Carter

Main Features

Status		Current Landings	
Stock level		Blue swimmer crab	
Blue swimmer crab	Acceptable	Commercial	12 t
Mud crab	Unknown	Recreational	3.4 t
Fishing Level		Mud crab	
Blue swimmer crab	Acceptable	Commercial	1.3 t
Mud crab	Acceptable	Recreational	9387 retained animals

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. A species identification waterproof card

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 Leeuwin 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).

The Kimberly Developing Mud Crab fishery targets the green (giant) mud crab and the brown (orange) mud crab via the use of crab traps, between Broome and Cambridge Gulf near the WA and Northern Territory border, with fishing effort concentrated around Cambridge Gulf, Admiralty Gulf, York Sound and King Sound (see North Coast Crab Figure 1 and 2). From 1994 to 2005 commercial fishing for mud crabs was authorised through permissive conditions on Fishing Boat Licences. From 2006 to present, access to the Kimberly Developing Mud Crab Fishery has been granted via

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*

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.

NORTH COAST BIOREGION

Exemptions, which were formerly issued under Section 7(3)(c) of the Fish Resources Management Act 1994, for ‘the exploration or development of fisheries or the development of fishing technology’.

The design of mud crab trap permitted to be used is not prescribed in the management arrangements at present, in order to allow some flexibility for exemption holders to determine the most appropriate gear for the high tidal conditions. However, prior to use the design of mud crab trap must be approved by the Department of Fisheries. At present in the Fishery there are two styles of mud crab trap used, a rectangular trap or a round trap. The rectangular design generally follows the dimensions of not more than 1000 mm length, 600 mm width and 300 mm height with a rigid mesh of 50x70 mm with 2 openings for crabs to enter the trap. The round trap design is generally 500 mm high; 1000 mm diameter with flexible nylon mesh of around 50 mm mesh size (knot to knot) with 4 openings for crabs to enter the trap.

Access to the Kimberly Developing Mud Crab Fishery is made up of two broad groups: Aboriginal Community Commercial Mud Crab Exemption holders and Commercial Exemption holders. 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 Management 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 commercial 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 which applies in the Pilbara Developing 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. 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

Since 2006, access to the Kimberly Developing Mud Crab Fishery has been granted via Instruments of Exemption, issued under Section 7 of the *Fish Resources Management Act 1994*. 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. Three commercial operators are permitted to fish 300 traps from King Sound to the Northern Territory border, one Aboriginal Corporation is permitted to fish in King Sound using 150 traps, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier Peninsular, north of Broome using 20 traps. Prior to the exemption not being renewed in 2011, a third aboriginal corporation fished in Carnot Bay and Camp Inlet using 20 traps.

From 1 May 2013, mud crab exemption holders have been permitted to retain by catch of other *Portunid* crabs for a two year trial period ending 30 April 2015. This is likely to result in small numbers of blue swimmer crabs being retained. A minimum size limit of 135 mm for blue swimmer crabs has been imposed, consistent with the size limit used in the Pilbara Developing Crab Fishery. No limits have been placed on the number of blue swimmer crabs retained.

Breeding stocks are protected by maintaining minimum size limits (150 mm CW for green mud crab and 120 mm CW for brown mud crabs) set well above the size at sexual maturity (90-110mm CW for green and 86-89mm CW for brown). These size limits apply to both the recreational and commercial take of the species.

Recreational fishers for mud crabs are restricted to a daily bag limit of 5 mud crabs, with a boat limit of 10 mud crabs.

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 & Lee., 2012)¹ and environmental correlations with mud crab catches in the Northern Territory (Meynecke *et al.*, 2010)². A third FRDC project has also been recently completed on equipping the mud crab industry with innovative skills through extension of best practice handling (Poole *et al.*, 2012)³.

Retained Species

Commercial landings (season 2011/12):

Blue swimmer crabs **12 tonnes**

Mud crabs **1.3 tonnes**

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 2011/12 was 12 t, a 40% decrease on the 2010/11 catch of 20 t (North Coast Crab Figure 3). All of the recorded catch was taken by the trap fishery, with trawlers retaining no crabs during 2011/12. This catch accounted for 3% of the state commercial blue swimmer crab catch of 352 t for 2011/12 (West Coast Blue Swimmer Crab Figure 1).

Mud Crab

The total trap catch of mud crabs for the Kimberly Developing Mud Crab Fishery during 2012 was 1269 kg which represented 99.8% of the total catch of mud crab in Western Australia (North Coast Crab Figure 4). Logbooks submitted during 2012 reported that 99% or 1256 kg were brown mud crab and 1% or 13 kg were green mud crab. This catch level is significantly higher than the 218 kg reported in 2011 due to an increase in effort, with three commercial operators fishing and no Aboriginal Corporations fishing in the 2012 period. However, catch in 2012 was lower than the 5 year (2007 – 2011) mean of 3348 kg and may be attributed to the combination of cyclonic and flooding weather events and difficulty in retaining crew and securing local markets in 2012.

Recreational catch:

Blue Swimmer Crab

North Coast bioregion (boat-based catch 11-12)

3.4 tonnes

An integrated survey of boat-based recreational fish in WA was conducted from 1 March 2011 to 29 February 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.

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 Poole, S., Mayze, J., Calogeras, C. (2012) Equipping the mud crab industry with innovative skills through extension of best practice handling. FRDC Project 2010-302. 183 pp.

(Ryan *et al.*, 2013)¹. The boat-based estimate for the North Coast bioregion was 3.4 t, compared with total landings of 15 t by the commercial sector over the same period.

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)². 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.

Mud Crab

An integrated survey of boat-based recreational fish in WA was conducted from 1 March 2011 to 29 February 2012 and reported that 9387 green and brown mud crabs were retained during this period. Unfortunately a conversion to weight is not possible as species and sex was not recorded during the surveys. Mud crab species vary significantly in weight with anecdotal evidence suggesting brown mud crabs average around 300 grams, whereas green mud crabs can vary between 500 grams and 1.5 kg. There are also marked differences in weight between males and females.

Fishing effort/access level

Blue Swimmer Crab

Crab trap fishers along the Pilbara coast reported 13,880 trawlifts during 2011/12, a 40% decrease on the 23,310 trawlifts reported for 2010/11.

Mud Crab

Mud crab fishers along the Kimberley coast reported 2490 trawlifts during 2012, a 908% increase on the 274 trawlifts reported for 2011 (North Coast Crab Figure 4). However, this 2012 level of effort is significantly lower than the 5 year average of 4254 trawlifts (2007-2011).

Stock Assessment

Assessment complete:

Blue Swimmer Crab	Pilbara - Yes
Mud Crab	No

Assessment level and method:

Blue Swimmer Crab	Level 2 - Catch rate
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Breeding stock levels:

Blue Swimmer Crab	Pilbara - Adequate
Mud Crab	Unknown

1 Ryan K.L., Wise, B.S., Hall, N.G., Pollock, K.H., Sulin, E.H. and Gaughan, D.J. (2013). An integrated system to survey boat-based recreational fishing in Western Australia 2011/12. Fisheries Research Report No. 249, Department of Fisheries, Western Australia 162 pp.

2 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, 61 pp.

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 2011/12 of 0.9 kg/trawlift – a slight increase on the catch rate of 0.8 kg/trawlift reported during the previous year.

Mud Crab

Between 1994 and 2005, trap catch and effort for mud crabs in the Kimberly remained low, ranging between 68 kg and 2869 kg and between 40 trawlifts and 5250 trawlifts. Catch rate varied significantly during these years between 0.2 and 2.0 kg/trawlift. When exemptions were formally established for commercial fishers and Aboriginal corporations in 2006, the catch and effort peaked at 9293 kg from 18720 trawlifts. The majority of catch and effort was attributed to the extensive exploratory efforts of a single fisher with catch per unit effort for the fishery around 0.5 kg/trawlift. Although catch and effort declined in 2007, catch rate increased significantly to 1.1 kg/trawlift potentially due to greater knowledge of the fishery. Catch and effort remained fairly stable in 2008 and 2009 (~ 5000 kg from ~ 8000 trawlifts) but has since declined significantly due to a lack of fishing by the majority of fishers, with one exemption not renewed in 2011. Catch rate over the past 5 years (2008 – 2012) has remained relatively steady between 0.5 and 0.8 kg/trawlift, with a catch rate of 0.5 kg/trawlift reported in 2012. Historically, the majority of commercial crabbing has occurred in the areas of Cambridge Gulf, Admiralty Gulf, York Sound and King Sound, with fishing reported from Cambridge Gulf and Admiralty Gulf in 2012.

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 2011/12, 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 2012 season, this fishery employed 3 commercial operators. The increased number and effort from commercial fishers in 2012 proportionally resulted in an increased catch and effort from 2011 when only 1 commercial and 1 aboriginal corporation fished. However the combination of unusual weather including seasonal flooding and cyclone activity coupled with difficulty with retaining crew, attracting investment and meeting local market requirements of product resulted in this lower than normal fishing level for the 2 Aboriginal Corporations in 2012.

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.

Mud Crab

Mud crab landings from the Kimberly mud crab fishery during 2012 were worth approximately \$33,000, an 82% increase on the \$6,000 generated in 2011. As the Kimberly region is the only commercial mud crab fishery in Western Australia this essentially represents the total value of the commercial mud crab fishery in Western Australia. The average beach price for green (uncooked) mud crabs in the Kimberly for 2012 was around \$26/kg (however note this value is based on a small proportion of total catch from an individual processor). Aboriginal corporations may also trade and barter product adding value to the local communities that cannot be estimated.

Fishery Governance

Target catch (or effort) range:

Blue Swimmer Crab Pilbara	N/A
Mud Crab	N/A

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 had not fished under his exemption since the 2007/08 fishing season. This exemption was subsequently rescinded in 2009, and the number of traps in the Pilbara trap fishery has reduced from 600 down to 400.

Mud Crab

The mud crab fishery is currently being fished at low/precautionary levels due to the low number of fishers operating in the fishery and relatively low effort across a large area of the Kimberly. Although some fishing occurs in localised areas of the coastline it is believed that stock levels are not being significantly affected at this time.

New management initiatives

Blue Swimmer Crab (2011/12)

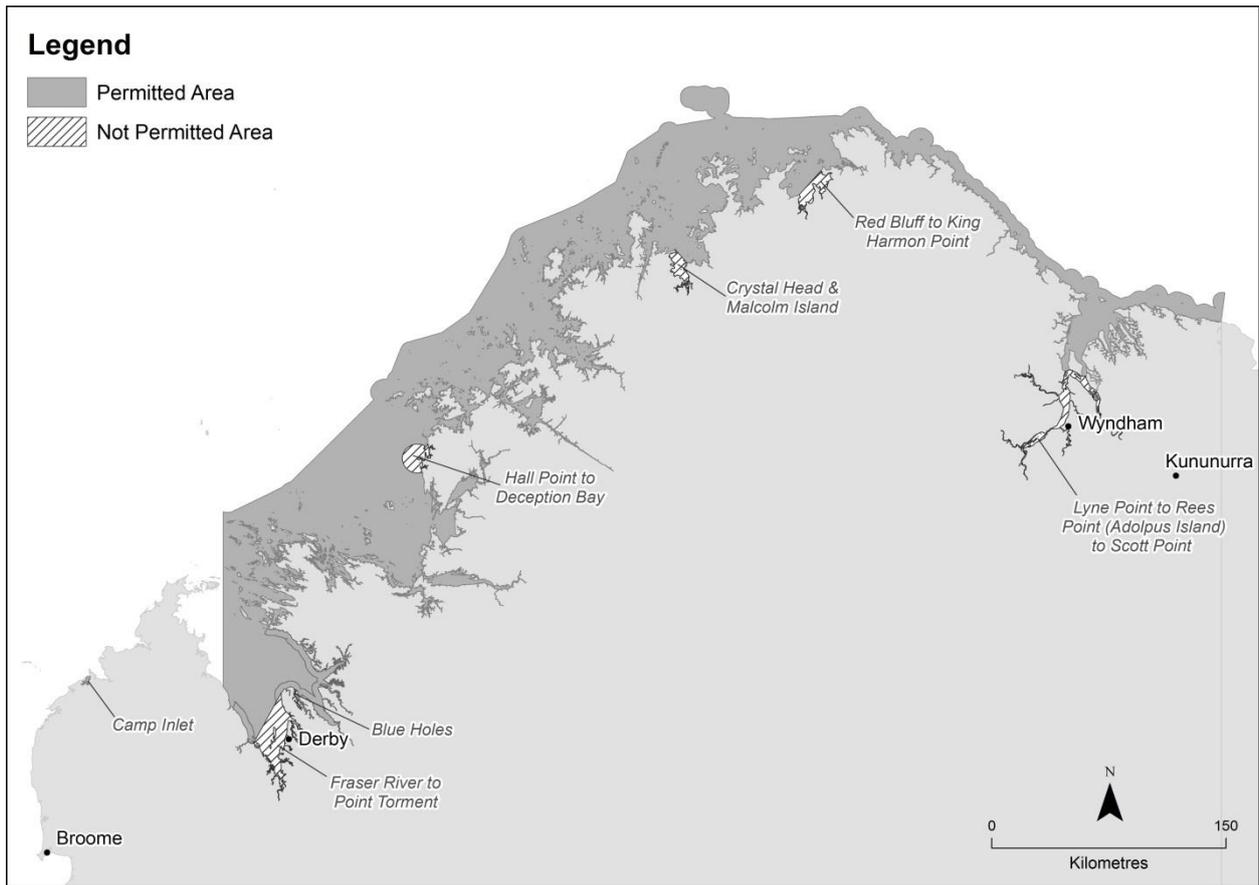
The Department proposes to bring the Pilbara Crab DNF under formal management arrangements in the near future.

Mud Crab (2012)

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.



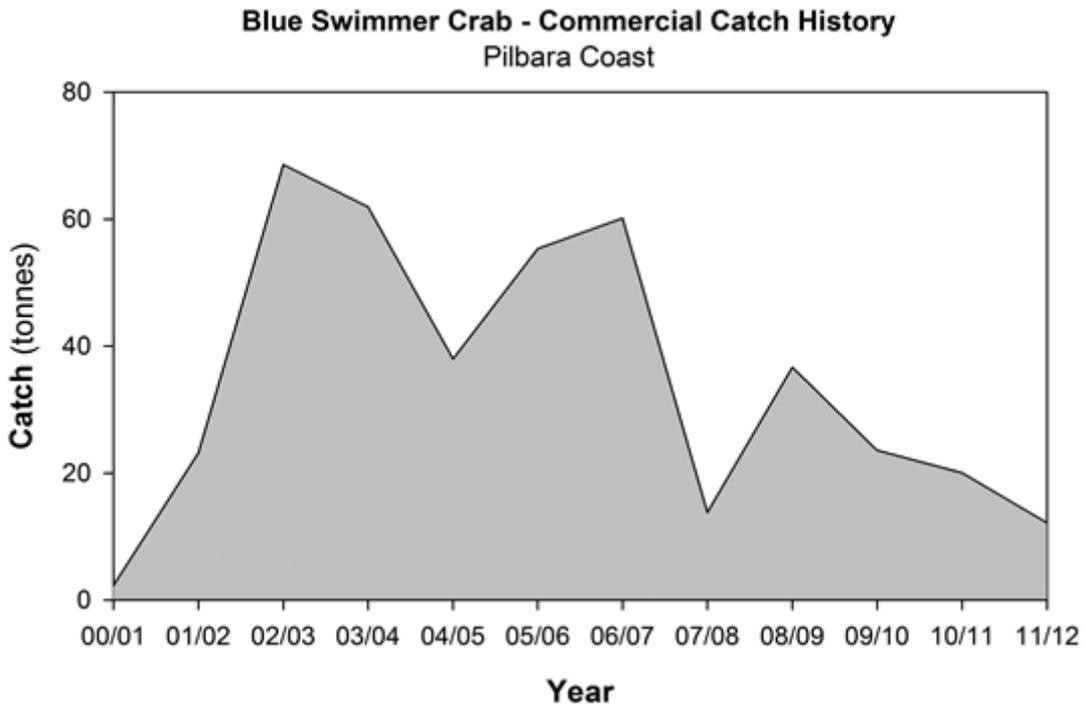
NORTH COAST CRAB FIGURE 1

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



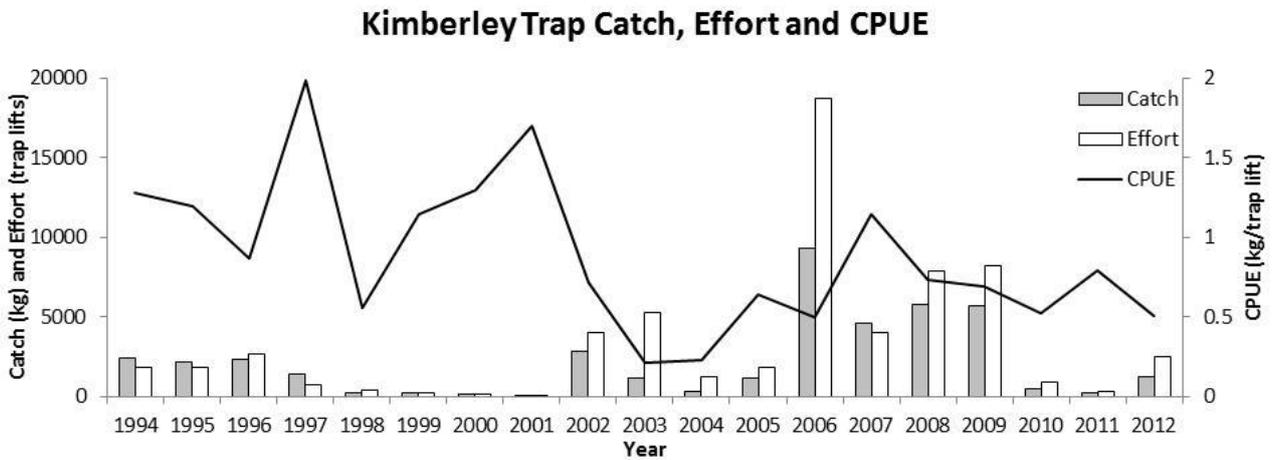
NORTH COAST CRAB FIGURE 2

Key areas fished by exemption holders operating in the Kimberly Developing Mud Crab Fishery in Western Australia.



NORTH COAST CRAB FIGURE 3

Commercial catch history for the blue swimmer crab (*Portunus armatus*) along the Pilbara coast since 2000/01. Data represents the total crab catch for trap and trawl sectors, consequently it is difficult to incorporate effort and CPUE in this figure. Trap effort and CPUE is summarised in the text.



NORTH COAST CRAB FIGURE 4

Annual catch, effort and catch rate (CPUE) for the Kimberly Region since 1994 when permissive conditions of fishing boat licenses were issued. The Kimberly Developing Mud Crab fishery commenced by exemption in 2006.

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. Located in the vicinity of Cone Bay, the Kimberley zone is expected to be established by the end of 2013.

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

NORTH COAST BIOREGION

placed on developing materials that focus on local issues and their dissemination through regional brochure stockists and local publications.

Activities during 2011/12

During 2011/12, the North Coast Bioregion's FMOs delivered a total of 6,314 officer hours of active compliance patrol time (North Coast Compliance Table 1). – an increase of 1,394 hours from the previous year (North Coast Compliance Figure 1) due to the impact of two additional Marine Park FMO's. FMOs also achieved 15,040 personal compliance contacts with the fishers and non-fishers across the recreational and commercial sectors.

There was improved engagement with short and long term visitors to the Pilbara and the Kimberley through a dedicated education program targeting caravan parks.

In the commercial sector FMOs undertook prosecution action as a result of compliance operations in 2011/12. This resulted in 11 infringement warnings, 28 infringement notices being issued and 41 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 174 infringement warnings were issued, 207 infringement notices and 22 matters resulted in prosecution action.

Initiatives in 2012/13

The Department will begin dedicated compliance and education patrols of the Camden Sound and 80 Mile Beach Marine Parks.

At sea compliance patrols of the 80 Mile Beach Marine Park will be carried out utilising the Departments first amphibious vessel, purposely built to be launched and retrieved in the large tides encountered in the Kimberley.

A new position as Marine Park Education and Interpretive Officer will be created for the Camden Sound Marine Park.

The Department's office in Kununurra will be increased to two FMO's. 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 Fremantle based Statewide Mobile Patrol Unit will be based in the Pilbara District for July and August 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.

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 2011/12 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	6,314 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	241
Infringement warnings	11
Infringement notices	28
Prosecutions	41
Fishwatch reports***	1
VMS (Vessel Days)****	7,852
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	14,799
Infringement warnings	174
Infringement notices	207
Prosecutions	22
Fishwatch reports	21
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	459
Fishwatch reports	47

* 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.

*** Fishwatch reports are allocated to the District Offices relevant to the Bioregion. It is not possible to distinguish between calls relating to Inland Bioregions.

**** 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

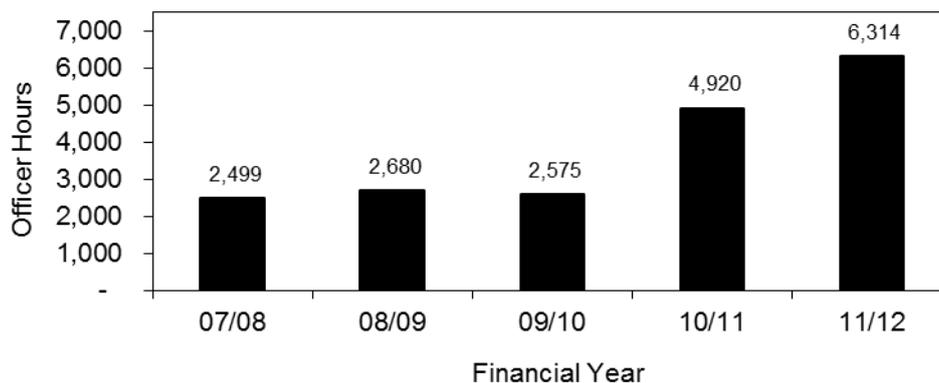
This table gives summary statistics for pearling compliance in all bioregions in the 2011/12 fishing season.

Total compliance hours*	460.5 Officer Hours
Field contacts by Pearling Officers	16
Letters of Warning issued**	0
Prosecutions	27

* 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 2011/12 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 (1,350 in 2011/12).

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.