

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast Bioregion (North Coast Overview Figure 1) 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.

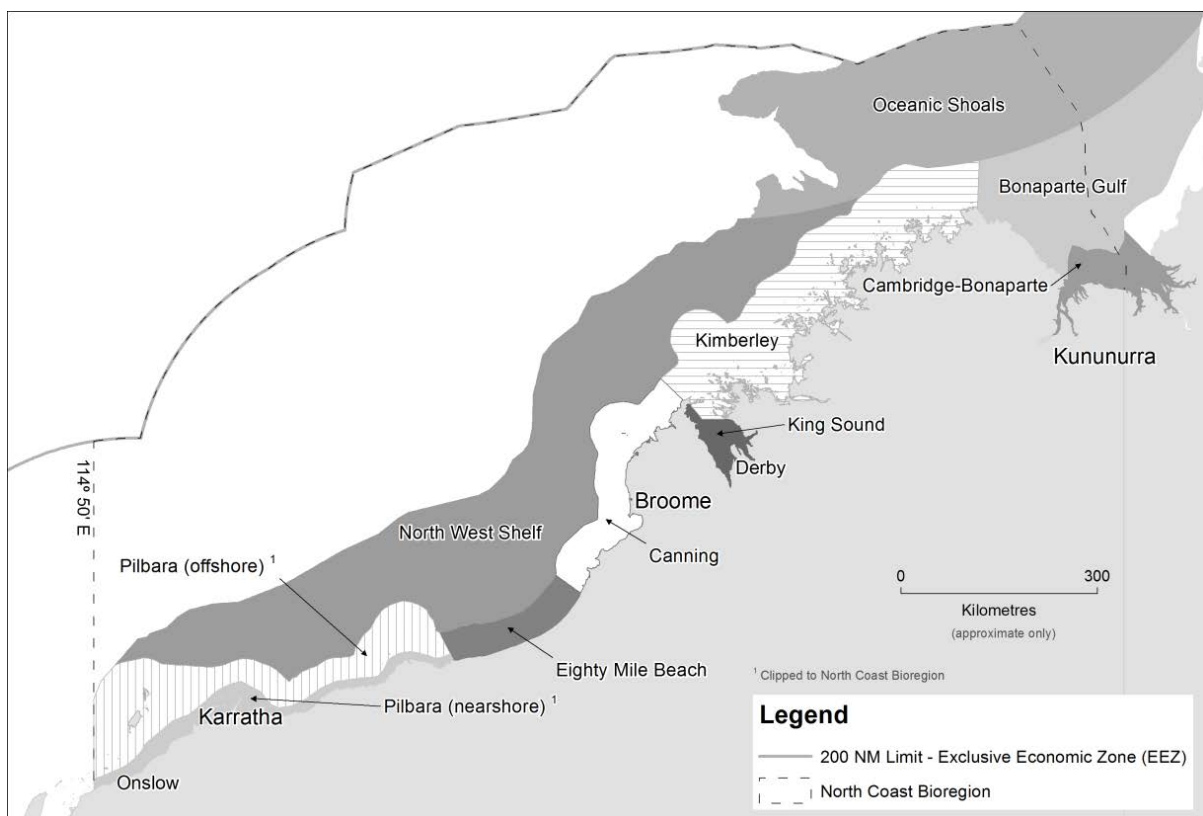
Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters, particularly along the Pilbara coastline. Fish stocks in the North Coast Bioregion are entirely tropical, with most having an Indo-Pacific distribution extending eastward through Indonesia to the Indian 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 localised coastal productivity can be associated with cyclone events, with run-off ceasing during winter. Despite localised areas of high productivity the region is generally oligotrophic and large areas of the coastline receive no riverine input. 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.

Other significant factors influencing coastal waters include the macro-tidal regime related to the wide continental shelf and the convergence of ocean currents. Spring tides range from greater than 11 metres along the Kimberley section of the coast down to more than 2 metres in the West Pilbara.



NORTH COAST OVERVIEW FIGURE 1

Map showing the North Coast Bioregion and IMCRA (V 4.0) meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

As a result of these factors, the generally tropical low-nutrient offshore waters can, in the few small 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 in areas locally 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.

The ecosystem boundaries as defined by IMCRA (V 4.0) in the bioregion are depicted in Figure 1. The potential threats and risks to these ecosystems are often similar. For simplicity risk ratings were allocated by grouping the ecosystems into two broad groups, estuarine or marine. However, if a particular ecosystem is unique and/or is exposed to different or significant threats, risk was allocated to these ecosystems separately.

SUMMARY OF ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Climate Change

Some of the key environmental trends that may be affecting ecosystems in WA include:

- Increasing frequency of El Niño/Southern Oscillation (ENSO) events;
- More years with a weaker Leeuwin Current;
- Increase in water temperature off the lower west coast of WA;
- Increases in salinity, which includes some large annual fluctuations;
- Change in the frequency and location of storms (and rainfall) affecting the lower west coast; and

- Change in the frequency of cyclones (and summer rainfall) affecting the north-west coast.

The North Coast Bioregion is predicted to have relatively minor impacts from climate change, especially in the coming decade, compared to more southerly locations (Fletcher and Santoro 2012). The variables expected to drive climate change impacts include changes in water temperature, ocean currents, winds, rainfall, sea level, ocean chemistry and extreme weather conditions.

It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions within communities, exotic species invasions and impacts, and the structure and dynamics of communities, including changes in productivity. Species distribution shifts are the most commonly reported changes and are often the easiest to recognise and measure. Changes in the distribution of key indicator species are being monitored in a national citizen-science program (www.redmap.org.au) that the Department is collaborating in.

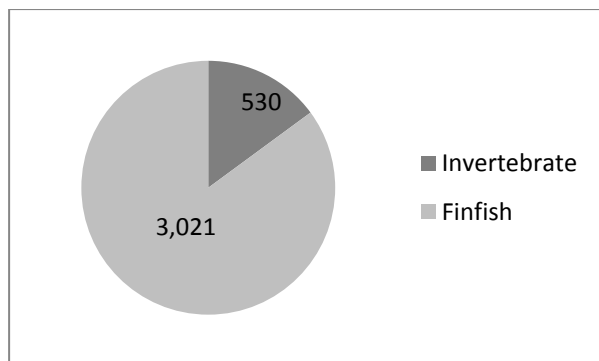
Commercial Fishing

There are 15 different state-managed commercial fisheries that operate within the North Coast Bioregion. These fisheries target a variety of species including finfish, crustaceans, molluscs and echinoderms (North Coast Overview Figure 2). The principal commercial fisheries in the North Coast Bioregion focus on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by the Pilbara trap, line and trawl fisheries and the Northern Demersal Scalefish (trap and line) Fishery. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of at least \$12 million, the most valuable finfish sector in the State. A number of other finfish fisheries operate in the Bioregion, including near-shore beach seining and gillnetting for barramundi and threadfin salmon (the Kimberley Gillnet and Barramundi Managed Fishery) and surface trolling for Spanish mackerel (the Mackerel Managed Fishery).

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 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. These fisheries include the Onslow, Nickol Bay, Broome and Kimberley Prawn Managed Fisheries (collectively referred to as the North Coast Prawn Managed Fisheries). Two small trap-based crab fisheries also exist in the Bioregion, targeting blue swimmer crabs in the Pilbara (the Pilbara Developing Crab Fishery) and mud crabs in the Kimberley (the Kimberley Developing Mud Crab Fishery). Sea cucumbers (also known as bêche-de-mer or trepang) are collected by hand by divers and waders throughout the Kimberley region as part of the Bêche-de-Mer Fishery. Catches are mainly comprised of two species, sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). The Trochus Fishery is a small fishery based on the collection of a single target species, *Tectus niloticus* from King Sound and the Buccaneer Archipelago. This fishery is operated by the Bardi Jawi and Mayala Aboriginal Communities, who have been collecting trochus in this area since the 1960s.

A traditional artisanal fishery also exists in an area around Roti Island, known as the MOU box. The MOU Box is an area within the Australian EEZ over which there is a bilateral agreement between Australia and Indonesia. The MOU allows Indonesian fishers to fish using traditional methods within Australian waters and has been operational since 1974.



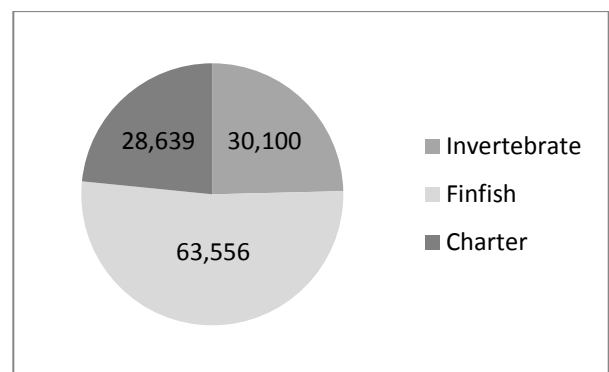
NORTH COAST OVERVIEW FIGURE 2

Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the North Coast Bioregion. Numbers represent total catch (in tonnes) based on all major assessed fisheries identified in the Overview section of this report (North Coast Overview Table 1).

Recreational Fishing

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 may have been added to by the increased recreational fishing resulting from 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 finfish species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods and catfish, and invertebrate species including blue swimmer crabs, mud crabs and squid (North Coast Overview Figure 3). Offshore islands, coral reef systems and continental shelf waters provide recreationally caught species including tropical snappers, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

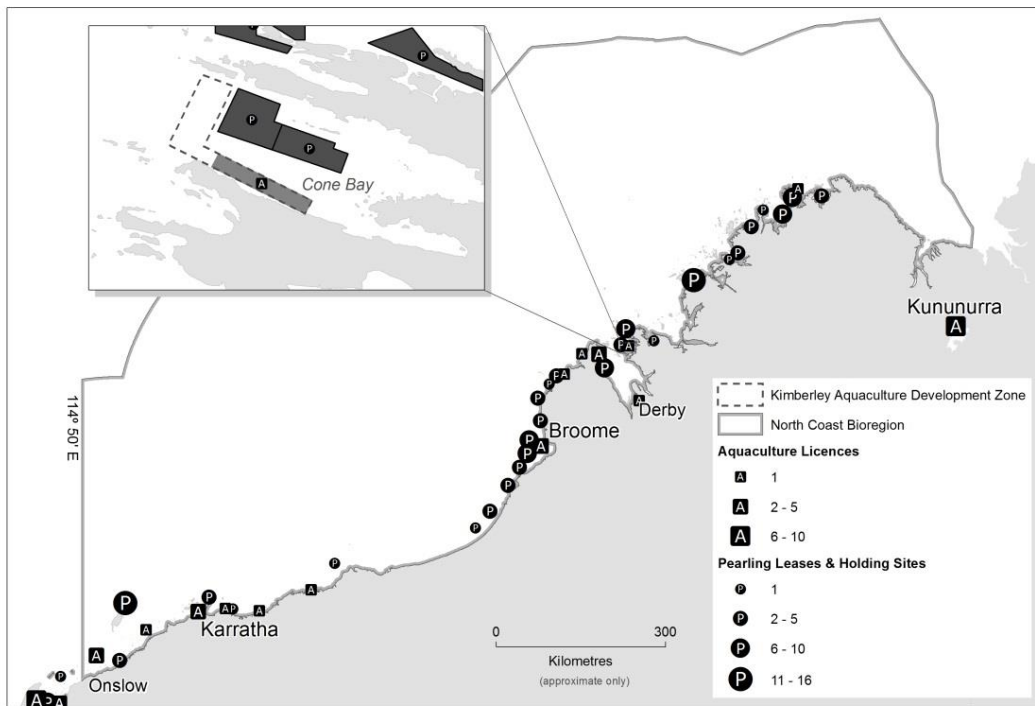


NORTH COAST OVERVIEW FIGURE 3

The North Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2013/14, and the charter boat catch numbers for the same period.

Aquaculture

Aquaculture development in the North Coast Bioregion is dominated by the production of pearls from the species *Pinctada maxima*. An overview of aquaculture activities in the Bioregion is detailed in North Coast Overview Figure 4. 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.



NORTH COAST OVERVIEW FIGURE 4

Overview of aquaculture activity in the North Coast Bioregion, detailing locations of licensed finfish aquaculture facilities and pearling leases. Also indicated is the Kimberley Aquaculture Development Zone that is under development.

Developing marine aquaculture initiatives in this region include growing trochus and barramundi. Marine production of barramundi is focussed in Cone Bay where an operator is currently licensed to produce 2,000 tonnes per annum. Establishment of an aquaculture zone has been funded in this area in which the Department of Fisheries will secure strategic environmental approvals, thereby streamlining the approvals processes for commercial projects and providing an “investment ready” platform for prospective investors. This is expected to lead to the development of further aquaculture operations in the region.

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.

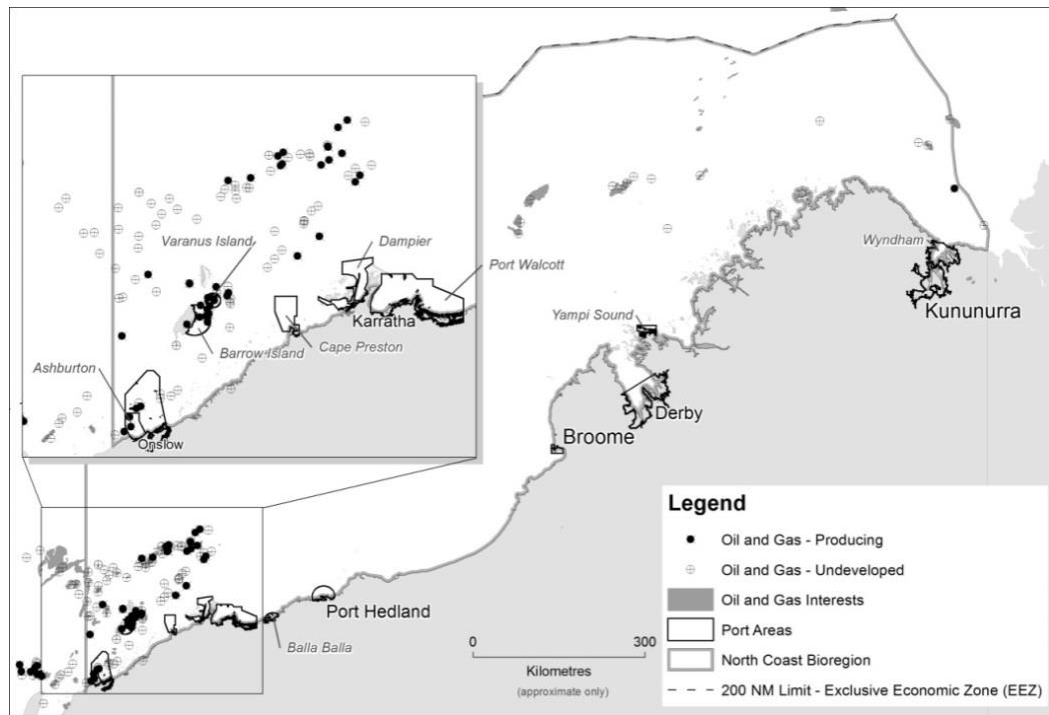
A company developing a project culturing marine microalgae for the production of bio-fuels, omega-3 lipid and protein biomass previously established a demonstration facility near Karratha. The company is currently assessing alternative sites for the project.

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

Tourism

The marine tourism industry has experienced significant growth within the North Coast Bioregion, particularly along the Kimberley coast in recent decades. As coastal access is limited, tourists generally access the coast by boat from major population centres, such as Broome and Wyndam. Activities include charter fishing, diving, snorkeling, whale, turtle and dolphin watching, and sightseeing cruises.

Sites of greatest interest to tourists include places to fish, areas for sightseeing and secluded locations for general relaxation. Luxury cruises take tourists along the coastline and increasingly out to isolated coral atolls for fishing and diving. Primary dive locations include the Rowley Shoals, Scott Reef, Seringapatam Reef, Ashmore Reef and Cartier Island.



NORTH COAST OVERVIEW FIGURE 5

North Coast offshore oil and gas production sites and major ports.

Oil and Gas Activity

Offshore oil and gas is a large and rapidly growing industry in the North Coast Bioregion. Within the Bioregion, the Northern Carnarvon, Browse and Bonaparte Basins hold large quantities of gas, and multiple projects are in various stages of development, production and exploration (North Coast Overview Figure 5). The main disturbances associated with oil and gas exploration and production include noise pollution from seismic surveys, potential for fish movement/impact arising from seismic surveys, disturbance to the marine habitat through drilling and/or dredging activities, release of produced formation water, shipping and transport activities and oil spill accidents.

Shipping and Maritime Activity

There are three major ports in the North Coast Bioregion: Broome, Dampier and Port Hedland (North Coast Overview Figure 5). The Port of Broome provides vital support for the Browse Basin offshore oil and gas industry. Other business includes livestock export, cruise liner servicing, coastal trading vessels, pearling, fishing and tourism charters. The Port of Dampier services both the land-based iron ore reserves and the offshore gas fields of the Carnarvon Basin. The Port of Port Hedland is the world's largest bulk exporter, with 99 % of the total cargo volume constituting exports. The port primarily exports iron ore, along with salt, livestock and petroleum products. There are eight

other non-port authority ports in the North Coast Bioregion. In general, these ports and related export facilities are operated by resource companies. Most handle raw bulk commodity exports such as iron ore, crude oil and salt. An increase in shipping and port expansion associated with growth of the resources sector has potential implications for the marine environment. Potential threats include loss or contamination of marine habitats as a result of dredging and sea dumping, oil spills, interactions between vessels and listed species and the introduction of marine pests.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview). Management measures specific to the North Coast Bioregion include:

Climate Change

Extensive work has been undertaken as part of a three-year FRDC-funded project (Caputi *et al.* 2015a,b) that assessed the effects of climate change on the marine environment and key fisheries, as well as management implications. Although these

studies focused on Bioregions more susceptible to increases in SST to the south, there were no documented effects of climate change occurring on the species selected (Caputi *et al.* 2015a,b). However, if anecdotal information is quantified on a southward shift in the range of Narrow-Barred Spanish Mackerel then it is possible that the total biomass of this species in Western Australia will increase due to various factors associated with breeding and availability of suitable habitats (Caputi *et al.* 2015b).

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch also recently completed a pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The establishment of standardised long term resource monitoring programs is fundamental to understanding and thus mitigating the impacts of climate change on marine resources. 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. 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.

Spatial Closures

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Overview Figure 6). However, trawling is still permitted in a small number of limited locations, which in total represent less than 11% of the shelf waters (North Coast Ecosystem Management Table 1; 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 the 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 or higher (as per Dudley, 2008 and

Day *et al* 2012¹; 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 with various management objectives, summarised in North Coast Overview Figure 7. These include 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 Department of Fisheries has also participated in the marine conservation reserve planning process in this Bioregion and has established baseline and ongoing monitoring and research to underpin ecosystem management. There is considerable interest in developing further marine protected areas within the Kimberley region, and the State Government is developing management plans, Indigenous Land Use Agreements (ILUA) and zoning arrangements for marine protected areas at Eighty Mile Beach, Roebuck Bay, Horizontal Falls and the North Kimberley. The proposed Dampier Archipelago marine conservation reserves are still under consideration by Government. 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 Western Australian Marine Science Institute (WAMSI) Kimberley Marine Research Program projects.

The Commonwealth Government 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 had announced a final reserve network proposed for the North-West which spans the North Coast and Gascoyne Bioregions was under review by the current Government.

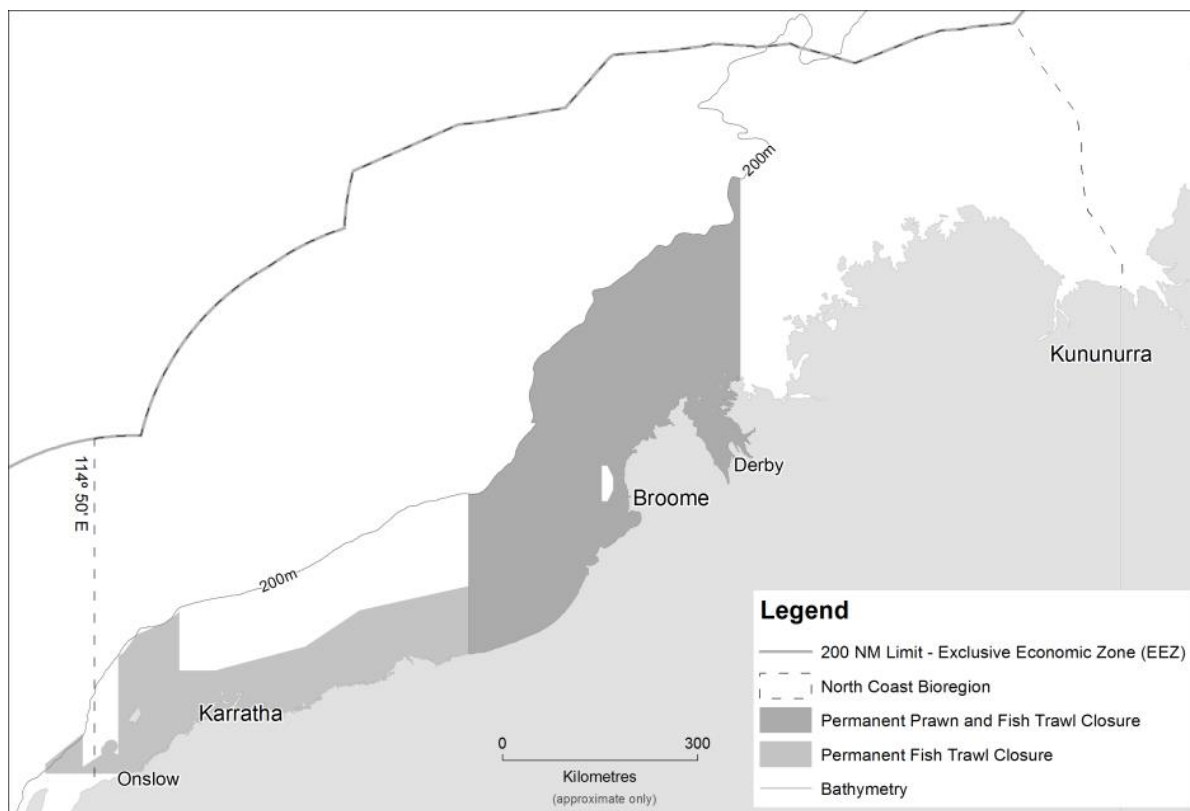
¹ Dudley N. (editor) 2008. Guidelines for applying protected area management categories. IUCN. Gland, Switzerland.

Day J, Dudley N, Hockings M, Holmes G, Laffoley D, Stolton S, and Wells S. 2012. Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. IUCN. Gland, Switzerland: 36pp.

NORTH COAST ECOSYSTEM MANAGEMENT TABLE 1

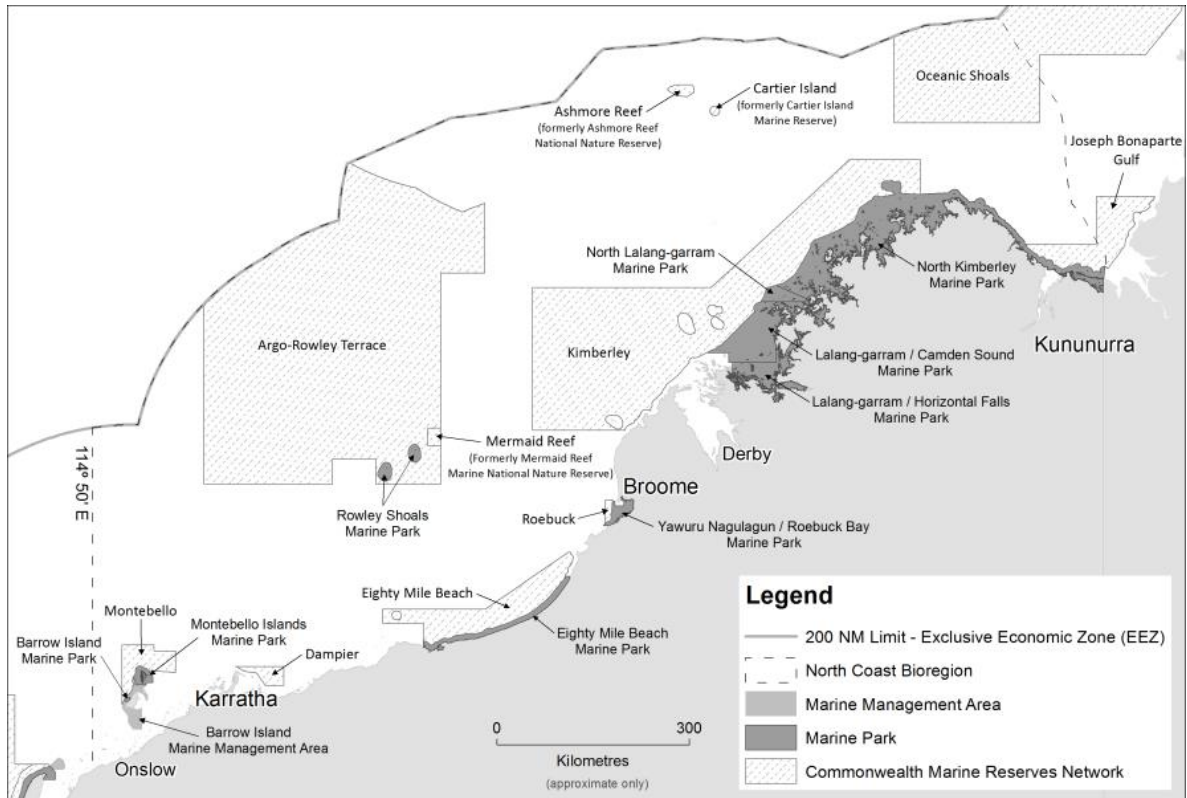
The areas and proportions of the North Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with the IUCN criteria for classification as marine protected areas. This table does not yet include the closures that may be implemented by the Commonwealth as part of their marine planning zones.

IUCN category or equivalent	State Waters only (65,400 km ²)				All Waters (837,500 km ² (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km ²	%	km ²	%	km ²	%	km ²	%
I	0	0	0	0	0	0	1,300	< 1
II	0	0	1,900	3	0	0	1,900	< 1
III	0	0	0	0	0	0	0	0
IV	19,100	29	3,500	6	149,200	18	3,500	< 1
V	0	0	0	0	0	0	0	0
VI	36,800	56	4,100	6	677,500	81	4,100	< 1



NORTH COAST OVERVIEW FIGURE 6

Map showing the North Coast Bioregion and areas closed to all trawling. The areas permanently closed to trawling are consistent with IUCN marine protected area category IV.

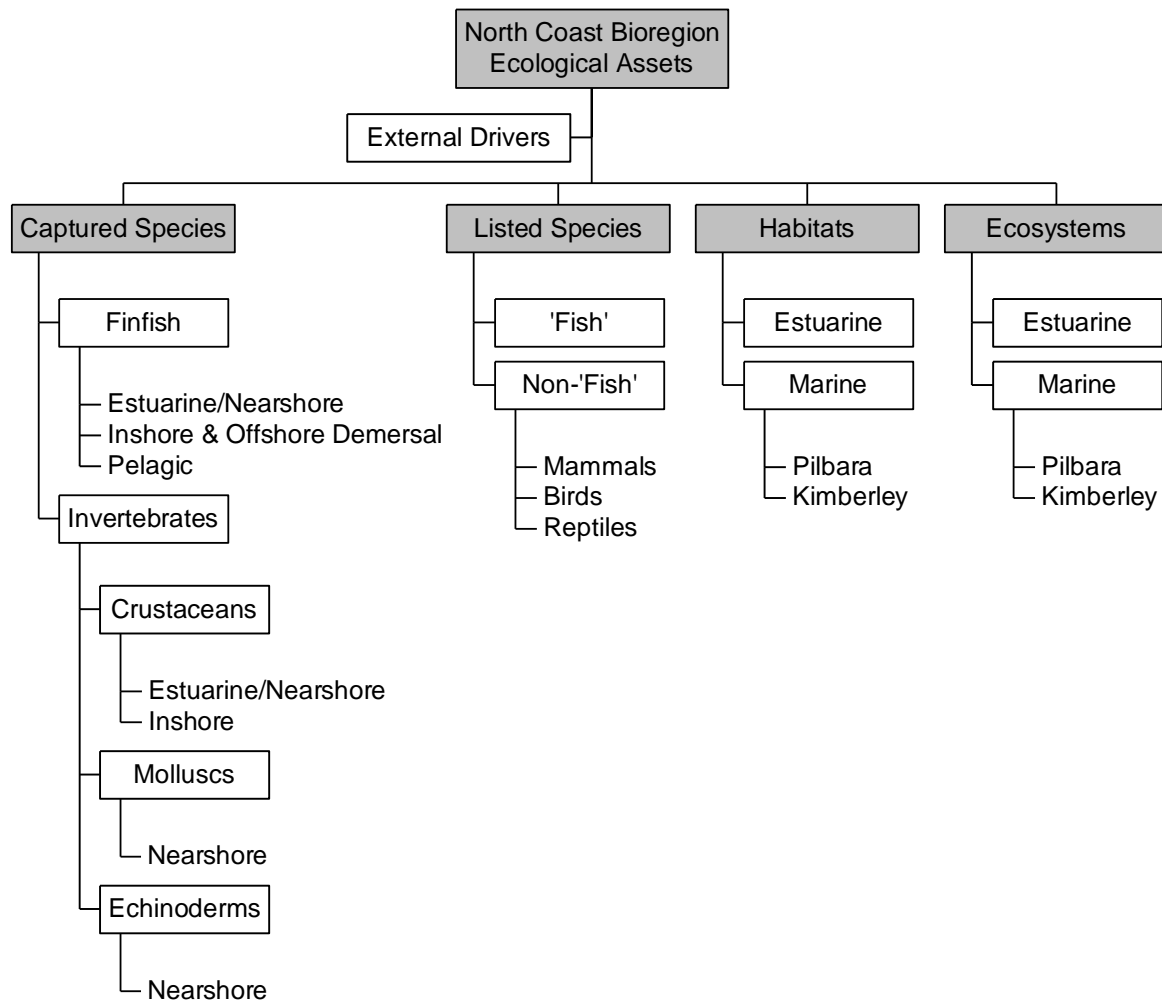


NORTH COAST OVERVIEW FIGURE 7

Map showing the North Coast Bioregion and current and proposed state and Commonwealth marine parks and reserves along the northern WA coast.

ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the North Coast Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (See How to Use section for more details). These key ecological assets identified for the North Coast Bioregion are identified in North Coast Overview Figure 8 and their current risk status reported on in the following sections.



NORTH COAST OVERVIEW FIGURE 8

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

External Drivers

External factors include factors impacting at the Bioregional-level that are likely to affect the ecosystem as whole and may not fall within the direct control of Fishery legislation (e.g. climate change). An understanding of these factors, which are typically environmental (cyclones, ocean currents) is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the North Coast Bioregion include climate, introduced pests and diseases and oil and gas development activities.

Climate

External Drivers	Current Risk Status
Climate	LOW

The North Coast Bioregion is predicted to have relatively minor impacts from climate change,

especially in the coming decade, compared to more southerly locations. (Cheung *et al.* 2012)²⁹ examined the effects of climate change on the distribution of 30 species of marine fish and invertebrates along the Western Australian coast. Important North Coast Bioregion species included western king prawns (*Penaeus latisulcatus*), blue swimmer crabs (*Portunus armatus*), redthroat emperor (*Lethrinus miniatus*), Spangled emperor (*Lethrinus nebulosus*), common coral trout (*Plectropomus leopardus*), rosy snapper (*Prestipomoides filamentosus*), goldband snapper (*Pristipomoides multidens*) and scaly mackerel (*Sardinella lemuru*). Changes in distribution were simulated using outputs from both a Regional Oceanographic Model and a Global Circulation Model. Results indicated a median shift of around 19 km per decade towards higher latitudes and 9 m deeper per decade by 2055 relative to 2005. As a result of these shifts, the temperate coast of Western Australia is expected to experience a

29 Cheung W, Meeuwig J, Feng M, Harvey E, Lam V, Langlois T, Slawinski D, Sun C, and Pauly D. 2012. Climate-change induced tropicalisation of marine communities in Western Australia. *Marine and Freshwater Research* 63: 415-427.

‘tropicalisation’ of the marine community, with an increased dominance of warmer-water species, resulting in shifted fishing grounds and unexpected trophic effects (Cheung *et al.* 2012).

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	LOW
Introduced Diseases	LOW

The increase in international shipping movement and dredging activity associated with resource development in the North Coast Bioregion is considered to present a risk to the marine environment because of the potential for the introduction of non-indigenous marine organisms, including animals, plants, pathogens and diseases. The Department implements a range of monitoring and research activities in the Bioregion, focussed on early detection of potential marine pests. Further details see Appendix section entitled “Activities of the Marine Biosecurity Research Group during 2015/16”.

Oil and Gas Development Activity

External Drivers	Current Risk Status
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 planned or in place.

Captured Species

Finfish

The principal fisheries in the North Coast Bioregion focus on tropical finfish, particularly the high-value emperors, snappers and cods. These species are taken by the Pilbara Demersal Scalefish Fishery (trawl, trap and line sectors) and the Northern Demersal Scalefish Fishery (trap and line). The typical catch is in the order of 3000 t annually at an estimated annual value of around \$ 12 million, making these fisheries the most valuable finfish

sector in the state. A number of other finfish fisheries operate in the Bioregion, including near-shore beach seining and gillnetting for barramundi and threadfin salmon (the Kimberley Gillnet and Barramundi Managed Fishery) and surface trolling for Spanish mackerel (the Mackerel Managed Fishery).

Indicator species which reflect the characteristics of the broader exploited stocks are monitored in order to assess ecological risk to the ranges of species targeted.

Estuarine/ Nearshore (0-20m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Estuarine/Nearshore	MODERATE

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) is the only commercial fishery operating in the nearshore and estuarine zones of the North Coast Bioregion. The primary target species are barramundi and threadfin salmon. Stocks of barramundi and threadfin salmon are considered to be at acceptable levels.

Inshore (shelf) Demersal (20-250 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Inshore (shelf) demersal (20-250m depth)	MODERATE

There are four State-managed commercial fisheries in the Inshore Demersal region, which use multiple methods to target demersal fish stocks. These fisheries include: The Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); The Pilbara Trap Managed Fishery (PTMF); The Pilbara Line Fishery (PLF); and The Northern Demersal Scalefish Managed Fishery (NDSF).

These fisheries all target the tropical demersal scalefish suite in the Pilbara and Kimberley Inshore Ecosystem and are collectively referred to as the Pilbara Demersal Scalefish Fisheries (PDSF) and Kimberley Demersal Scalefish Fisheries (KDSF). The trawl fisheries land the largest component of the catch, comprising more than 50 scalefish species. 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

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MODERATE

The Spanish Mackerel stock in this region targeted by the Mackerel Managed Fishery is at acceptable levels, and there are few other pelagic fish that are impacted.

Invertebrates

A significant commercial invertebrate fishery in this Bioregion, is the Pearl Oyster Managed Fishery, which is based on the collection of pearl oysters (*Pinctada maxima*) for use in the aquaculture production of pearls. The North Coast Bioregion also has a number of small, limited-entry trawl fisheries for prawns, producing around 700 t annually and valued at around \$10 million. Two small trap-based crab fisheries also exist in the Bioregion, targeting blue swimmer crabs in the Pilbara (the Pilbara Developing Crab Fishery) and mud crabs in the Kimberley (the Kimberley Developing Mud Crab Fishery). Sea cucumbers (also known as bêche-de-mer or trepang) are collected by hand by divers and waders throughout the Kimberley region. Catches are mainly comprised of two species, sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). The Trochus Fishery is a small fishery based on the collection of a single target species, *Tectus niloticus* from King Sound and the Buccaneer Archipelago. This fishery is operated by the Bardi Jawi and Mayala Aboriginal Communities, who have been collecting trochus in this area since the 1960s.

Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Crustaceans (Crabs)	Estuarine/ Nearshore	LOW
Crustaceans (Prawns)	Inshore	MODERATE

There is a small amount of fishing for mud crabs and blue swimmer crabs in some estuarine and inshore areas and its ecological risk is considered to be low.

There are a number of separate prawn stocks and fisheries within this Bioregion and 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

Captured Species	Aquatic zone	Ecological Risk
Molluscs (Pearls)	Nearshore	MODERATE
Molluscs (Trochus)	Nearshore	MODERATE

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.

The North Coast Trochus Fishery in King Sound is an indigenous fishery targeting the commercially important gastropod shell *Tectus niloticus*, commonly known as trochus. It is a hand collection fishery open to nominated fishers from the community. No fishing took place in 2012.

Echinoderms

Captured Species	Aquatic zone	Ecological Risk
Bêche-de Mer	Nearshore	MODERATE

The majority of the effort for bêche-de-mer has been expended in the Kimberley region, although there have been several years with substantial effort directed into the Pilbara region.

Listed Species

A number of endangered, threatened and protected³⁰ (ETP) species can be found within the North Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish, crocodiles and seabirds and migratory shorebirds. These species are protected by various international agreements and national and state legislation. International agreements include:

- Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention);

³⁰ Note that being on a listed species list does not automatically indicate that a species is either threatened or endangered.

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- The Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974 (JAMBA)³¹;
- The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA)²;
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007 (ROKAMBA)²; and
- Any other international agreement, or instrument made under other international agreements approved by the environment minister including the EBPC Act 1999.

Primary pieces of national and Western Australian legislation include the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act), the Western Australian Wildlife Conservation Act 1950 (WC Act), and the Fish Resources Management Act 1994 (FRMA).

The only fisheries in the region that have reported any interactions with ETP species are the two trawl fisheries, the Onslow Prawn Managed Fishery (OPMF) and the Nickol Bay Prawn Managed Fishery (NBPMF) and the Kimberley Gillnet Barramundi Fishery (KGBF). ETP interactions with the trawl fisheries are few, due to fishing arrangements, such as the use of bycatch reduction devices and the separation of trawling activities from most ETP species' primary habitat. Similarly, Fishers in the KGBF actively avoid capturing ETP species; however, a small amount of interactions have been reported with saltwater crocodiles and sawfish.

Fish

Listed species	Risk
Fish	MODERATE

The sawfish (Pristidae), spartooth shark (*Glyphis glyphis*) or the northern river shark (*Glyphis garricki*) 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.

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.

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 (*Epinephelus tukula*), 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.

Non-Fish

Listed species	Risk
Mammals	LOW
Reptiles and Birds	MODERATE

Dolphins are captured by the Pilbara trawl fishery, but dolphin excluder devices have reduced this incidence to acceptable levels, with further refinements in net design currently being trialled. The Pilbara fish trawl fishery recently secured a three year WTO with further conditions around dolphin and sawfish interactions and monitoring.

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.

Crocodiles are occasionally captured in nearshore/freshwater fisheries' nets and most often are released alive.

Anecdotal information from Lake Argyle fishers suggests that interactions with birds and crocodiles 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.

³¹ Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at www.environment.gov.au/biodiversity/migratory/index.html

Habitats and Ecosystems

Coastal geography is extremely variable within the North Coast Bioregion and its identified meso-scale ecosystems include a range of key habitats in depths of less than 40 m (where the vast majority of relevant fisheries resources are located and fishing activities are undertaken in this Bioregion) which include:

- **Mangroves:** Mangroves occur throughout the Bioregion, and within the Kimberley, are considered to be very well developed and relatively pristine. The mangrove communities of Roebuck Bay and Eighty Mile Beach have been listed as Ramsar Wetlands of International Significance mainly due to the numbers of migratory wading birds they support.
- **Seagrasses:** Seagrasses are mainly tropical species. Twelve species have been identified throughout the North Coast Bioregion, including one endemic species (*Cymodocea angustata*). Within the Bioregion, seagrasses are generally found in shallow water environments near the mainland coast and offshore reefs and shoals.
- **Algae:** Algal growth is restricted by the limited presence of hard substrates on the North West Shelf. Throughout the Kimberley, the effects of strong tidal currents and high turbidity result in low macroalgal diversity. Surveys in the Kimberley have identified 72 species of macroalgae in the southern Kimberley and 90 species (not including coralline algae) in the northern Kimberley, most of which are widespread tropical taxa.
- **Sponges and Filter-Feeding Communities:** Sponges are found from tidal areas to the deep waters of the Abyssal Plain and generally occur as part of a mixed filter-feeding community. Species richness varies considerably throughout the Bioregion, with both relatively low-diversity communities (< 25 species, e.g. Rowley Shoals) and exceptionally rich communities (> 250 species, e.g. Dampier-Port Hedland regions). Sponge communities throughout the Bioregion are also broadly different. For example, a study by the Western Australian Museum found more than half the sponges identified at Mermaid, Scott and Seringapatam Reefs were unique to a single reef (WAM, 2006).
- **Coral Reefs:** Coral reefs in the Bioregion fall into two general groups: the fringing reefs around coastal islands and the mainland shore and large platform reefs, banks and shelf-edge atolls on the mid and outer shelf. North of Cape Leveque, the Kimberley supports extensive

nearshore reef systems. Areas of fringing reef development include islands in the Buccaneer Archipelago, the Heyward island group, islands of the Bonaparte Archipelago and off mainland shores of Cape Voltaire and Cape Bougainville. Coral diversity is typically high, with surveys of the Buccaneer Archipelago having recorded 280 species of coral from at least 55 genera. Coral reefs are also well developed around offshore island such as Ashmore, Cartier, Hibernia, Seringapatam and Scott Reefs, Browse Island and the Rowley Shoals.

- **Sand/Mud:** Embayments along the Kimberley are known to have extensive muddy tidal flats and the majority of the offshore area is dominated by soft sediment seabeds, which are mainly sand/mud with occasional patches of coarser sediments.

In depths beyond 40 m, ecosystems include hard- and soft-bottom benthic communities, sand banks and pelagic communities. Given the low levels of activities in these depths, there is little detailed information on these environments.

A high level of protection of the ecosystems and habitats within the North Coast Bioregion is ensured based on the limited area of the Bioregion that is available to commercial trawl fishing activity (North Coast Bioregion Overview Figures 6 and 7). If the areas that are not trawled is taken into account, 89 % of statewide benthic habitats out to the 200 m isobath are, in practical terms, fully protected and may never have been trawled (North Coast Ecosystem Management Table 1). In addition to fisheries-related closures, the North Coast Bioregion has a number of marine protected areas described under the preceding “spatial closures” section.

The Department identifies and monitors trends in the condition of ecosystems and their associated habitats to ensure the long term sustainability of both these key ecological assets and the fisheries that depend on them.

Habitats

Habitats	Aquatic zone	Current Risk Status
North Coast	Estuarine	LOW
Kimberley	Marine	LOW
Pilbara	Marine	MODERATE

The majority of these fishing activities occur in mud/sand habitats in estuaries, tidal creeks and

embayments . Trawl activities are considered to have the highest relative impact of the methods used within the bioregion which also includes low impact activities of trap, gillnets and hand collection based fisheries. However, the spatial extent of trawling activities is small, and there are a variety of measures in place to manage any impacts. The spatial distribution of all fishing activities are also managed through the use of seasonal and area closures to protect sensitive habitats.

Ecosystems

Ecosystems	Aquatic zone	Current Risk Status
North Coast	Estuarine	NEGLIGIBLE
Kimberley	Marine	LOW
Pilbara	Marine	MODERATE

There are a number of oil and gas related offshore and onshore developments exist or are proposed in this bioregion. While some specific areas may be locally impacted, these still only pose a low risk to the overall ecosystem of this Bioregion.

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. Assessments of the community structure and trophic level of all commercially caught fish species in the region over the past 30 years found no evidence that there have been any systematic changes. (Hall and Wise 2011). The majority of catch from each fishery is comprised of the main target species, and catches of these species have remained stable throughout the history of each fishery. None of the main target species are known to be involved in any strong ecological interactions and their removal at current rates is unlikely to seriously or irreversibly alter community structure.

NORTH COAST PRAWN RESOURCE STATUS REPORT 2016

E. Sporer, M. Kangas, S. Wilkin, I. Koefoed, P. Cavalli and L. Pickles



OVERVIEW

The four northern prawn managed fisheries all use low opening, otter prawn trawl systems to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), and endeavour prawns (*Metapenaeus endeavouri*). High opening, otter trawl systems are also used when targeting banana prawns (*Penaeus merguensis*) which is the

target species for two of these fisheries.

Management of these fisheries is based on input controls, including limited entry, gear controls (maximum headrope units) seasonal and area openings and closures.

The fisheries have Commonwealth export approval for the next ten years.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	273 t	Not applicable	
Fishing Level	Acceptable		
Stock/Resource Performance	Stock Status	Assessment Indicators	
Nickol Bay	Adequate	Catch, Effort, Rainfall-Catch Relationships	
Kimberley	Adequate	Catch, Effort, Biomass, Rainfall-Catch Relationships	
Broome	Adequate	Catch, Effort	
Onslow	Adequate	Catch, Effort	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Low Risk	Listed Species	Low Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	Amenity Score 1 Risk Level 1	Economic	KPMF: Level 2 (\$1 – 5 million) BPMF: Level 1 (<\$1 million) NBPMF: Level 2 (\$1 – 5 million) OPMF: Level 1 (<\$1 million) Risk Level 4
Governance	Kimberley - Plan review	External Drivers	Risk Level 4 (climate)

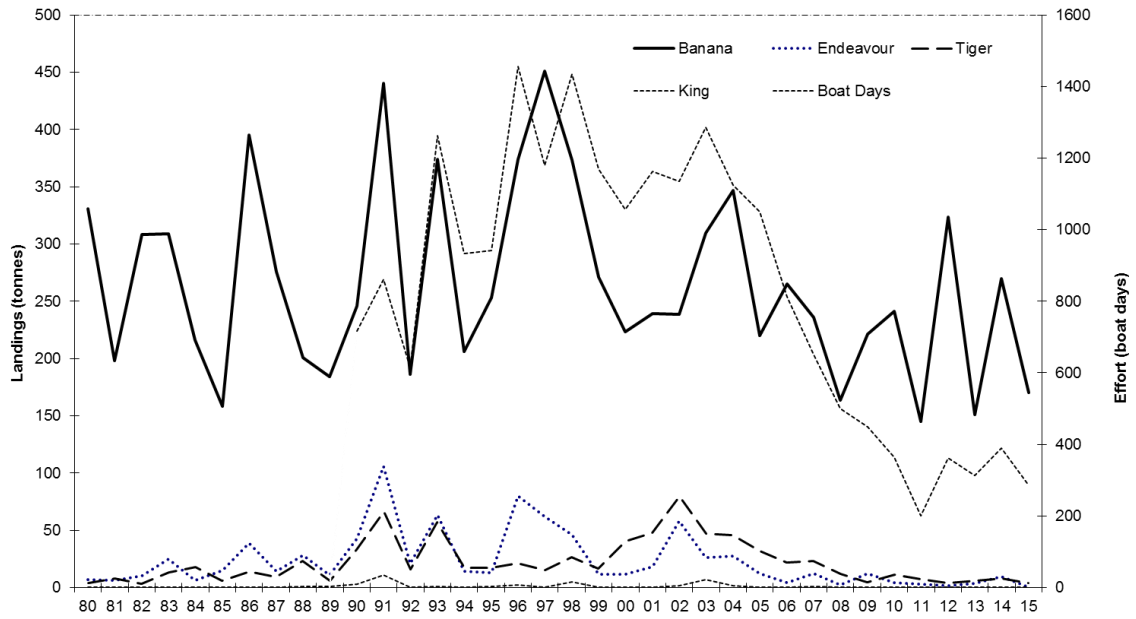
CATCH AND LANDINGS

Kimberley Prawn Managed Fishery

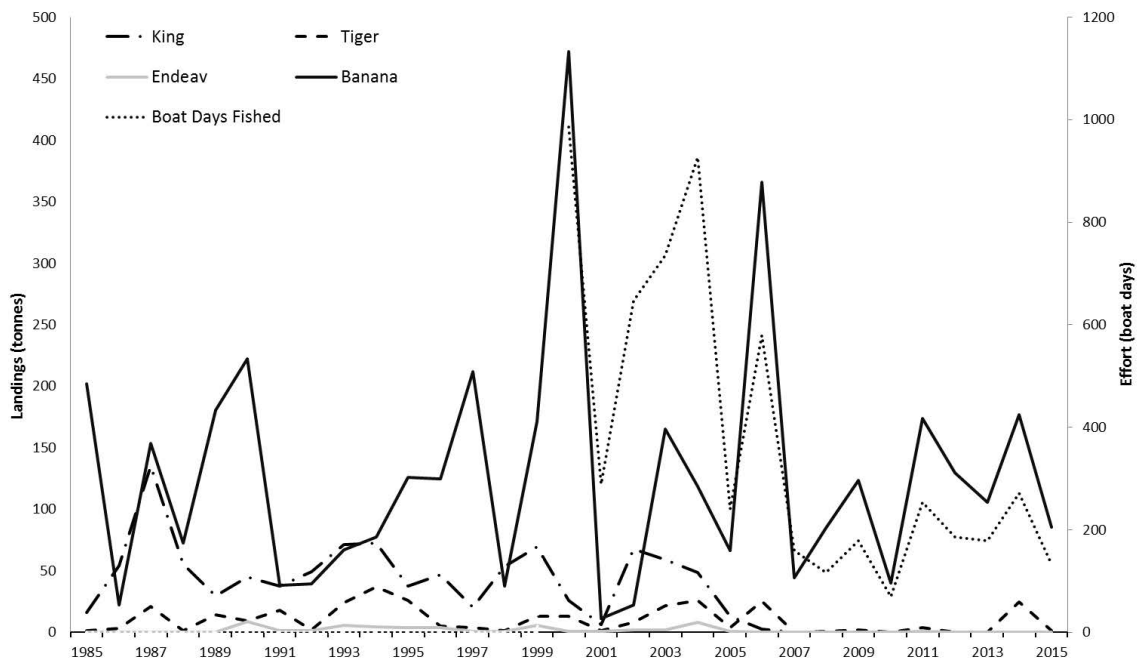
The total landings in 2015 for the KPMF were 175 t, similar to the levels caught during the past 8 years. This catch comprised 170 t of banana prawns, 4 t of brown tiger prawns and 1 t of endeavour prawns (North Coast Prawn Figure 1).

Fishing occurred in both fishing periods however the second part of the season had much reduced fishing effort compared to previous years.

Negligible quantities of byproduct were reported.



NORTH COAST PRAWN FIGURE 1. Annual prawn landings (t) and fishing effort (total adjusted hours) for the Kimberley Prawn Managed Fishery 1980-2015.



NORTH COAST PRAWN FIGURE 2. Annual prawn landings (t) and fishing effort (total adjusted hours) for the Nickol Bay Prawn Managed Fishery 1985-2015.

Broome Prawn Managed Fishery

Minimal effort and landings were recorded in 2015. This included 0.3 t of western king and 0.8 t of coral prawns. The byproduct caught was <0.1 t of cuttlefish.

Nickol Bay Prawn Managed Fishery

The total landings of major penaeids for the 2015 (North Coast Prawn Figure 2) season was 87 t, which was similar to levels caught over the past 7 years. The 85.2 t banana prawns landed was slightly above the predicted range (49 – 73 t) plus there was 1.6 t of brown tiger prawns, and negligible amounts of western king and endeavour prawns.

Onslow Prawn Managed Fishery

The total landings of major penaeids for the 2015 season were 10.1 t, comprising <0.1 t of western king prawns, 5.6 t of brown tiger prawns, 0.5 t of endeavour prawns and 4.0 t of banana prawns.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Kimberley Prawn Managed Fishery – Banana prawns (*Adequate*)

Banana prawns are distributed from Exmouth Gulf across to northern New South Wales. They live between one and two years and prefer shallow estuarine and intertidal areas and with limited burrowing capacity they are generally restricted to turbid waters to avoid predation (Penn 1984). Which in the Kimberley, turbid habitats can occur a significant distance from the coast.

Since the change in the economics of fishing in about 2005, there was a marked reduction in the number of fishers with fishing effort (vessel-days) now well below historical levels. Catch levels have been maintained with an increase in catch rates and estimated levels of fishing mortality from a preliminary biomass dynamic model which all indicate the breeding stock is **adequate**.

Broome Prawn Managed Fishery – Western king prawns (*Adequate*)

The western king prawn is widely distributed throughout the Indo-West Pacific region. They are nocturnal so their catchability is influenced by lunar cycles and temperature.

No fishing takes place during the breeding season and there is minimal overlap of fishing on the

breeding stock due to the widespread nature of this species and the current low level of fishing effort. The breeding stock is therefore considered **adequate**.

Nickol Bay Prawn Managed Fishery – Banana prawns (*Adequate*)

On the basis of annual trends in catch and effort, and more recently with annual catch rates and the outputs of preliminary stock production models and a biomass dynamics model the stock is being fished at a sustainable level with the breeding stock considered **adequate**.

Onslow Prawn Managed Fishery – Brown Tiger and Western King Prawns (*Adequate*)

The breeding stock of brown tiger prawns is protected with low landings and low effort primarily due to marginal profit opportunities.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Low Risk*)

Bycatch levels for all these fisheries are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. In addition to grids, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. All boats also use hoppers (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality.

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids have largely eliminated turtle and other large animal captures.

Protected species interactions recorded in the daily logbooks for each fishery in 2015 are;

Kimberley: One turtle was reported as being caught and returned alive, one dead sawfish was recorded; 28 sea snakes were recorded as being caught with 26 returned to the sea alive.

Broome: The fishery operates in relatively deep water, combined with the short season, restricted trawl area and very low effort results in minimal interaction, and no interactions were reported.

Nickol Bay: Two turtles were reported caught which were all returned alive, whilst seven sea snakes were released alive and six were returned

dead. Four sawfish were reported with two released alive and the other two dead. There were no reported interactions with protected species in the **Onslow** fishery.

HABITAT AND ECOSYSTEM INTERACTIONS (*Low Risk*)

Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of these fishery and controls on effort indicate that its environmental effect is likely to be low. The area fished in the four northern prawn fisheries where fishing was undertaken ranged from 1.4% in the Kimberley fishery to <1% in the Broome fishery, within the boundaries of these fisheries. The fisheries are generally restricted to clean sand to mud substrates where trawling activity has minimal long term physical impacts.

Although the prawn species are managed at relatively high levels of annual harvest, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality, extent of non-trawled nursery areas and variable biomass levels of prawns resulting from variable environmental conditions such as cyclone events.

SOCIAL AND ECONOMIC OUTCOMES

Social

The estimated employment in the fisheries for the year 2015 was 40 to 50 including skippers and other crew for all north coast fisheries combined.

Economic

Ex-vessel (beach) prices for prawns vary, depending on the type and quality of product and the market forces operating at any one time. The total estimated value of the fisheries includes byproduct; KPMF - \$2.1 M, BPMF - negligible, NPMF - \$1.0 M and OPMF - \$0.1 M.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

KPMF: banana prawns, 200 - 450 t: (**Acceptable**) Banana prawn landings were below the target range as well as the predicted range due to low fishing effort.

BPMF: western king prawns, 35 -170 t: (**Acceptable**) Minimal fishing occurred in 2015.

NPMF: banana prawns, 40 - 220 t: (**Acceptable**)

The brown tiger prawn catch was just below the target range (2 - 40 t) and the western king prawn landings were extremely low and below the target range for this species. Total landings were just below the allowable range, but landings of banana prawns, were within their normal catch range and slightly above their predicted catch range.

OPMF: brown tiger prawns, 10 - 120 t and western king prawns, 10-55 t: (**Acceptable**) Effort and catch were minimal in 2015.

Harvest Strategy

Management arrangements for all four fisheries are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly brown tiger prawns). For the KPMF an upper limit effort cap of 1500 vessel days is set. Bycatch reduction devices (BRDs) and a secondary fish escape devices (FED) are mandatory under the EPBC Act.

Compliance

It is a requirement that all vessels in these fisheries are fitted with an Automatic Location Communicator (ALC). The implementation of an ALC enables the Department of Fisheries (Department) to monitor the fleet using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Meetings between the Department of Fisheries, WAFIC and licence holders to consider the status of the stocks and recommend the opening and closing dates and fishing arrangements that operate within the season.

Management Initiatives/Outlook

Review of the KPMF Management Plan is scheduled in 2016/17, 2017/18.

EXTERNAL DRIVERS

A positive relationship has been observed with summer rainfall and banana prawn landings, particularly in the NBPMF (Caputi *et al.* 2014a).

High water temperatures are also having a negative effect on western king prawn catches in

recent years (Caputi *et al.* 2014b, 2016) which may be impacting these northern prawn fisheries that target western king prawns. Brown tiger prawns were ranked as a **high risk** to climate change effects and western king prawns as **medium-high** so both these species need to be monitored (Caputi *et al.* 2014b, 2015).

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NORTH COAST NEARSHORE AND ESTUARINE RESOURCE STATUS REPORT 2016

S. Newman, C. Skepper and P. Dobson



OVERVIEW

The Kimberley Gillnet and Barramundi 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 gillnet in inshore waters and the taking of barramundi (*Lates calcarifer*) by any means. The principal species landed are barramundi (*Lates calcarifer*) and two species of threadfin (king threadfin *Polydactylus macrochir* and blue threadfin *Eleutheronema tetradactylum*). Small quantities of Elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis*) are also landed.

The main areas of operation for the commercial fishery are the river systems and tidal creek systems of the Cambridge Gulf (including Ord River), the Ria coast of the northern Kimberley (six small river systems), and King Sound. Access to the KGBF is limited to five licences, following the buyout of the two licences from the Broome coast (Roebuck Bay) in 2013. Commercial fishing is now prohibited between 19°00' S and 17°44' S latitude (north of Willie Creek) within three nautical miles of the high water mark. There are commercial fishing area closures around major town sites and recreationally important fishing locations, namely 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.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	82 t	15 t (11 - 19 t 95% CIs)	
Fishing Level	Acceptable	Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Barramundi	Sustainable – Adequate	Level 1 – Catch Range	
King Threadfin	Sustainable - Adequate	Level 1 – Catch Range	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Low Risk
Habitat	Negligible Risk	Ecosystem	Negligible Risk
Social	Low Risk	Economic	Moderate Risk Level 3 GVP (< \$1 mill)
Governance	New Marine Parks being progressed	External Drivers	Low Risk

CATCH AND LANDINGS

The total reported catch of all species in the KGBF in 2015 was 82 t (North Coast Nearshore and Estuarine Table 1). The total landings of barramundi in 2015 were 52.4 t (North Coast Nearshore and Estuarine Table 1), an increase on

the 2014 catch of 44.2 t. The 2015 landings of threadfin from the KGBF were 26.2 t (North Coast Nearshore and Estuarine Table 1), which represented a slight increase to those reported in 2014 (23.4 t).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Barramundi (Sustainable-Adequate)

The barramundi catch in 2015 was 52 t, above the target catch range but below the limit range. The increased catch was obtained with high catch rates (136.1 kg/block day) across the fishery suggesting there was a higher stock abundance. There is a need to update the stock assessment for barramundi and also a need to re-evaluate the effort measure used in the fishery.

The above evidence indicates that the biomass of these stocks is unlikely to be recruitment overfished and that current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment overfished. Thus the breeding stock is classified as **adequate/sustainable**.

King threadfin (Sustainable-Adequate)

Threadfin catches are dominated by king threadfin. Catches of king threadfin in 2015 was 25 tonnes (t), similar to that reported in 2014 and are stable at this low level. Catches are well below the average of 74.5 t for the 10-year period from 2004–13. This is due to the low effort levels now available in the fishery. This follows the removal of two fishing licenses from the Broome coast area, with this area now closed to commercial fishing. King threadfin are landed by recreational and charter fishers, but only in small quantities (1 t). The above evidence indicates the biomass of this stock is unlikely to be recruitment overfished and that the current fishing pressure is unlikely to cause the stock to become recruitment overfished.

On the basis of the evidence provided above, the breeding stock of King Threadfin is classified as a **adequate/sustainable**.

NORTH COAST NEARSHORE AND ESTUARINE TABLE 1. Summary of the reported catch (t) in the Kimberley Gillnet Barramundi Fishery in 2015 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin	26.2	31.9
Barramundi	52.4	63.9
Tripletail	0.2	0.3
Black jewfish	1.4	1.7
Sharks	1.0	1.2
Other fish	0.8	1.0
Total	82.0	100

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: (Negligible Risk) 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 impose a negligible risk to the stocks involved.

Protected Species: (Low Risk) 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 2015, listed species interactions were reported for both crocodiles and sawfish.

Catches of the speartooth 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. Effort levels inside freshwater drainages will be monitored.

HABITAT AND ECOSYSTEM

INTERACTIONS (*Negligible Risk*)

This fishery poses a negligible risk on the nearshore and estuarine ecosystem of the Kimberley region due to the low spatial density of fishing effort. 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 AND ECONOMIC OUTCOMES

Social (*Low Risk*)

During 2015, four vessels fished in the KGBF with an average crew level of approximately 2.4 people, with an estimate of at least 9 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.

A significant number of recreational and charter anglers also fished across the region. Recreational fishing attracts many visitors to the North Coast Bioregion, particularly in nearshore areas over the winter dry season (April – October). This provides employment through local charter fishing services and fishing tackle outlets around key population centres, as well as more remote charter operations offering wilderness fishing experiences in the north Kimberley region. 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).

Economic (*Moderate Risk*)

The fishery's score value in 2015 was estimated to be Level 1 (i.e. Risk level – **Low**; Economic value – < \$1 million). The new marine parks may impact on the economic viability of the KGBF.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels (*Acceptable*)

The target commercial catch range was calculated based on catch information from 1989 – 1999, a period during which the fishery was stable and levels of exploitation were considered to have been sustainable. However, the target catch range for barramundi has recently been revised to be consistent with the reference points and control rules adopted for other fisheries. The current approach specifies this range as the values within the minimum and maximum catches observed during the reference period. The threshold values for the target commercial catch range have been calculated as being within the range of 33 – 44 t, with a limit reference range of 23-54 t. Monthly catch and effort data from the commercial fishery are used to assess the status of barramundi populations targeted by the fishery.

Harvest Strategy

The harvest strategy for barramundi in the Kimberley Gillnet and Barramundi Managed Fishery in the Kimberley region of Western Australia is based on a constant commercial catch policy where the annual commercial catches of barramundi are allowed to vary within the target catch range, which is based on a historical catch range during which the fishery was stable and levels of exploitation were considered to be sustainable.

Compliance

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures and gear restrictions. There is a closed season in which fishing is prohibited in the KGBF. In the southern KGBF (west of Cunningham Point, 123°08.23' E longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year. There

are also limits on the length of net and mesh sizes to be used in the fishery.

Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months). Fish species in the North Coast Bioregion are assigned bag and size limits according to their ecological suite and risk to sustainability. The bag and size limits are species-specific (e.g. barramundi) or species group specific (e.g. mullet) to ensure that stock levels are maintained. 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.

Consultation

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

Management Initiatives (New Marine Parks)

The KGBF management plan was amended in June 2012 to modernise the fishery management arrangements. The next management review of the fishery is scheduled after the 2016 /17 financial year. New marine parks are currently being developed for the Kimberley region.

EXTERNAL DRIVERS (*Low Risk*)

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 sectors on barramundi stocks needs to be monitored.

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 by regional population growth resulting from gas and mining developments), and specific management arrangements may be needed in the future.

In addition, the introduction of new marine parks (State and Federal) 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.

NORTH COAST DEMERSAL RESOURCE STATUS REPORT 2016

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



OVERVIEW

There are a number of commercial and recreational fisheries which target demersal scalefish resources in the North Coast Bioregion of Western Australia. These fisheries catch the following tropical, demersal fish species (in order of gross tonnage); goldband snapper (*Pristipomoides multidens*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*Lutjanus malabaricus*), rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and Moses' snapper (*Lutjanus russelli*).

Commercial fisheries landing demersal scalefish resources include the Northern Demersal Scalefish Managed Fishery (NDSMF) in the Kimberley region (east of 120° E longitude), and the Pilbara Demersal Scalefish Fisheries (PDSF) in the Pilbara region (west of 120° E longitude). The Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The PDSF collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The main species landed by these fisheries are bluespotted emperor, red emperor, and rankin cod.

The permitted means of operation within the NDSMF (Area 2 – offshore area) includes 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 primary management measures. Area 2 of the NDSF is 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 area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m. The main species landed by this fishery are goldband snapper and red emperor. The inshore area of the NDSMF (Area 1) permits line fishing only, within a boundary between the high water mark and a line approximating the 30m isobath.

Recreational fishing activities in the North Coast Bioregion are mostly line based fishing from boats which are concentrated in inshore areas around key population centres. The recreational fishery for demersal fish is managed through the use of input controls (e.g. recreational licenses, size limits) and output controls (e.g. bag and /or boat limits). The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial fisheries that target demersal scalefish.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational
Total Catch 2016	Kimberley : 1,046 t Pilbara: 1,779 t	North Coast Bioregion: 56.2 t* (± 4.1 t SE)
Fishing Level	Kimberley: Acceptable Pilbara: Acceptable	Kimberley: Acceptable Pilbara: Acceptable
Stock/Resource Performance	Stock Status	Assessment Indicators
Kimberley Demersal	Sustainable - Adequate	Annual: Catch, Catch Rate Periodic: Spawning Biomass, SPR, Fishing Mortality
Pilbara Demersal	Sustainable - Adequate	Annual: Catch, Catch Rate Periodic: Spawning Biomass, SPR, Fishing Mortality

EBFM Performance

Asset	Level	Asset	Level
Bycatch	Kimberley: Low Risk Pilbara: Low-Moderate Risk	Listed Species	Kimberley: Negligible Risk Pilbara: Low-Moderate Risk
Habitat	Kimberley: Low Risk Pilbara: Moderate Risk	Ecosystem	Kimberley: Negligible Risk Pilbara: Low Risk
Social	Kimberley: Low Risk Pilbara: Low Risk	Economic	Kimberley: Level 3 (\$5-10 million) Pilbara: Level 3 (\$5-10 million)
Governance	Stable	External Drivers	Low Risk

*Top 10 demersal species only from 2013/14 survey (Ryan et al. 2015)

CATCH AND LANDINGS**Kimberley**

Since 2008, NDSF annual catches have exceeded 1,000 t. The 2015 catch of 1,046 t is within the acceptable catch range of 903– 1,332 t (see Allowable Catch Tolerance Levels) for the fishery. Total catches in each zone (A, B and C) of the NDSF were also within the range of those recorded since 2008. The catch in Zone B (893 t) was the lowest since 2011.

Pilbara

The PDSF annual catches from the domestic trawl, trap and line fisheries peaked at 3,600 t in 1996, but have not exceeded 2,000 t since 2008. In 2015, 66% (1,172 t) of the total commercial catches of demersal scalefish in the Pilbara (1,779 t) were landed by the trawl sector, with 29% (510 t) taken by the trap sector and 5% (97 t) taken by the line sector.

Total trawl catches have reduced from an annual average of approximately 2,500 t during the period 1995-2004 to an annual average of 1,159 t since 2008, in response to the effort reductions imposed on the PFTIMF since 2008. The total demersal scalefish catch in the PFTIMF was within the acceptable catch range in 2015 (i.e. 940-1,416 t).

The total annual catch taken by the trap and line sectors have remained relatively consistent over the past decade, averaging 438 t and 97 t per year, respectively. The total catch of the trap and line fisheries were within the acceptable catch ranges in 2015 (i.e. 241-537 t for trap and 36-127 t for line).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS**Kimberley (Sustainable-Adequate)**

Due to the resource comprising a large number of species, indicator species have been selected from the suite of demersal scalefish (based on their inherent vulnerability, management importance and overall risk to sustainability) for assessing the status of the overall resource. The demersal indicator species for the Kimberley region are red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidentis*).

The stocks of these indicator species are assessed periodically (~ every 5 years) using an integrated age-structured model fitted simultaneously to age composition, catch and catch rate data to estimate spawning stock biomass. For all retained species, risk (vulnerability) assessments are also undertaken to identify if there have been any substantial changes in the catches of these species, relative to historical levels. For each assessment, the relevant performance indicator is compared to specified biological (target, threshold and limit) reference points to determine current stock status.

A 2015 assessment of the two indicator species in the Kimberley estimated the spawning biomass of red emperor stock to be currently around the target level (1.33 B_{MSY}). Similarly, the spawning biomass of the goldband snapper stock was estimated to be currently above the threshold level (which corresponds to B_{MSY}).

Representative age structure samples of each indicator species in the Kimberley region are due to be collected in late 2016 and early 2017, and will be processed and used to update the stock assessments in 2017/18. The life history

parameters for these species are also currently being reviewed and updated to better inform the assessment model and support MSC full assessment.

On the basis of the evidence provided above, the biological stock is classified as a **sustainable** stock.

Pilbara (Sustainable-Adequate)

Due to the resource comprising a large number of species, indicator species have been selected from the suite of demersal scalefish (based on their inherent vulnerability and overall risk to sustainability) for assessing the status of the overall resource. The three demersal indicator species for the Pilbara region are red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*) and rankin cod (*Epinephelus multinotatus*). The indicator species' stocks are assessed periodically (~ every 5 years) using an integrated age-structured model fitted simultaneously to age composition, catch and catch rate data to estimate spawning stock biomass. For all retained species, risk

(vulnerability) assessments are also undertaken to identify if there have been any substantial changes in the catches of these species, relative to historical levels. For each assessment, the relevant performance indicator is compared to specified biological (target, threshold and limit) reference points to determine current stock status.

A 2016 assessment of the three indicator species in the Pilbara estimated the spawning biomass of red emperor stock to be currently **above** the threshold level (which corresponds to B_{MSY}). The stocks of bluespotted emperor and Rankin cod are **well above** the target spawning biomass levels.

Representative age structure samples of each indicator species in the Pilbara region collected in 2015 will be processed and used to update the stock assessments in 2017/18. The life history parameters for these species are also currently being reviewed and updated to better inform the assessment model and support MSC full assessment for the Pilbara trap fishery. On the basis of the evidence provided above, the biological stock is classified as a **sustainable** stock.

NORTH COAST DEMERSAL TABLE 1. Summary of the commercial catches and the relative contribution (% composition) of each of the major or iconic species taken within the Pilbara and Kimberley sectors of the North Coast Bioregion in 2015.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch tonnes
	tonnes	% total	tonnes	% total	
Red emperor	116.4	47	131.7	53	248.1
Saddletail snapper	74.1	43	99.4	57	173.5
Crimson snapper	158.6	80	38.7	20	197.3
Brownstripe snapper	112.2	86	18.3	14	130.5
Goldband snapper	208.9	31	457.2	69	666.1
Spangled emperor	44.4	72	16.9	28	61.3
Bluespotted emperor	238.8	84	45.1	16	283.9
Rankin cod	84.0	62	51.5	38	135.5
Frypan snapper	29.3	>99	< 0.1	<1	29.3
Rosy threadfin bream	86.5	>99	0.2	<1	86.7
Moses snapper	29.5	69	13.2	31	42.7
Longnose emperor	7.0	66	3.6	34	10.6
Mozambique bream	24.8	88	3.5	12	28.3
Grass emperor	0.3	13	2.1	88	2.4
Barcheek coral trout	15.5	81	3.7	19	19.2
Other demersal scalefish	549.0	77	161.1	23	710.1
Total all demersal scalefish	1779.3	63	1046.4	37	2825.7

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Kimberley Trap / Pilbara Trap

There is a limited quantity of non-retained bycatch in these fisheries. The most common bycatch species is the starry triggerfish (*Abalistes stellaris*), but the numbers taken are considered to pose a negligible risk to the sustainability of this species.

Using trap gear in continental shelf regions is very unlikely to interact with listed species. Previous 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. However, potato cod rarely enter traps due to their large size and girth limiting their capacity to pass through the entrance funnel into the traps.

The Kimberley and Pilbara trap fisheries regularly capture sea snakes. In 2015, the Pilbara and Kimberley trap fisheries reported ~300 and 199 sea snakes, respectively. Sea snakes are returned to the water alive.

Pilbara Fish Trawl

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

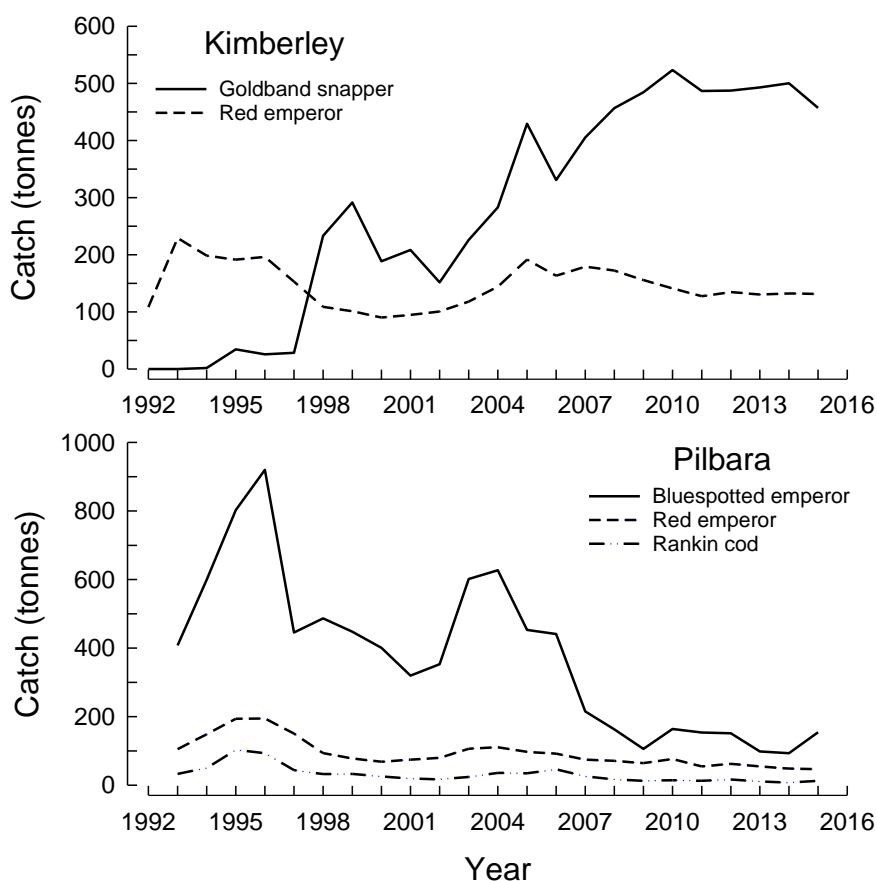
scalefish resources are considered to provide an adequate indication for similar or less vulnerable retained and bycatch species.

The use of Bycatch Reduction Devices (BRDs) have been mandatory in the PFTIMF since 2006. Overall, ~27% of day-trawls have no chondrichthyan, reptile and dolphin megafauna bycatch, with BRDs resulting in 38.3% of megafauna being expelled rapidly through the escape hatch (91.4% in < 5 minutes). BRDs are highly effective in reducing reptile (turtles and sea snakes) bycatch. Bottlenose dolphin interactions with BRDs are rare (5.2 per 1,000 trawls) despite high levels of attendance and depredation during trawling. Loss of targeted teleosts through the BRD hatch is also rare (1.3% of fish during day trawls). Based on high levels of subsurface observer coverage in 2012 (60% of day trawls or 56% of day trawl hours), the subsurface expulsion of megafauna in poor condition was negligible (see Wakefield *et al.* 2014; Wakefield *et al.* 2016).

The Pilbara Fish Trawl Interim Managed Fishery was re-accredited a Wildlife Trade Operation (WTO) under the Commonwealth of Australia's Environmental Protection and Biodiversity Conservation (EPBC) Act for three years from mid-2014. This included specific conditions around the observing, reporting and mitigation of endangered, threatened and protected species interactions. As such, an ongoing 12 month independent electronic observer program will be conducted during this accreditation period.

NORTH COAST DEMERSAL TABLE 2. Reported bycatch of listed species by skippers in the Pilbara trawl fishery in 2015. *Where the condition was not reported, the animal was considered deceased.

Species	Number released Alive	Number deceased*	Total Reported
Bottlenose dolphins	2	16	18
Pipefish	3	34	37
Green sawfish	6	11	17
Narrow sawfish	8	7	15
Seahorses	2	8	10
Sea-snakes	51	31	82
Turtles	6	0	6



NORTH COAST DEMERSAL FIGURE 1. Annual commercial catches of indicator species from the Kimberley and Pilbara demersal scalefish fisheries from 1993 to 2015.

HABITAT AND ECOSYSTEM INTERACTIONS

Kimberley Trap / Pilbara Trap and Line

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

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.

Pilbara Trawl

The Pilbara Fish Trawl Interim Managed Fishery is restricted to less than 5% of the North West Shelf (North Coast Demersal 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, monitoring has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) are detached per year. 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.

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 and thus represents a low risk to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

Kimberley: Seven vessels fished in the 2015 fishing season, and at least 24 people (3-4 crew per vessel) 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.

Pilbara: It is estimated that 14 fishers on 3 vessels were directly employed during 2015 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 37 people (e.g. 3-4 crew per vessel) were directly employed in the Pilbara Demersal Scalefish Fisheries.

Recreational fishing attracts many visitors to the North Coast Bioregion, particularly in inshore areas over the winter dry season (April – October). This provides employment through local charter fishing services and fishing tackle outlets around key population centres, as well as more remote charter operations offering wilderness fishing experiences in the north Kimberley region, as well as offshore locations such as the Rowley Shoals. There was an estimated 45,604 (SE 3,603) boat

fishing days in the North Coast Bioregion in 2013/14 (Ryan *et al.* 2015).

The North Coast Demersal Scalefish Resource provides a high social amenity to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **low** level of risk to these values.

Economic

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.

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 \$1-5 million. For social amenity some of the species may be caught recreationally and/or there is some specific interest in the resource 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 they also have social amenity value. For the line fishery the economic value is < \$1 million and social amenity is low because there is little recreational fishing for these offshore species and no specific broader community interests.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

Kimberley

For the 2015 calendar year, the total allowable effort was set at 986 standard fishing days in Zone B of the fishery, and 616 and 1,100 standard fishing days in Zone A and C of the fishery, respectively. 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 903–1,332 t. The 2015 catches were within this range.

Pilbara

The total catch of the trawl, trap and line fisheries were within the **acceptable** catch ranges in 2015.

Harvest Strategy

A harvest strategy for the North Coast Demersal Scalefish Resource is in development to support the full MSC assessments for the trap fisheries. It will provide a description of the objectives, performance indicators, reference levels, and associated control rules that articulate pre-defined, specific management actions designed to maintain the resource at target levels.

The harvest strategy focuses on the exploitation and stock status of the indicator species in the Kimberley and Pilbara demersal scalefish fisheries. These indicator species include red emperor and goldband snapper in the Kimberley, and red emperor, bluespotted emperor, and rankin cod in the Pilbara. Periodic assessments of selected non-indicator species are also occasionally undertaken to validate the indicator species approach and ensure that the status of other retained species remains at acceptable levels. The assessment and harvest strategies of these species are primarily based on estimates of spawning stock biomass (or an appropriate proxy for biomass), relative to internationally accepted target, threshold and limit reference levels.

The commercial sectors are managed primarily through input controls in the form of a total allowable effort allocation system via individually transferable effort allocations. The recreational and charter sector are primarily managed using size limits for some species, and daily bag and possession limits. Recreational fishers operating from a boat are required to have a current Recreational Fishing from Boat Licence (RFBL). Charter operators are required to have a Fishing Tour Operators Licence.

Compliance

The primary management measures of gear time usage and spatial zone access for North Coast trap and trawl fisheries are monitored and enforced using a satellite-based vessel monitoring system (VMS). The annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch. Additional management measures include size limits, and limits on the numbers of fish that can be taken by individual recreational fishers and by recreational fishers fishing from boats.

Consultation

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. Consultation processes for the recreational fishing sector are facilitated by Recfishwest under a Service Level Agreement, although the Department undertakes direct consultation with the community on specific issues.

Management Initiatives/Outlook Status Kimberley

Age structure data for the indicator species will be collected in late 2016 and early 2017 in order to revise the next assessment scheduled for mid-2017.

The Northern Demersal Scalefish Fishery Operators Guide to the Management Arrangements 2016 (DoF, 2016) was published in July 2016, and is a plain English guide to the management arrangements, designed to assist licence holders.

Pilbara

In 2016, the Department is collaborating with permit holders in the Pilbara Fish Trawl Interim Managed Fishery to adhere to the conditions of the re-accredited Wildlife Trade Operation approval; this will include a logbook validation program, through electronic monitoring.

EXTERNAL DRIVERS

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).

NORTH COAST BIOREGION

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.

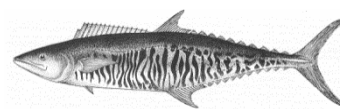
The North Coast trap fisheries are in the process of undergoing MSC full assessment.

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STATEWIDE LARGE PELAGIC FINFISH RESOURCE STATUS REPORT 2016

P. Lewis and R. Jones



OVERVIEW

The large pelagic resource is distributed throughout Western Australia (WA) and includes a range of tropical and temperate pelagic species. The three indicator species are Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*Scomberomorus semifasciatus*) representing the Tropical suite, and Samson fish (*Seriola hippos*) for the Temperate suite (DOF 2011).

Commercially the resource is predominantly accessed by the Mackerel Managed Fishery (MMF)

in the North Coast (NCB) and Gascoyne Coast Bioregions (GCB) targeting Spanish mackerel. In the West Coast (WCB) and South Coast Bioregions (SCB) the major retained temperate species is Samson fish as bycatch (see relevant chapters for more details). The recreational fishery for large pelagic fish is dominated by Spanish mackerel with the majority of the catch released (Ryan *et al.* 2015). For further details see the Statewide Large Pelagic Scalefish Resource Assessment Report (in prep) and SAFS (2016).

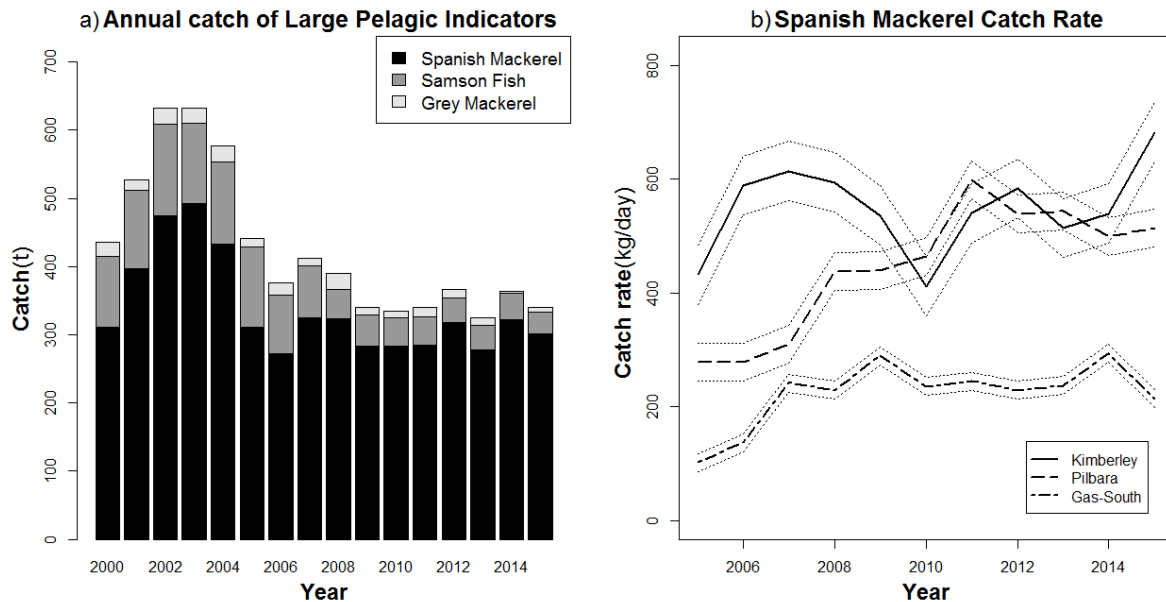
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	302 t	75-107 t (Statewide - indicator species)	
Fishing Level	Acceptable (\leq 430 t)	Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Tropical Large Pelagic	Sustainable - Adequate	Annual: Catch; Catch Rate	
Temperate Large Pelagic	Sustainable - Adequate	Annual: Catch	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Negligible Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	Moderate Amenity Negligible Risk	Economic	GVP Level 2 –(\$3-5 million) Low Risk
Governance	Stable	External Drivers	Low Risk

CATCH AND LANDINGS

The commercial catch of Spanish mackerel by the MMF was 302 t in 2015 and has been 270-330 t since quotas were introduced in 2006 (Large Pelagic Finfish Figure 1a). The commercial landings of other large pelagic species in the NCB and GCB were all <10 t in 2015. In the WCB and SCB only the annual catch of Samson fish was >10 t, at 35 t in 2015.

The estimated state-wide recreational boat based harvest of the three large pelagic indicator species in 2013/14 was 75-107 t (95% CI) of which Spanish mackerel contributed 63-86 t (Ryan *et al.* 2015). A similar or higher amount is released or discarded.



LARGE PELAGIC FINFISH FIGURE 1. a) Annual statewide commercial catch (t) for the three large pelagic indicator species and b) Annual catch rate of Spanish mackerel in the MMF by area, with dotted line around each representing +/- standard errors.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Spanish mackerel (Sustainable-Adequate)

Spanish mackerel are fast growing, moderately long lived (to 26 years), grow to a large size (to 40 kg), high fecundity and have a young age at sexual maturity (less than 2 years) (Mackie *et al.* 2003) indicating resilience to fishing pressure. Spanish mackerel in WA are likely a shared biological stock with the Northern Territory.

Following management changes in 2006, catch and effort throughout the MMF have been relatively stable. This suggests that the overall spawning stock is stable or increasing. The recreational catch has also remained stable between the 2011/12 and 2013/14 boat based surveys at 57-80 t and 63-86 t, respectively with similar numbers kept as discarded (Ryan *et al.* 2015). The spawning biomass of Spanish mackerel in Western Australia is therefore considered to be **adequate**.

Grey mackerel (Sustainable-Adequate)

Grey mackerel in WA likely constitute a single biological stock (Newman *et al.* 2010). Grey mackerel are fast growing, relatively short lived (to 12 years) and have a young age at sexual maturity (less than 2 years) (Cameron and Begg 2002) indicating resilience to fishing pressure.

Grey mackerel catches in the MMF since 2000 have been relatively low at 3.5 to 24 t (Large Pelagic Finfish Figure 1a). This level of catch is well below the TACC (60 t for each of the three management areas) for grey mackerel. The low levels of catch are likely to reflect the gear limitations (line only) and limited targeting of the species in the MMF. The recreational catch of grey mackerel is also low at an estimated 2-6 t and has been consistent between the 2011/12 and 2013/14 boat based surveys (Ryan *et al.* 2015). On the basis of the evidence provided above, the breeding stock is classified as **adequate**.

Samson fish (Sustainable-Adequate)

Samson fish in WA is likely to constitute a shared biological stock with South Australia. The species are moderately long lived (to 29 years), can grow to a large size (40kg+), mature at four years of age, undertake large scale movements and are able to withstand capture from deep water (Rowland 2002), indicating resilience to fishing pressures.

In 2015 the statewide commercial catch of Samson fish was 31 t, split between the WCB and SCB. Since 2008 catches have been at historically low levels of <45 t (Large Pelagic Finfish Figure 1a), due primarily to reductions in the WCB since management changes in the WCDSMF and TDGDLMF. Over the past 5 years the catches of Samson fish have been 9-19 t in both the SCWL and WCDSF, and 7-11 t in the TDGDLMF. The

species is targeted recreationally with the majority (>70%) discarded. Statewide recreational landed catch estimates have been consistent between the 2011/12 and 2013/14 boat based surveys at 8-14 and 12-20 t, respectively (Ryan *et al.* 2015). On the basis of the evidence provided above, the breeding stock is classified as **adequate**.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

Bycatch: The non-mackerel bycatch taken by the MMF are predominantly other large pelagic species which annually contribute <1 t (2012). Thus, there is **negligible risk** to the breeding stocks of other finfish species, by fishers targeting the large pelagic resource.

Protected species: Due to the selectivity of the fishing methods used by commercial and recreational fishers targeting large pelagic species, and the rarity of interactions with protected species by the MMF there is considered to be a **negligible risk** to listed species.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The surface and midwater troll fishing methods used by the MMF and recreational fishers targeting large pelagic species does not impact with the benthic marine environment (DEWHA 2009). On longer fishing trips the vessels may anchor but the impacts from anchoring are considered to be minimal, as anchors are set in naturally dynamic environments.

Ecosystem: The amount of Spanish mackerel removed from the ecosystem is unlikely to impact trophic interactions, as mackerel are generalist carnivores and consume a wide range of fish and invertebrate species from both pelagic and demersal habitats (Mackie *et al.* 2003).

Therefore, the fishery is considered to be a **low risk** to both habitat structure or ecosystem interactions.

SOCIAL AND ECONOMIC OUTCOMES

Social

Approximately 33 people were directly employed in the MMF during the 2015 mackerel fishing season. The estimated participation rate for recreational fishing in the population of WA is 29.6% in 2013/14 (DoF 2015). Recreational boat based surveys indicated that Spanish mackerel is in

the top 5 of retained species by number in the NCB and GCB (Ryan *et al.* 2015) while other iconic large pelagic species are targeted but released/discarded in high numbers.

The large pelagic resource provides a moderate social amenity to recreational fishing and diving and to consumers via commercial fish supply to markets and restaurants. There is currently a **negligible** level of risk to these values.

Economic

In 2012, the estimated value (to fishers) of the Spanish mackerel annual catch was level 2 approximately \$ 3 million. The value of the annual catch of grey mackerel and other Large Pelagic species was estimated at less than \$500,000. There is currently a **low** level of risk to this return.

GOVERNANCE SYSTEM

Governing Legislation

Mackerel Managed Fishery Management Plan 2011 (Management Plan): The MMF is the only WA commercial fishery licensed to land mackerel species. The MMF is controlled by Individual Transferrable Quota system (ITQs) to control catch and has annual catch tolerance ranges established. The recreational and charter fishers are managed by output controls including daily bag limits for the resource.

Annual Catch Tolerance Levels (Acceptable)

The target commercial catch range for Spanish mackerel in the MMF is 246-430 t. The annual catch tolerance ranges for the three areas of the MMF are Kimberley Area is 110 – 225 t, the Pilbara Area is 80 – 126 t and Gascoyne/West Coast Area is 56 – 79 t. The 2015 Spanish mackerel catch of 204 t in the Kimberley is within the range while the catches of 71 and 27 t in the Pilbara and Gascoyne/West Coast, respectively, are below the ranges but have been for most years since 2006 and the catch rates are stable so deemed **acceptable**.

Harvest Strategy (Under development)

For Spanish mackerel the current method of assessment focuses on analysis of catch and catch rates (Levels 1 and 2), with previous analyses having been used to determine the Tolerance Levels and TACC.

A draft harvest strategy has been developed for the MMF using reference levels for the catch rates of Spanish mackerel which have been derived from data collected over a reference period (2006 to 2011) when fishing was considered sustainable (DoF in prep).

Compliance

All boats in the MMF are fitted with an Automatic Location Communicator (ALC) which enables the Department to monitor the fleet using a Vessel Monitoring System (VMS). Masters of an authorised boat within the MMF are also required to submit logbook records and catch and disposal records (CDRs) The Department also undertakes vessel inspections at sea to ensure fishing is being undertaken in accordance with the governing legislation (e.g. gear requirements, catch reporting).

Consultation

Annual Management Meetings are held between the Department and MMF licensees, in conjunction with the Industry Consultation Unit of the Western Australian Fishing Industry Council (WAFIC).

Consultation on recreational fishing regulations or relevant commercial management changes is undertaken through the peak body, Recfishwest.

Management Initiatives (Stable)

In August 2015, the Fishery received an exemption from the export controls of the EPBC for a period of ten years.

The Department increased the capacity (TACC) of the Kimberley Area of the MMF by 20t (10%) for the 2016 season. This was completed through a management plan amendment with consultation occurring prior to this being implemented.

A review of the nomination requirements within the MMF is currently occurring with the implementation of any outcomes expected to occur in 2016/17.

A review of size limits for finfish in WA is also currently underway with all minimum legal lengths for large pelagic species proposed to be abolished (DoF 2016).

EXTERNAL DRIVERS (Low Risk)

Many large pelagic species experience annual variations in recruitment strength and adult movement due to environmental fluctuations. The changing marine environment off the WA coast may benefit some tropical species in the southern parts of their range, as seen during the marine heatwave of WA when Spanish mackerel distribution shifted southwards (Pearce *et al.* 2011). Other external factors on the fishery include the petroleum industry restricting access to fishing grounds in some parts of the Pilbara Area, the high proportion of discarded fish and the unknown level of mortality rates and in some areas the increased mortality of hooked and discarded large pelagic species by depredation.

However, these external factors constitute an overall **low risk** to WA's Large Pelagic resource, with possible impacts varying among individual species.

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NORTH COAST PEARL OYSTER RESOURCE STATUS REPORT 2016

A. Hart, D. Murphy and R. Jones



OVERVIEW

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 coast bioregion and targets the silver lipped pearl oyster (*Pinctada maxima*). The fishery is currently managed under its own Act and uses output controls in the form of a total allowable catch (TAC) divided up into individually

transferable quotas (ITQs). Fishing for *P. maxima* is one component of the pearling industry's activities with seeding and grow-out of pearl oysters to produce pearls.

This fishery has been accredited for export under the EPBC Act for a period of ten years (re-assessment in 2025) and is currently undergoing an MSC certification process. Further information can be sourced from Hart *et al.* (2016).

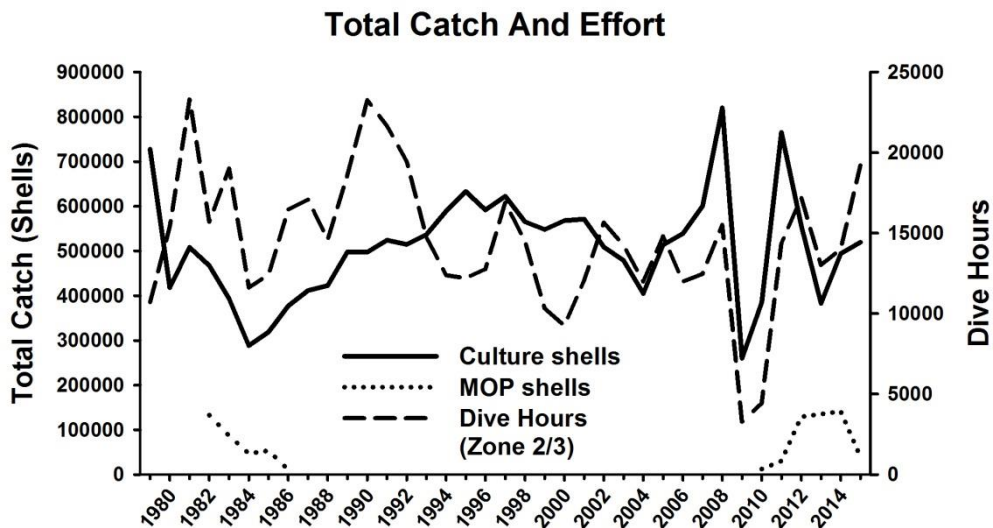
SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	560,005 shells	NA	
Fishing Level	Acceptable	NA	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Silver-lipped Pearl Oyster	Sustainable - Adequate	Annual: Level 3 Surveys, Catch Rate Predictions, Standardised Catch Rates	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Negligible Risk
Social	Moderate Amenity Negligible Risk	Economic	GVP – (\$78 million) Low Risk
Governance	Fishery undergoing MSC certification. New ARMA will subsume Pearling Act	External Drivers	Moderate - High Risk

CATCH AND LANDINGS

In 2015, catch was taken in Zones 1, 2, and 3 and the number of wild-caught pearl oysters was 560,005 comprising of 519,743 culture shells and 40,262 MOP shells (Pearl Oyster Figure 1). Total effort was 20,455 dive hours (Pearl Oyster Figure 1), an increase of 45% from the 2014 effort of 14,011 hours. Of this total effort, 19,743 hours was focused on culture shell fishing, and the remaining

712 hours was applied to MOP fishing. Fishing continued in Zone 1 for the second year, after a hiatus from 2008 to 2013, however was only a minor proportion (3%) of the catch. In 2015, the number of wild-caught pearl oyster shell in Zone 1 was 19,504 comprising of 19,341 culture shells and 163 MOP shells.



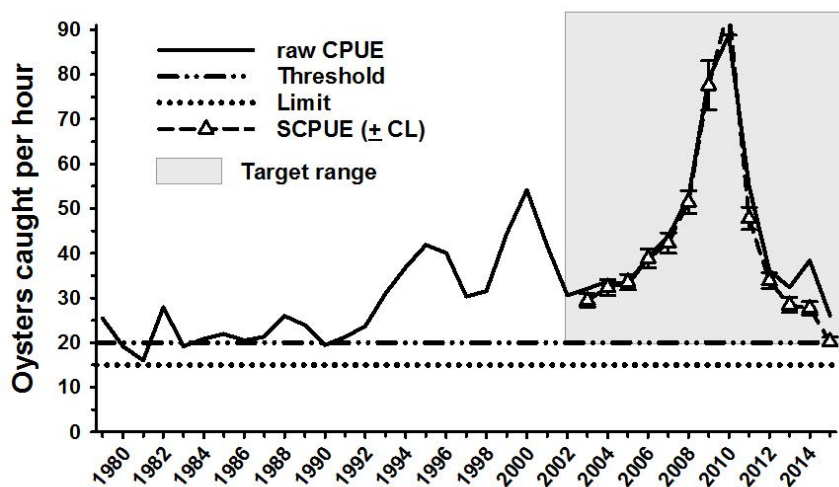
PEARL OYSTER FIGURE 1. Total pearl shell catch (all areas) and effort (Zone 2/3). ‘Culture shells’ are pearl oysters ≥ 100 and < 175 mm shell length, ‘MOP shells’ are pearl oysters ≥ 175 mm.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Silver-lipped pearl oyster (Sustainable-Adequate)

A stock assessment of the *P. maxima* fishery was undertaken for the 2015 fishing season based on catch and effort statistics, estimates of age 0+ and 1+ relative abundance, length-frequency sampling, shell discard rates by size and location, population dive surveys, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

The culture-shell catch rate achieved by the fishery in Zone2/3 is an indicator of the abundance of pearl oysters specifically targeted for pearl production. A standardised catch per unit effort (SCPUE) are used to inform the TAC setting under the harvest strategy (DoF, 2016). In 2015 the SCPUE was 20 shells per hour, compared to 28 shells per hour in both 2014 and 2013 which is close to the threshold level (Pearl Oyster Figure 2). This indicates stock levels have returned to more normal levels after record high levels observed in 2008 - 2011 as a result of good spat settlement in 2005.



PEARL OYSTER FIGURE 2. Standardized (SCPUE) and nominal (raw CPUE) pearl culture shell catch per unit effort in the Zone 2/3 fishery with threshold and limit reference points and target range indicated.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (*Negligible Risk*)

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 pearl oysters are returned to the substrate. Therefore bycatch impact is **negligible**.

There is no interaction between the pearl oyster fishing operation and protected species (Hart *et al.*, 2016).

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

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. 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 AND ECONOMIC OUTCOMES *Social (Low Risk)*

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 pearl oysters. 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 2015 was six. Most vessels presently operate 10 – 14 crew for the fishing of pearl oysters between March and August each year. These vessels also support pearl oyster operations and a number of

other pearl oyster farm functions throughout the year.

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 oyster farms. However the impact of the GFC resulted in a substantial reduction in personnel employed in the pearling industry and current full-time FTEs is estimated around 300.

Economic (High Risk)

A precise estimate of the total industry value is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place. Based on information provided by the industry, the value of cultured pearls and by-products in 2015 was considered to be approximately \$78 million, which is 16% higher than to 2015 when it was \$67 million.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

(Acceptable)

TAC (667,350 pearl oysters in 2015) to be caught in 14,071-20,551 dive hours.

Commercial catch (pearl oysters) for season 2015: 560,005 oysters at 20,079 dive hours.

Both the catch and effort levels were **acceptable**.

Harvest Strategy (Formal)

The harvest strategy for *P. maxima* is a constant exploitation approach, operationalised through an annual TAC, divided into ITQs. The TAC is set in proportion to overall stock abundance. Harvest control rules determine the TAC according to the relation of predicted catch rates in comparison to target, threshold, and limit reference levels (DoF, 2016). The control rules in place ensure that the catch is reduced when predicted recruitment is low, in order to provide increased protection to the stock, but also allows the catch to be raised in years when predicted abundance is high.

Compliance

The pearling industry is highly regulated by the Department. Access to the wildstock pearl oysters is limited to holders of the relevant pearling (wildstock) licence, and attached quota. Similarly companies producing hatchery-reared pearl oysters must hold the appropriate hatchery

licence(s), pearling (seeding) licence- hatchery quota if seeding is occurring, health certification and transport approvals when appropriate and pearl oyster farm leases. Applications for a pearl oyster farm lease are reviewed and approval by the Department. The total area a company holds is linked to the pearl oyster quota and stock holding held by that company.

Consultation

The Department undertakes consultation directly with the Pearl Producers Association (PPA) and licensees on operational issues. Formal license holder engagement is convened by the West Australian Fishing Industry Council (WAFIC) under a Service Level Agreement with the Department. The stock assessment and sustainable harvest levels are discussed by the Stock Assessment Working Group (SAWG) and with licence holders, the PPA and WAFIC at the Annual Management Meeting (AMM) each year. SAWG advice, a summary of discussions at the AMM and a PPA letter are provided to the Director General when determining the annual TAC for the pearl oyster fishery.

Management Initiatives (MSC Certification/New Act)

The full-assessment for Marine Stewardship Council (MSC) approval has continued throughout

2015 for the pearling industry. Currently the reports are being reviewed with the expectation of an announcement on full accreditation in late 2016 or early 2017.

A new State Act of Parliament to ensure the sustainability and management of all WA's aquatic biological resources was introduced into Parliament in 2015. The new Act (currently the Aquatic Resource Management Bill 2015) will replace both the Fish Resources Management 1994 and the Pearling Act 1990. The Department is reviewing the current legislative framework ahead of the introduction of the new Act to transition the pearl oyster fishery and activities associated with pearl culture.

EXTERNAL DRIVERS

External influences include other activities and factors that occur within the pearl oyster fishery that may or may not impact on the productivity and sustainability of fisheries resources and their ecosystems. The main external influences included here are catch from other fisheries, environmental factors (i.e. cyclones and climate variation), market influences, tourism, liquid natural gas (LNG) exploration, disease and introduced species. Pearl oysters were ranked as a **moderate-high risk** to climate change effects.

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NORTH COAST SEA CUCUMBER RESOURCE STATUS REPORT 2016

A. Hart, D. Murphy and P. Kalinowski



OVERVIEW

The Western Australian sea cucumber fishery is a commercial only fishery, with animals caught principally by diving, and a smaller amount by wading. It targets two main species; sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). Fishing occurs in the northern half of the state from Exmouth Gulf to the Northern

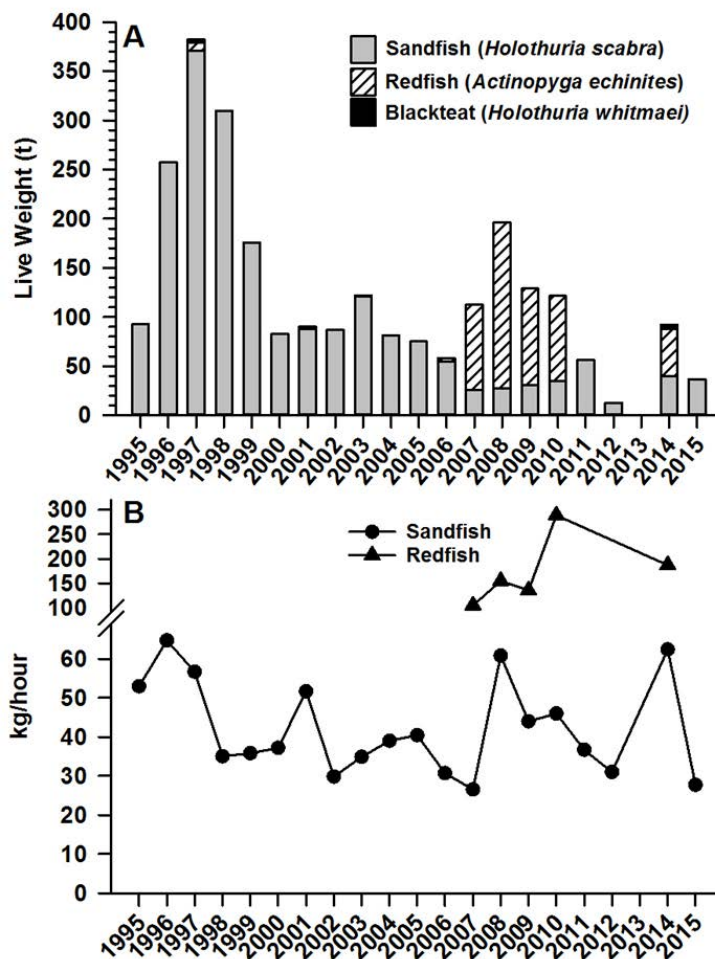
Territory border and is managed through input controls including limited entry, maximum number of divers, species-dependent minimum size limits, and gear restrictions. This fishery is undergoing assessment for Marine Stewardship Council certification.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	37 t	NA	
Fishing Level	Acceptable	NA	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Sandfish	Sustainable - Adequate	Annual: Catch, CPUE	
Redfish	Sustainable - Adequate	Annual: Catch, CPUE Periodic: Surveys	
EBFM Performance			
Asset	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Negligible Risk
Habitat	Negligible Risk	Ecosystem	Negligible Risk
Social	Low Amenity Low Risk	Economic	GVP (< \$1 million) Low Risk
Governance	MSC assessment and review planned	External Drivers	Low Risk

CATCH AND LANDINGS

In 2015, only sandfish (*H. scabra*) was targeted, with a total catch of 37 t (Sea Cucumber Figure 1). The industry has generally adopted a rotational fishing strategy for both sandfish and redfish with no catch taken for either species in 2013, and only a very limited amount in 2012.



SEA CUCUMBER FIGURE 1. A) Production (tonnes/live weight) by species, and B) catch rate (kg per hr) for the two main species from the Western Australian Sea Cucumber fishery.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Sandfish (Sustainable-Adequate)

The main indicator of stock status for both species is the catch rate derived from a daily catch and effort logbook (Sea Cucumber Figure 1). Sandfish catch rate declined in 2015, however is still within historical ranges, and above the species performance measure of 25 kg/hr. Estimates of Maximum Sustainable Yield (MSY) of sandfish for the entire WA fishery using a biomass dynamics model are updated every year. Current average catch of sandfish is well below the MSY (Sea Cucumber Table 1), indicating that the level of fishing is **sustainable**.

Redfish (Sustainable-Adequate)

Redfish was not harvested in 2015, however in 2014, the catch rate was around 180 kg per hour, which is above the species performance measure of 60 kg/hr. A population survey of redfish which is primarily located at the Montebello Islands, has recently been undertaken and will be used to estimate **sustainable** harvest levels in this species.

BYCATCH AND PROTECTED SPECIES INTERACTIONS (Negligible Risk)

Given the hand only method of fishing no bycatch is taken by the fishery and there are no known protected species interactions.

SEA CUCUMBER TABLE 1. *Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Sea Cucumber Fishery.*

Area	MSY	Current average catch (2006-2015)	Parameter Estimates		
			Intrinsic rate of increase	Carrying capacity (Virgin biomass)	Catchability or fishing power
Entire Fishery	152 t	32 t	0.86	997 t	0.18

HABITAT AND ECOSYSTEM INTERACTIONS (*Negligible Risk*)

Divers collect sea cucumber 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. 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. Due to the toxins present in their body tissues, it is highly unlikely they are a major diet for higher-order predators.

SOCIAL AND ECONOMIC OUTCOMES

Social effects (Low Risk)

Generally a vessel employs 4 to 6 crew with one of those a master, a deckhand and remaining divers. 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 (Low Risk)

The estimated annual value for 2015 was \$110,100 based on an average product price of \$3.00 per kg live weight and total catch of 36.7 tonnes. This is a farm-gate value and supports a substantial processing and value adding sector.

GOVERNANCE SYSTEM

Annual Catch Tolerance Range (Acceptable)

Commercial: sandfish 20-100 t, redfish 40-150 t. The catch of sandfish was within the catch tolerance range and the catch rate was above

threshold levels in 2015. There was no fishing for redfish in 2015.

Harvest Strategy

The harvest strategy has evolved over time, due to improved understanding of the dynamics of the fishery and improved accuracy and resolution of monitoring data. As part of stock assessment, catch and catch rate indices are compared against species-specific target catch ranges and annual catch rate target, threshold and limit values. Relevant harvest control rules, linked to catch and catch rate performance indicators, are applied to ensure that fishing does not reduce spawning biomass to a point which there is an unacceptable risk that recruitment could be compromised.

The Sea Cucumber Fishery is currently undergoing an MSC certification process and, as part of this process, the existing harvest strategy is being reviewed and updated, and is expected to include a new series of performance indicators, threshold levels, and control rules.

Compliance

There are no current issues.

Consultation

Industry Annual Management Meetings are convened by the Western Australian Fishing Industry Council (WAFIC), under a Service Level Agreement with the Department.

Management Initiatives (MSC Assessment and Review Planned)

A review of the sea cucumber fishery is planned for 2016. It is anticipated that this review will result in the fishery transitioning from Exemption

based to interim managed. 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. The WA Sea Cucumber Fishery is currently undergoing an MSC assessment and certification process.

EXTERNAL DRIVERS

The remoteness of the currently fished stock and the large tidal ranges where it occurs are natural barriers to uncontrolled expansion of fishing.

Marine park planning has to date restricted this fishery from general use zones of some MPAs.

Currently, lack of experienced fishers and suitable vessels is restricting catch to low levels.

Climate change could have positive or negative impacts on sea cucumber populations. It has been reported that higher sea temperatures will have a positive effect i.e. higher production and yields given the expected faster growth rates leading to larger sizes and increased fecundity.

NORTH COAST CRAB RESOURCE STATUS REPORT 2016

D. Johnston, R. Marks, C. Marsh and E. Smith



OVERVIEW

Blue swimmer crabs (*Portunus armatus*) are targeted by the Pilbara Developmental Crab Fishery, within inshore waters around Nickol Bay, using hourglass traps. Recreational fishers for this species use drop nets or scoop nets, with diving for crabs becoming increasingly popular.

Management arrangements for the commercial and recreational fisheries include minimum size, protection of breeding females, seasonal closures with effort controls for the commercial fishery (Johnston *et al.*, 2015).

Mud crabs are targeted by the Kimberley Developing Mud Crab Fishery using crab traps between Broome and Cambridge Gulf. The commercial fishery includes two broad groups: Aboriginal community commercial mud crab exemption holders and commercial exemption holders. There is also a small recreational fishery for mud crabs. All crab fisheries have been through the pre-assessment process for Marine Stewardship Council (MSC) certification and draft harvest strategies were developed.

SUMMARY FEATURES 2016

Fishery Performance	Commercial	Recreational	
Total Catch 2015	64.3 t	5.9 t (Boat survey May 13-Apr 14)	
Fishing Level	Pilbara BSC: Acceptable Kimberley MC: Acceptable	Pilbara BSC: Acceptable Kimberley MC: Acceptable	
Stock/Resource Performance	Stock Status	Assessment Indicators	
Pilbara BSC	Sustainable - Adequate	Level 2 Catch Rate	
Kimberley Mud Crab	Sustainable - Adequate	Level 2 Catch Rate	
EBFM Performance	Level	Asset	Level
Bycatch	Negligible Risk	Listed Species	Low Risk
Habitat	Low Risk	Ecosystem	Low Risk
Social	High Amenity Low Risk	Economic	GVP Level 1 (<\$1mill) Low Risk
Governance	Stable	External Drivers	Moderate Risk

CATCH AND LANDINGS

Commercial Sector

The total commercial catch of crabs in the North Coast Bioregion for 2015 was 64.3 t. The catch of blue swimmer crabs increased 7% on that taken in 2014 including some from a developmental licence in Cambridge Gulf. The North Coast catch accounts for < 9% of the state commercial blue swimmer crab catch of 561 t for 2015.

The catch of mud crab for the Kimberley Developing Mud Crab Fishery represents the entire mud crab catch landed in WA in 2015. The catch in 2015 was approximately 20% higher than 2014 and is the

highest catch on record. In 2015 the majority of catch was recorded as green mud crab, while a small proportion was recorded as brown mud crab.

Recreational Sector

The recreational crab catch estimated by the statewide survey of boat-based recreational fishing in 2013/14 estimated the retained blue swimmer crabs of 4.2 t (S.E.±0.9 t) for the North Coast Bioregion, representing approximately 6% of the state's recreational catch (Ryan *et al.*, 2015). This survey also estimated the mud crab catch for the North Coast Bioregion of 5.9 t (S.E.±0.89 t), representing

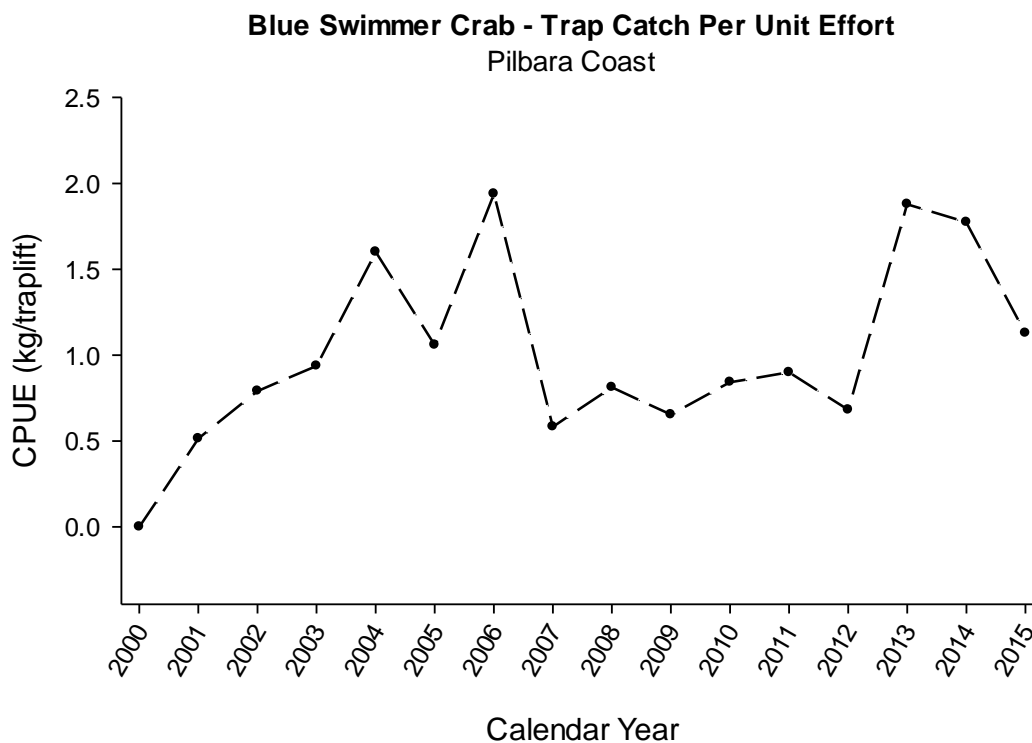
approximately 81 % of the state’s recreational catch with 3.5 t caught in the Kimberley and 2.4 t in the Pilbara (Ryan *et al.*, 2015).

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Blue swimmer crab (Sustainable-Adequate)

It is likely that stocks of blue swimmer crabs in Port Hedland, Nickol Bay and Onslow are genetically similar with potential for mixing. The reproductive biology and life cycle of blue swimmer crabs are likely to be similar to that in Shark Bay with spawning occurring year round and growth being rapid, with female maturity reached at about 92mm CW within 10-12 months and attaining commercial size (135 mm CW) within 15 months.

Catch rates from the Pilbara trap fishery provide an index of abundance to assess fishery performance. Crab trap catch rates increased steadily during the first three years of exploratory fishing 2000-2003 (North Coast Crab Figure 1) along the Pilbara coast. The increase in catch rate can be attributed to improvements to fishing gear and vessels and fisher knowledge. Favourable environmental conditions led to a significant increase in catch rates (1.6-1.8 kg/traplift) from 2004 to 2006 and 2012 to 2013, before returning to longer-term mean catch rates of 1.1 kg/traplift for 2015 (North Coast Crab Figure 1). Catch rates remain above the draft harvest strategy threshold of 0.6 kg/traplift, so currently the breeding stock is considered **adequate**.



NORTH COAST CRAB FIGURE 1. Annual commercial trap catch per unit effort (cpue) (kg/traplift) for the Pilbara Developmental Blue Swimmer Crab (*Portunus armatus*) Fishery since 2000.

Mud Crab (Sustainable-Adequate)

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). The stock structure of the mud crab population in the Kimberley has not been documented but is assumed to be one

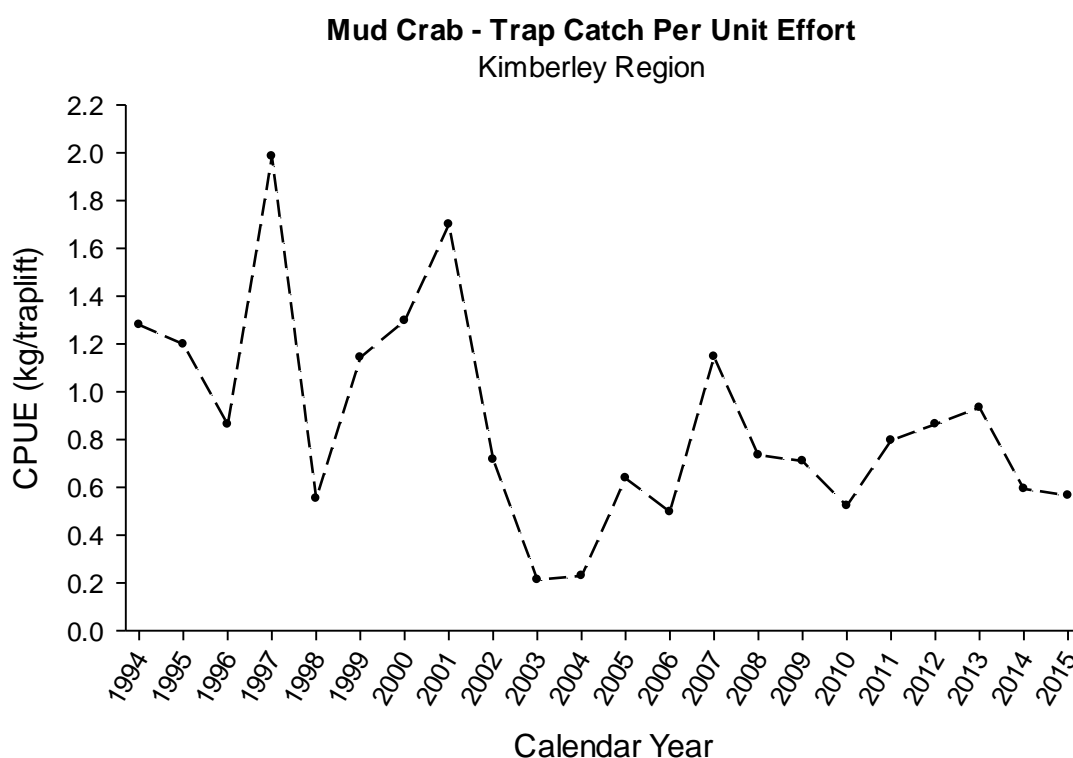
single stock of *Scylla serrata* and *Scylla olivacea* throughout the Kimberley. The maximum size reported for green mud crabs is between 250 - 280 mm carapace width (CW) and 135 - 139 mm CW for brown mud crabs. The green mud crab is predominantly found in estuarine habitats in north-western Australia, 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. The brown mud crab has a more restricted distribution limited to northern embayments, with most catches from King Sound, 200 km northwest of Broome.

The minimum legal size at first capture is 150 mm CW for green mud crab (*Scylla serrata*) and 120 mm CW for brown mud crab (*Scylla olivacea*). This is set well above the size at first maturity of 90-120mm CW for green and 86-96 mm CW for brown mud crab fisheries in the North Coast

Bioregion. Consequently, breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

Catch rate over the past 6 years (2010 – 2015) has fluctuated between 0.5 and 0.9 kg/traplift, with a catch rate of 0.6 kg/traplift reported in 2015, which is a slight decline compared to 2014 (North Coast Crab Figure 2). But it remains above the draft harvest strategy threshold of 0.5 kg/traplift, so currently the breeding stock is considered **adequate**.



NORTH COAST CRAB FIGURE 2. Annual commercial trap catch per unit effort (cpue) (kg/traplift) for mud crab in the Kimberley region since 1994 when permissive conditions of fishing boat licenses were issued. The Kimberley Developing Mud Crab Fishery commenced by exemption in 2006.

BYCATCH

Blue swimmer crab

The shift from using set nets 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 taking crabs as a by-product is dealt with in the status reports that are specific to each trawl fishery.

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, therefore posing a negligible risk to bycatch species. The gear is required to be pulled regularly, and undersized and berried crabs must be returned to the water.

PROTECTED SPECIES INTERACTIONS

Blue swimmer crab

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with listed 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 and is considered a **negligible risk**.

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 listed species is minimal and a **negligible risk**.

HABITAT

Blue swimmer crab

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do 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 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, posing a **low risk** to benthic habitat.

Mud crab

Trap fishing in the shallow waters of associated mangrove tidal creeks and near shore embayments results 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, posing a **low risk** to benthic habitat.

ECOSYSTEM INTERACTIONS

As the commercial take of blue swimmer and mud crabs represents a relatively small portion of the biomass, which is effectively renewed annually and subject to high levels of natural variation in abundance, secondary food chain effects are likely to be minimal in these fisheries and are a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

Blue swimmer crab

North Coast blue swimmer crab fisheries provide a high social amenity to recreational fishing and diving and to consumers via commercial crab supply to markets and restaurants. During 2015, 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

The Kimberley mud crab fishery provides a high social amenity to recreational fishing and to consumers via commercial mud crab supply to markets and restaurants. 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. There were two commercial operators that fished during 2015, with effort concentrated between June and October with one operator fishing throughout the year.

Economic

The estimated gross value of product (GVP) for the crab fishery within the Northern Bioregion for 2015 was \$500k- \$1 million (Level 1 <\$1 million).

Blue Swimmer Crabs: The average beach price for trap caught blue swimmer crabs across all Western Australian fisheries for 2015 was around \$5.36/kg. The crab catch from the Pilbara region was sold through local and interstate markets.

Mud Crabs: The average beach price for green (uncooked) mud crabs in the Kimberley for 2015 was around \$30.97/kg (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.

GOVERNANCE SYSTEM

Annual Catch Tolerance Levels

Pilbara BSC: n/a

Kimberley Mud Crab: n/a

Blue swimmer crab

While no formal tolerance range has been developed for the Pilbara Developmental Crab Fishery current effort levels in the fishery are considered acceptable. Fishing effort in this region is limited by very hot weather experienced during the summer months, which generally restricts fishing effort to between April and November.

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 Kimberley.

Harvest Strategy

The breeding stock of crab fisheries are protected by effort control, legal minimum size (127–130 mm) well below the size at maturity (86–98 mm carapace width), and seasonal closures in some fisheries.

Blue Swimmer Crabs: Preliminary harvest strategy have been determined for the Pilbara Developmental Crab Fishery where the primary performance indicator is nominal annual commercial catch rates, specifically within the Nickol Bay area due to the majority of fishing historically occurring in this area. The reference period is between 2005 and 2011 as defined by the period when the developing fishery status commenced but following the period of 2001–2004 when exploratory fishing occurred.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Mud Crabs: A preliminary harvest strategy has been determined for the Kimberley Developing Mud Crab Fishery where the primary performance indicator is nominal annual commercial catch rate. The reference period is between 2006 and 2011 as

defined by when the developing fishery status commenced under exemptions.

As the indicator was above the threshold, no changes to the management will occur for the 2017 season.

Compliance

Current risks to enforcement are low for North Coast Bioregion crab fisheries.

Consultation

Commercial

The Department undertakes consultation directly with licensees on operational issues and processes and is responsible for the statutory management plan consultation. Industry Annual Management Meetings are 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.

Management Initiatives

From 1 May 2013, mud crab exemption holders were permitted to retain bycatch of other portunid crabs for a two year trial period which ended on 30 April 2015. Negligible catches of blue swimmer crabs were retained during this trial. A minimum size limit of 135 mm for blue swimmer crabs was imposed, consistent with the size limit used in the Pilbara Developmental Crab Fishery. No limits were placed on the number of blue swimmer crabs which could be retained. It is proposed that permitting the retention of blue swimmer crabs as bycatch will be incorporated into future exemptions for the mud crab fishery. A new Management Plan is being developed for the mud crab fishery which is expected to commence in early-2017. The Management Plan is proposed to permit the take of portunid crabs (including blue swimmer crabs).

An increase of 200 traps (total 600 traps) was allocated in 2016 for Pilbara Developmental Crab Fishery, with the traps able to be used across two vessels. As a precautionary measure to this increase in traps numbers, an annual season

closure between 15 August and 15 November (inclusive) was implemented to protect berried and mated pre-spawning female. A new Management Plan is being developed for the Pilbara developmental crab fishery which is expected to commence in late-2017.

EXTERNAL DRIVERS

Levels of recruitment to many of the crab fisheries fluctuate considerably. These are considered most likely due to environmental influences (e.g. water temperature) both 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. The climate change implications associated with these environmental variables are also under consideration. Blue swimmer crabs were rated a **high risk** to climate change due to their sensitivity to water temperature changes.

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