

# GASCOYNE COAST BIOREGION

## ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast Bioregion (Gascoyne Overview Figure 1) represents a transition between the fully tropical waters of the North West Shelf of the North Coast Bioregion and the temperate waters of the West Coast Bioregion. Offshore ocean temperatures range from about 22°C to 28°C, while the inner areas of Shark Bay regularly fall to 15°C in winter. The major fish stocks are generally tropical in nature, with the exceptions of the temperate species, pink snapper, whiting and tailor, which are at the northern end of their range in Shark Bay.

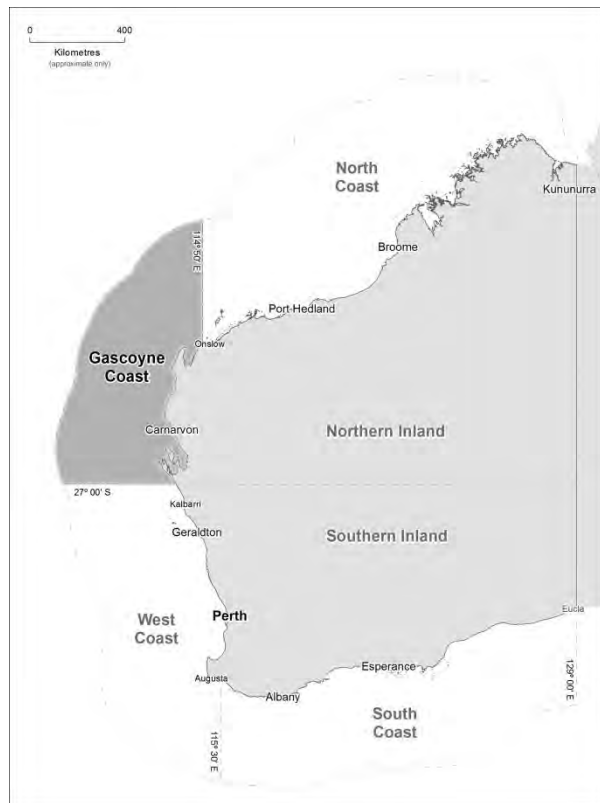
The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system. The Exmouth Gulf section of the Gascoyne Coast Bioregion is seasonally influenced by extreme tropical summer cyclones, while the Shark Bay end of the Bioregion receives infrequent cyclones, but is affected at times by river outflows from inland cyclone-based summer rainfall. The limited local rainfall comes mostly from the northern edge of winter storm fronts.

The waters off the Gascoyne Coast are also strongly influenced by the unusual southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, coupled with low rainfall and run-off plus the north flowing Ningaloo current, it supports the highly diverse Ningaloo Reef marine ecosystem.

The outer area of the large marine embayment of the World Heritage-listed Shark Bay is also influenced by the warm winter current. The inner waters of the embayment are hypersaline, owing to the high evaporation and low rainfall of the adjacent terrestrial desert areas. The sea floor of both Shark Bay and the continental shelf is typically sandy compared to Exmouth Gulf, which has more mud areas and greater turbidity.

The Gascoyne Coast Bioregion has been identified as one of 18 world 'hotspots' in terms of tropical reef endemism and the second most diverse marine environment in the world in terms of tropical reef species.

The Ningaloo reef in the north of the Bioregion is the largest continuous reef in WA and is one the most significant fringing reefs in Australia. The Bioregion also has some areas of mangroves, mostly in Exmouth Gulf, while seagrass beds are located in a number of areas.



**GASCOYNE OVERVIEW FIGURE 1**

Map showing the Gascoyne Coast Bioregion.

## 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;
- Increase 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 Gascoyne Coast Bioregion is predicted to be at enhanced risk from the effects of climate given that it spans a transitional zone between tropical and temperate regions. 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.

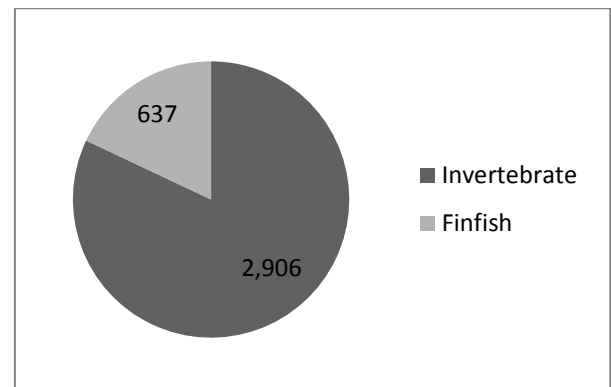
It is apparent that climate change will impact the biological, economic, and social aspects of many fisheries, and both positive and negative impacts are expected. Climate change can influence biological systems by modifying the timing of spawning, range and distribution, composition and interactions 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, and are being monitored in a national citizen-science program ([www.redmap.org.au](http://www.redmap.org.au)) that the Department is collaborating in.

## Commercial fishing

Commercial fishing is a significant industry in the region, with three of the State's more valuable fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop fisheries – landing combined catches valued in the range of \$40 – \$50 million annually. These trawl based fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of both management and research. Only a relatively small number of the approximately 1,400 species of fish inhabiting this bioregion are targeted by commercial fishing activity.

The Gascoyne Demersal Scalefish Fishery (GDSF) and Shark Bay Beach Seine and Mesh Net Fishery have operated in the bioregion since the 1960s, and provide a significant proportion of the snapper and whiting catch for the State. The GDSF originally only targeted pink snapper but has developed over the past decade into a broader fishing sector taking other demersal finfish species including emperors, cods and deeper water species such as goldband snapper. The Gascoyne includes part of the Mackerel Managed Fishery (which extends the NT border and is reported on in the North Coast Bioregion chapter) with this area having lower annual catches compared to more northern areas. The region also includes some other small commercial fishing activities including the marine aquarium fishery which collects small numbers of a wide variety of species but is not permitted within some areas of the Ningaloo Marine Park, Shark Bay Marine Park or any waters closed to fishing. There is also a small beach seining fishery within Exmouth Gulf.

The main invertebrate species captured by fisheries in the Gascoyne Bioregion include a number of penaeid prawns, scallops, blue swimmer crabs within the two main embayments of Shark Bay and Exmouth Gulf plus deep sea crabs in the offshore region. The fishery for blue swimmer crabs which operates throughout the waters of Shark Bay had grown in the last decade to be the largest Australian crab fishery until recently affected by environmental issues. Other minor commercial fishing activities for invertebrates operating in the bioregion include collecting silver lipped pearl oyster which is used in pearl culture, though most effort is focused in the North Coast Bioregion.



**GASCOYNE COAST OVERVIEW FIGURE 2**

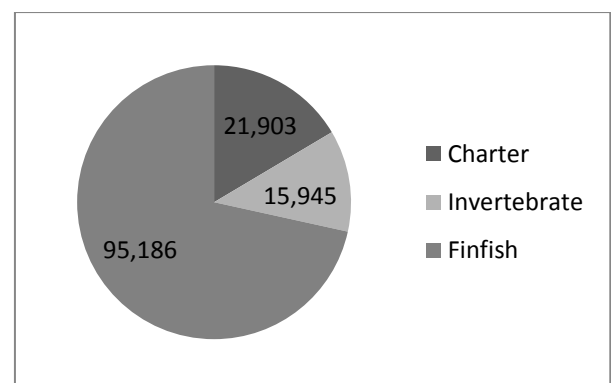
Relative contribution of finfish and invertebrates to the total commercial wild fishery catch originating from the Gascoyne Bioregion. Numbers represent total catch (in tonnes).

## Recreational Fishing

The special features of the Gascoyne Coast Bioregion, coupled with the warm, dry winter climate and accessible fish stocks, have made it a focal point for winter recreation by the Western Australian community. Fishing during this season is a key component of many tourist visits. A full range of angling activities is available, including beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo).

Recreational fishing is predominantly for tropical species such as emperors, tropical snappers, groupers, mackerels, cods, trevallies and other game fish and blue swimmer crab and squid. Some temperate species at the northern end of their ranges, such as (pink) snapper, tailor and whiting, provide significant catches, particularly in Shark Bay. (Gascoyne Coast Overview Figure 3)

Improved infrastructure (e.g. sealed roads) has led to increasing levels of domestic and international tourism to the Gascoyne. Enhanced access to coastal waters via new boat ramps (e.g. Bundegi, Coral Bay, Tantabiddi) and camping sites/facilities and the sustained popularity of recreational fishing also contribute to pressure on local fish stocks.



**GASCOYNE COAST OVERVIEW FIGURE 3**

The Gascoyne Coast Bioregion finfish and invertebrate catch numbers as assessed in the integrated survey of boat-based recreational fishing in WA 2011/12, and the charter boat catch numbers for the 2013 period.

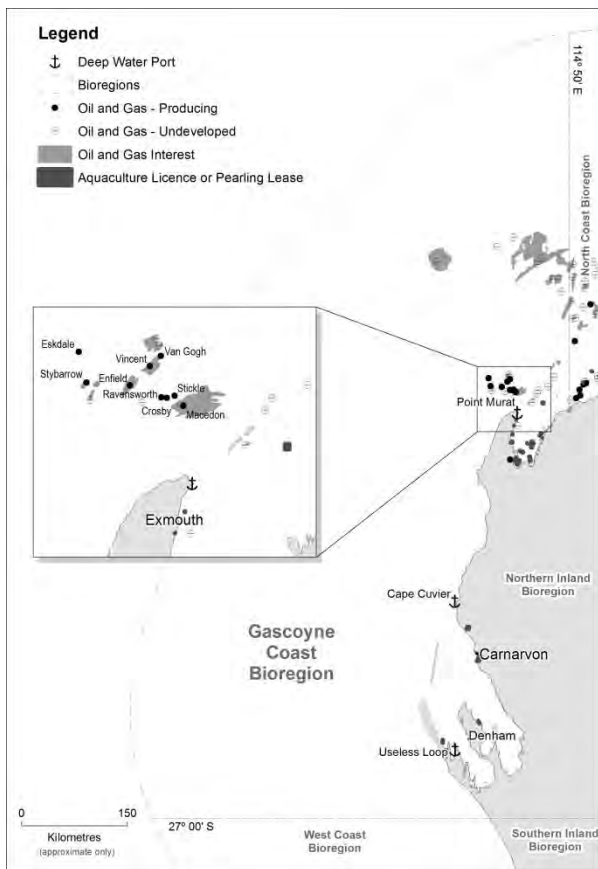
## Tourism

The Gascoyne Coast Bioregion is a focal point for winter recreation by the Western Australian community. Apart from its scenic beauty, the main attraction of the coastline for tourists is the quality of marine life. The region supports extensive scuba diving and snorkelling activities, particularly inside the coral lagoons of Ningaloo. Specialised eco-tourism activities include whale shark and manta ray observation at Ningaloo and dolphin and dugong viewing in Shark Bay. Fishing is a key component of many tourist visits, and a full range of angling activities is available.

## Oil and Gas Activity

Exploration and appraisal drilling has occurred mainly in the northern part of the Gascoyne Coast Bioregion (Gascoyne Overview Figure 4). There is significant oil and gas mining activity offshore of North West Cape in the Exmouth Sub-basin, and the Australian Government has also recently released two areas offshore of Carnarvon in the Southern Carnarvon Basin for further exploration.

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.



**GASCOYNE OVERVIEW FIGURE 4**

Exmouth Sub-basin offshore oil and gas production sites and Aquaculture Licences and Pearly Leases.

## Shipping and Maritime Activity

There are three deepwater port facilities currently operating in the Gascoyne Coast Bioregion: Useless Loop, Cape Cuvier (both private facilities servicing salt fields) and Point Murat, a naval port facility at Exmouth. The majority of shipping movements involve coastal cargo vessels, shipping associated with the two salt fields in the region, large passenger cruise vessels and fishing vessels operating out of the numerous small ports along the coast.

Other harbours and maritime facilities of the Gascoyne Coast Bioregion include Denham, Carnarvon, Coral Bay and Exmouth, all of which largely service local fishing and charter vessels, as well as the private vessels of local residents and tourists. The expansion of oil and gas, along with increased recreational, charter and eco-tourism activities, in the area has led to the expansion of many of these facilities.

The impacts from vessels and ships tend to be concentrated around ports and favoured anchorage areas. Impacts include physical damage to the habitat and the potential to introduce and spread marine pest species.

## ECOSYSTEM MANAGEMENT

A variety of measures have been implemented to manage the potential impact of activities on the ecosystem within the Gascoyne Coast Bioregion. These 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. The first phase of the project was to understand how environmental factors, such as water temperature and salinity, affect fish stocks in Western Australia based on available historical data. The second phase was to look at historical trends and possible future scenarios of WA marine environments using climate model projections. Lastly, existing management arrangements will be reviewed to examine their robustness to climate change effects and new management policies will be developed in consultation with stakeholders to deal with climate change effects on fish stocks. The Department is also a key collaborator in the Redmap (Range Extension Database & Mapping project) project ([www.redmap.org.au](http://www.redmap.org.au)) which uses a citizen-science approach to document range extensions of a number of key identified climate-change affected species. Understanding shifts in populations is likely to be increasingly important to adaptive fisheries management.

### Spatial Closures

The Department of Fisheries has established a comprehensive set of spatial management closures within the Gascoyne region that are equivalent to a number of IUCN categories for marine protected areas. Extensive trawl closures inside the 200 m depth zone in the Shark Bay and Exmouth region provide protection to sensitive benthic habitat, including coral reef, sand flats and seagrass beds of the continental shelf. These areas provide significant fish nursery, breeding

and feeding habitat (Gascoyne Overview Figure 5). The extent of these areas means that most of the Gascoyne Bioregion inside 200 m depth could be classified as one of the marine protected area IUCN categories (Gascoyne Ecosystem Management Table 1; as per Dudley, 2008 and Day *et al* 2012<sup>1</sup>). There are also a number of other 'formal' marine protected areas in this Bioregion that have been established under both the Conservation and Land Management Act 1984 and the Fish Resources Management Act 1994 (see Gascoyne Overview Figure 6). These include

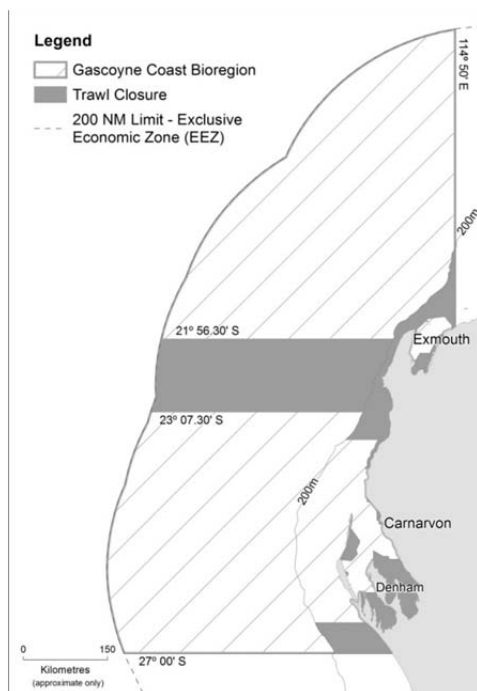
the Ningaloo and Shark Bay marine parks, the Murion Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas. Commercial and recreational fishing activities are restricted in these regions.

The Commonwealth Government is also undertaking a process of identifying additional protected areas for Commonwealth waters between Shark Bay and the Northern Territory border.

**GASCOYNE ECOSYSTEM MANAGEMENT TABLE 1**

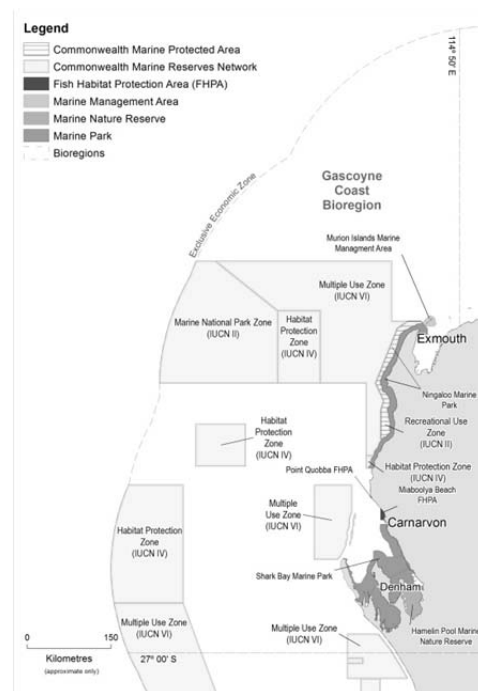
The areas and proportions of the Gascoyne Coast Bioregion making up State Waters and all continental shelf waters, out to 200 m depth, which are consistent with IUCN criteria for classification as marine protected areas.

IUCN category or equivalent	State Waters only (24,100 km <sup>2</sup> )				All Waters (416,300 km <sup>2</sup> (including State waters))			
	Fisheries		Existing MPA		Fisheries		Existing MPA	
	km <sup>2</sup>	%	km <sup>2</sup>	%	km <sup>2</sup>	%	km <sup>2</sup>	%
I	0	0	0	0	0	0	0	0
II	0	0	2,500	10	0	0	5,000	1
III	0	0	0	0	0	0	0	0
IV	3,100	13	6,400	27	13,200	3	6,400	2
V	0	0	0	0	0	0	0	0
VI	9,500	39	2,600	11	389,100	93	2,600	1



**GASCOYNE OVERVIEW FIGURE 5**

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



**GASCOYNE OVERVIEW FIGURE 6**

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

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

Day J. *et al*, 2012. Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. Gland Switzerland: IUCN. 36pp

## Management of Commercial Fisheries

There is a high degree of ecosystem management and protection for the ecological assets that are located within the Gascoyne Coast Bioregion. Each of these fisheries operates under a specific management plan, the arrangements of which are implemented through the legislative framework provided by the Fish Resources Management Act 1994 (FRMA). The FRMA and the management plan for each Fishery adhere to arrangements established under relevant Australian laws, with reference to international agreements that require conservation of all 'fish' and fisheries resources (which through the definition of fish includes nearly all aquatic organisms).

In WA, comprehensive controls on fishing were first introduced in the 1960s and now apply to all commercial fisheries. These controls are designed to ensure that all catches are kept at sustainable levels, which in turn requires that the annual catch is a relatively small proportion of the overall stock biomass. This approach maintains relatively high biomass levels for all harvested species compared to their unfished situation and therefore ensures that all trophic levels are being kept at relatively high levels of abundance. These management requirements have significantly reduced the risk of such trophic flow-on effects from occurring, and none are evident in the long-term trends in fish catches.

Strict limits on the use of fishing gear that can result in unwanted interactions with non-targeted species provide similar protection for bycatch and listed species and thus, biodiversity generally.

Examples of controls that operate in at least one fishery within the bioregion include:

- Limited entry;
- Variable spawning/size season closures (areas closed or opened depending upon catch rates and sizes);
- Permanent and seasonal area closures to preserve sensitive habitats that are essential nursery areas;
- Specific regulation to preclude use of gear types with high bycatch potential (eg large, mesh gillnets and long-lines)
- Temporal general closures;
- Primary and secondary bycatch reduction devices (BRDs);
- Total Allowable Catch limits;
- Target catch ranges;
- Minimum commercial size limits;
- Protection of berried females; and
- Monitoring of fishing activities using the Vessel Monitoring System (VMS)

The State is currently employing a bioregional approach to the pre-assessment of all its fisheries for potential third party certification according to the sustainability criteria developed by the Marine Stewardship Council (<http://www.msc.org/>). The progression of a number of fisheries to full certification is underway. This process will ensure independent assessment of the sustainability and effective management of assessed fisheries to an internationally recognised standard.

## Management of Recreational Fisheries

Recreational fishing in the Gascoyne has been managed via a bioregional-specific management strategy since 2003. This strategy consists of a set of bag, possession and size limits, permitted gear types and seasonal and area closures implemented under the Fish Resources Management Act 1994. For inner Shark Bay (pink) snapper stocks, more complex arrangements are used within the Eastern Gulf, Denham Sound and Freycinet Estuary, where these stocks are managed separately and have explicit Total Allowable Catches (TACs). All recreational fishing activities, including those of the charter sector, are subject to the closures associated with the Ningaloo and Shark Bay Marine Sanctuary Areas, Nature Reserves and Conservation areas. In 2010, a statewide recreational 'fishing from boat' licence was also introduced.

A number of recreational fishing surveys have been undertaken in the region, including recent statewide recreational fishing from boat surveys in 2011 and 2013. The results of such surveys are used to estimate recreational catch and effort of targeted finfish and crustaceans and to maintain a sustainable bioregional-specific management strategy.

## Compliance and Community Education

Significant effort is put into ensuring adequate compliance with commercial and recreational fishing regulations. This includes at sea and aerial patrols to ensure closed seasons, closed areas, and operational rules are being adhered to. The use of VMS on commercial vessels also helps the Department monitor vessel location and speed, thus increasing compliance with closures while decreasing the need for untargeted patrol activities.

## Biosecurity Risk Management

The International Maritime Organisation has identified the introduction of invasive marine species into new environments by ship's ballast water and biofouling as one of the four greatest threats to the world's oceans. Introduced marine pests can predate on native and farmed species, out-compete natives for space and food, alter nutrient cycle, lead to a loss of diversity in local species, cause human health impacts, negatively affect commercial fish and seafood species, negatively affect amenity and recreational activities and reduce the fuel efficiency for all vessel types. With increasing human population and associated travel, transport and trade, the risk of introducing new species is likely to grow.

Biosecurity risks associated with commercial vessel movements are managed through the routine monitoring of ports for marine pest species and management of risk associated with biofouling on commercial vessels utilizing state waters. Oil and gas related developments in the region have their own ministerial guidelines to ensure marine and coastal resources are protected. These developments undertake 'proof of freedom' pest monitoring to ascertain they have no pests present.

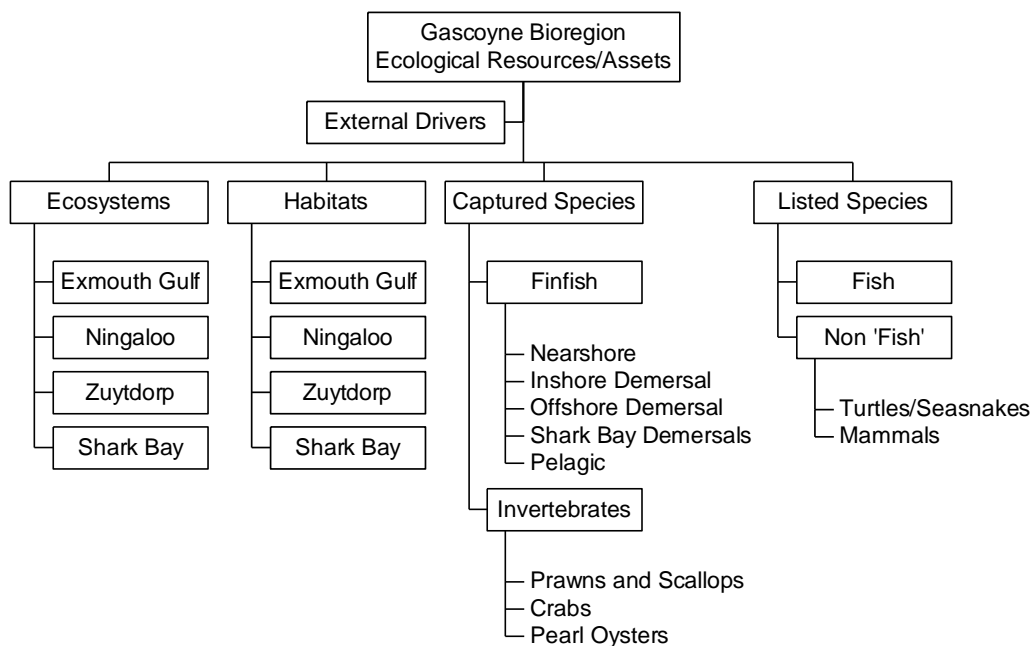
## Management of Aquaculture Activities

The main focus of the Department of Fisheries in the Gascoyne continues to be on the regulation of the regional pearling industry, including the blacklip oyster *Pinctada margaritifera*, which now complements the major State industry sector built on the silver lip pearl oyster (*Pinctada maxima*). A local aquaculture sector is emerging, focusing on the production of aquarium species, including coral and live rock. This developing sector is regulated according to the policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

## ECOSYSTEM MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the Gascoyne 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)<sup>1</sup>(see How to Use section for more details) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment.

These key ecological assets identified for the Gascoyne Bioregion are identified in Gascoyne Overview Figure 7 and their current risk status reported on in the following sections.



**GASCOYNE OVERVIEW FIGURE 7**

Component tree showing the ecological assets identified and separately assessed for the Gascoyne Coast Bioregion. Under the integrated marine and coastal regionalisation for Australia scheme, the bioregion has been divided into 4 meso-scale regions (See Introduction Fig. 1): Zuytdorp, Shark Bay, Ningaloo, and Exmouth Gulf (imcra, v 4.0, 2006) which have been adopted for sub-regional management within an EBFM framework.

### 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 Gascoyne Coast Bioregion include climate and introduced pests and diseases.

### Climate

External Driver	Current Risk Status
Climate	MODERATE in short term HIGH in medium term

Being a transitional zone between tropical and temperate regions, the biota of the Gascoyne Bioregion is at enhanced risk of being affected by climate change. Climate change can influence fisheries and biological systems by affecting the timing of spawning, range and distribution, composition and

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

interactions within communities, exotic species invasions and impacts, community structure and productivity. Waters off the Gascoyne coast are strongly influenced by the Leuwin current which brings warm low salinity water southward. After experiencing a weakening trend from the 1960’s to the early 1990’s, the strength of the Leeuwin Current has rebounded in the past two decades which has been driven by changes in frequency of El Niño/La Niña Southern Oscillation (ENSO) patterns. During the summer of 2010/11, a significant warming event took place off the coast of Western Australia, with widespread reports of fish kills and of tropical species being found further south than their normal range.

Sea-surface temperatures were > 3 °C above the normal summer averages in some regions. The “marine heat-wave” was associated with extremely strong La Niña conditions, leading to a record strength Leeuwin Current for that time of year, which resulted in record high summer sea levels along the mid-west and Gascoyne coast. The heat wave resulted in what is considered to be the first WA regional-scale coral bleaching event, affecting corals south to Rottnest Island and north to the Montebello and Barrow Islands. This warming event may also have contributed to a significant decline in blue swimmer crab and scallop stocks in Shark Bay and a subsequent recruitment failure for both of these species in 2011.

A preliminary assessment of fisheries-dependent indicators of climate change in WA was undertaken in 2010. This work is being completed as part of a three-year FRDC-funded project (2010/535) that will assess the effects of climate change on the marine environment and key fisheries, as well as management implications. The first phase of the project was to understand how environmental factors, such as water temperature and salinity, affect fish stocks in Western Australia based on available historical data. The second phase was to look at historical trends and possible future scenarios of Western Australian marine environments using climate model projections. Lastly, existing management arrangements will be reviewed to examine their robustness to climate change effects and new management policies will be developed in consultation with stakeholders to deal with climate change effects of fish stocks.

**Introduced Pests and Diseases**

External Driver	Current Risk Status
Introduced Pests and Diseases	LOW

The Department is the lead agency with responsibility for managing the threat posed by introduced marine species to our marine environment. As such it implements a range of risk-based policy, research, monitoring and compliance measures aimed at preventing introduction and establishment of marine pests in State waters.

The Gascoyne represents a transition between tropical and temperate regions and is an increasing focus of oil and gas exploratory activity. As such, there is an increasing risk of introduction and establishment of numerous nationally listed pest species to inhabit this region. Currently, recreational vessel movements, practices and the fouling present on these

vessels represents one of our biggest gaps in marine biosecurity knowledge. The Marine Biosecurity Research and Monitoring Group is implementing research activities in the Bioregion focussed on vessel risk analysis. Further details for these projects may be found in the “Introduced Pests Status Report” at the end of this section and also in the Appendix section entitled “Activities of the Marine Biosecurity Research Group during 2014/15”.

**Ecosystems and Habitats**

A high level of protection of the ecosystems and habitats within the Gascoyne Coast Bioregion is ensured based on the limited area of the Bioregion that is available to commercial fishing activity.

If the areas that are not trawled is taken into account, more than 90 % of statewide benthic habitats out to the 200 m depth contour are, in practical terms, fully protected and may never have been trawled (Ecosystem Management Table 1). There are extensive trawl closures inside the 200 m depth zone in both Shark Bay and Exmouth Gulf that provide protection to sensitive benthic habitats including coral reef, seagrass and sand flats. These areas also provide significant nursery, breeding and feeding habitats for many retained and listed species. There is also a large area from Point Maud to Tantabiddi Well off the Ningaloo Coast (23° 07.30’ S to 21° 56.30’ S) that is closed to all commercial fishing activities (Gascoyne Overview Figure 5).

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. Utilising the Integrated Marine and Coastal Regionalisation for Australia (IMCRA) scheme, the bioregion has been divided into four meso-scale ecosystems; the Ningaloo Coast, Shark Bay and Zuytdorp and Exmouth Gulf ecosystem (Introduction Figure 2).

The key habitats occurring 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) include:

- Coral reefs: the Ningaloo ecosystem has the only major coral reef system in the bioregion. The Ningaloo Reef the largest continuous reef area in Western Australia and is considered one of Australia’s most significant fringing coral reef systems.
- Mangroves: The eastern coast of Exmouth Gulf supports one of the largest areas of mangroves in the region. These areas are thought to be significant sources of nutrients that contribute to the prawn fishery of the Gulf and provide nursery areas for juvenile fish and invertebrates.
- Seagrasses: The central Gascoyne coast and Shark Bay support major seagrass communities, which play important roles in sedimentary processes, food chains and nutrient cycling. Smaller seagrass beds also occur in the eastern and southern sections of Exmouth Gulf. Seagrass beds provide important nursery habitats for many finfish and invertebrate species, such as spangled emperor.
- Sand banks: Extensive sand areas support seagrasses and provide substrate for microalgae in all areas, particularly Ningaloo Reef. In both Exmouth Gulf and Shark Bay,

shallow sand banks provide productive habitat and nursery areas for local prawn and finfish stocks. Within the deeper central areas of Shark Bay and Exmouth Gulf, bare sandy/muddy bottom habitats provide the main habitat for juvenile and adult prawns within the trawl areas.

- Other habitats that are located in the ecosystems within the Gascoyne Coast Bioregion include algal communities, rocky shore communities, hard- and soft-bottom benthic communities, and pelagic mid-water communities.

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.

### Exmouth Gulf

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Exmouth Gulf ecosystem	Marine	LOW
Exmouth Gulf benthic habitat	Sand, Mud, Sponge	LOW

### Ecosystem

There is significant protection in place for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. Approximately 29 % (335 nm<sup>2</sup>) of Exmouth Gulf is trawled. Trawling is prohibited in a designated nursery area in the southern and eastern section of the Gulf. The nursery area covers 344 nm<sup>2</sup> and represents 28 % of Exmouth Gulf. A major project surveying biodiversity on and off the trawl grounds in Exmouth indicated that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the current level of trawling activity does not affect overall biodiversity and cannot be distinguished from other sources of variation in community structure. The ecosystem in this region could be at increased risk if a number of proposed developments are implemented.

### Habitat

There is a large permanent closure to trawling on the eastern and southern sides of the Gulf which protect sensitive habitats that operate as nursery areas. In the area open, trawling effort is focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. The total area trawled each year has to remain below 40%. The area trawled each year is monitored.

Trawling effort is focused in the deeper central and north-western sections of the Gulf which is primarily mud. The mud substrate in Exmouth Gulf is generally comprised of coarse and heavy sediments, which are more resistant to disturbance by trawling. Seagrass beds are spatially separated from trawling activities and are protected within the permanent nursery area closure along the southern and eastern sections of the Gulf. Current estimates of the amount of soft coral and sponge habitat within Exmouth Gulf suggest that there are only relatively small amounts and that trawling,

given that the target prawn species prefer mud substrate, does not impact these areas. Macroalgal beds are predominantly located in the southern reaches and on the periphery of Exmouth Gulf in the shallow subtidal and low intertidal limestone pavement regions. The majority of these areas are permanent nursery closures therefore trawling does not impact these habitats.

### Ningaloo

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Ningaloo ecosystem	Marine	LOW
Ningaloo benthic habitat	Sand, Coral	LOW

### Ecosystem

The Ningaloo ecosystem is protected via establishment of the Ningaloo Marine Park (NMP) which was established in 1987 and expanded in 2004 to cover and protect the entire Ningaloo Reef. The NMP covers a total area of 4,566 km<sup>2</sup> from the shoreline to continental slope. No commercial fisheries operate in the waters of the NMP and 34% of the park is zoned as no-take sanctuary areas. A significant level of research and monitoring is being undertaken in the Ningaloo marine park region by DPaW, CSIRO, AIMS and universities. This reflects the main pressures on the ecosystem which are largely not fishing-related. An assessment of the community structure and trophic level of all commercially caught fish species in the Gascoyne Bioregion over the past 30 years through an FRDC project found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem (Hall and Wise, 2011)<sup>1</sup>. The Department is a contributor and supporter of the extensive ecological research and monitoring that has been undertaken in the NMP, much of which was funded by the recently completed WAMSI Node 3 (see [www.WAMSI.org.au](http://www.WAMSI.org.au) for full details).

### Habitat

Protection of habitats within Ningaloo occurs mainly through the use of spatial zoning throughout the Ningaloo Marine Park. There are no trawl activities conducted in this area. Corals are the most important reef building organisms within the NMP and provide food, shelter and settlement substrate for a variety of other marine flora and fauna. The main risk is to coral habitat results from tourism and other boating related activities. No major pressure on seagrass communities, which are general small, patchily distributed in this region have been identified (CALM 2005).

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



**Zuytdorp**

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Zuytdorp ecosystem	Marine	LOW
Zuytdorp benthic habitat	Sand, Reef	NEGLIGIBLE

**Ecosystem**

The Zuytdorp ecosystem is largely protected due to the lack of trawling that occurs in this area. The effects of the various scalefish fisheries (handline, dropline, longline and gillnet) on the Gascoyne Coast Bioregion ecosystem have been investigated by Hall and Wise (2011). This study used detailed statistical analyses on over 30 years of commercial catch data to determine if any major changes in community composition have occurred.

Results suggest there is no evidence of a decline in the mean trophic levels or mean maximum lengths of catches taken in the Gascoyne Coast Bioregion. Total catches of the three retained species of deep sea crabs represent a very small biomass, and any impact of crab fishing on the general food chain is expected to be minimal. There is also a large commercial closure between Point Maud and Tantabiddi Well, which limits the spatial extent of commercial fishing activities within the Gascoyne Coast Bioregion.

**Habitat**

The benthic habitats of the Zuytdorp ecosystem are dominated by mud/sand bottoms, likely to support a relatively sparse invertebrate community. The majority of non-trawl based fishing takes place over sand habitats in depths of 20-250 m, depending on which species is being targeted. Underwater video work, in 20-250m, has shown that the habitat is dominated by sponges, soft corals and gorgonians (DoF 2002)<sup>1</sup>. The Gascoyne Demersal Scalefish Fishery operates in this ecosystem and is based on using hook and lines, meaning that there is virtually no impact on benthic habitats. Fishing typically occurs over harder patches of hard bottom around the entrance to Shark Bay and the adjacent ocean. Fishing does not normally occur over sensitive seagrass or hard coral habitats. The West Coast Deep Sea Crustacean Fishery operates in this area in depths from 150-1200m. Crab traps in the Zuytdorp are mainly set over mud bottom areas and occasionally bring up solitary corals or sponges that get entangled in the pot. The footprint of the pots and effort levels are both extremely small in relation to the extent of this habitat. There are thus few direct impacts of fishing activity to these habitats.

**Shark Bay**

Ecosystem/habitat	Aquatic zone/category	Current Risk Status
Shark Bay Gulfs	Marine	LOW
Shark Bay Gulfs	Sand, Sponge	MODERATE
Shark Bay Gulfs	Seagrass	NEGLIGIBLE

<sup>1</sup> Department of Fisheries, (2002). Fisheries Environmental Management Plan for the Gascoyne Region. Fisheries Management Paper No. 142

**Ecosystem**

Shark Bay is considered to be a highly productive system with protection for all sensitive habitats and restrictions on the level of impacts that can occur in less sensitive habitats. Benthic habitats and communities of Shark Bay have been described and mapped (CALM 1996). The current level of fishing by all methods does not appear to have noticeably affected the trophic/community structure in Shark Bay. A study of biodiversity in Shark Bay has found that no significant difference in the fish and invertebrate abundance, species richness, evenness or diversity between trawled and untrawled areas (Kangas *et al.* 2007)<sup>2</sup>. Therefore, the closed areas provide protection to those species more vulnerable to trawling (Kangas *et al.* 2007).

**Habitats**

The extent of various habitat types, such as seagrasses and corals, has been described and mapped (CALM 1996). Seagrass is extensive throughout the eastern and western gulfs, and corals can be found primarily along the eastern coast of the western gulf, and the eastern coasts of Dirk Hartog, Dorre and Bernier Islands. Almost all of these areas are part of the Shark Bay Marine Park and are permanently closed to trawling activities.

The majority of sponge/coral habitats and other sensitive habitats are also contained within specific trawl closures and there are limits to the trawled area to less than 40% of the sand habitats. The few unprotected areas where coral occur (e.g. Egg Island and Bar Flats) are not part of the actively trawled areas. The main areas where trawling occurs, in the central bay, north Cape Peron and in the northern area of Denham Sound, are sand/shell habitat, which is the preferred substrate of the main targeted species.

There are permanent closures include the Sanctuary and Special Purpose Zones of the Shark Bay Marine Park and the Hamelin Pool Marine Reserve. In addition, specific areas of the Bay are closed to certain fishing methods. Permanent trawl closures protect the majority of seagrass and coral habitats in the eastern and western gulfs.

**Captured Species****Finfish**

The Gascoyne supports a diverse fish fauna and is noted for its high quality of both commercial and recreational fishing. Approximately 1400 species of fishes could be expected to inhabit this region. Of these only a relatively small number are targeted by commercial fishing activities with demersal finfish species (e.g. pink snapper) captured in the Zuytdorp region and nearshore finfish species (e.g. Whiting) within the Shark Bay region. The Department manages commercial and recreational fishing in the State coastal waters (generally 3 nm). By way of the *Offshore Constitutional Settlement 1995* (OCS) agreement between the State and Commonwealth Governments, control is also given to WA for most fisheries which operate out to 200 nm from the coast (except for trawling where WA's jurisdiction is limited to the 200 m isobath).

<sup>2</sup> Kangas, M.J., Morrison, S., Unsworth, P., Lai, E., Wright, I. and Thomson A. 2007. Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report 2002/038. Department of Fisheries, Western Australia, Fisheries Research Report No. 160. 333 pp.

Due to the broad spatial distribution of both species and fisheries, the majority of finfish species in this area are managed at the Bioregional scale within four recognized aquatic zones. Indicator species which reflect the characteristics of the broader exploited stocks are monitored in order to assess ecological risk to the range of species targeted. The major fishery operating at the bioregional level is the Gascoyne Demersal Scalefish Fishery. This is a line fishery that originally targeted pink snapper has been developed over the past decade into a broader fishing sector targeting other demersal finfish species including emperors, cods and deeper water species and is managed as the Gascoyne Demersal Scalefish (Managed) Fishery.

The Gascoyne Coast Bioregion also has the Shark Bay-based beach seine fishery (the Shark Bay Beach Seine and Mesh Net Managed Fishery) that since the 1960s has provided most of the whiting catch for the state.

#### Nearshore (0-20m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Nearshore (0-20m depth)	MODERATE

The indicator species for this suite (e.g. whiting) are all considered to have adequate breeding stocks, fishing catch and effort has been occurring at the same acceptable levels for over 40 years and there are no additional risks that have been identified. Annual catch and effort monitoring is continuing.

#### Inshore demersal (20-250 m depth)

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

The main fishery operating in this region is the Gascoyne Demersal Scalefish Fishery, for which a detailed status report is provided at the end of this chapter. The key indicator species for this suite is pink snapper which is currently in a rebuilding phase and spangled emperor, in northern part of the bioregion, is considered to be suffering overfishing (but the overall stock is at an acceptable level). Pink snapper are sampled to provide representative catch-at-age data for used in an integrated stock assessment model which is updated every 3 years (most recently in 2014). Comprehensive research on spangled emperor and goldband snapper has generated 'weight of evidence' based assessments. Monitoring of commercial catches and age structure is continuing and further research is planned to refine estimates of the key biological parameters.

#### Offshore demersal (>250 m depth)

Captured Species	Aquatic zone	Ecological Risk
Finfish	Offshore demersal (>250 m depth)	MODERATE

Concerns around deeper-water species (e.g. ruby snapper, various cods) are largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. The main risk to these stocks comes from potential increases in fishing by Commonwealth licensed trawlers who operate outside of 200 m depth and the current discussions about altering this line.

#### Pelagic

Captured Species	Aquatic zone	Ecological Risk
Finfish	Pelagic	MODERATE

The stock status and fishing levels of these species (e.g. Spanish mackerel) are both at acceptable levels

#### Shark Bay Gulf Demersal

Captured Species	Ecosystem	Ecological Risk
Finfish	Shark Bay Gulf Demersal	MODERATE

The main fishery operating in this ecosystem is the Inner Shark Bay Scalefish Fishery, for which a detailed status report is included at the end of this chapter.

The spawning biomass of pink snapper has returned above the target level (40%) in the Eastern Gulf, Denham Sound Freycinet Estuary. These inner gulf stocks are monitored using daily egg production method [DEPM] surveys to estimate spawning biomass approximately every 3-5 years and intermittent surveys of recreational catch. It is possible that grass emperor will be added to the set of indicators for this suite.

#### Invertebrates

Commercial fishing for invertebrates is a very significant industry within the Gascoyne Coast Bioregion; three of the State's most valuable fisheries (the Exmouth Gulf Prawn, Shark Bay Prawn and Shark Bay Scallop Managed Fisheries) land combined catches valued in the range of \$AUD 40-50 million annually. These trawl-based fisheries have operated in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of both management and research (Fletcher and Santoro 2012). A fishery for blue swimmer crabs (the Shark Bay Crab [Interim] Managed Fishery), based primarily in Carnarvon but operating throughout the waters of Shark Bay, has grown in the last decade to be the largest Western Australian crab fishery. The Gascoyne also supports the majority of the catch of deep sea crabs off the coast of Western Australia as part of the West Coast Deep Sea Crustacean Managed Fishery.

**Nearshore (0-20 m depth)**

Captured Species	Aquatic zone	Ecological Risk
Crabs	Nearshore (0-20 m depth)	MODERATE
Pearl Oysters	Nearshore (0-20 m depth)	MODERATE

There are a number of issues related to resource sharing and gear conflicts between the Shark Bay crab trap and Shark Bay prawn and scallop trawl fisheries. A recent (2011 stock assessment) concluded that there was conflicting evidence about the level of impact the current catch levels were having on the stock. Subsequent to this review, the relative abundance of all size classes of crabs in Shark Bay declined significantly. The reasons for this unexpected and substantial decline appear to be linked to several adverse extreme environmental events and this has had a significant impact on the 2011/12 and 2012/13 fishing seasons.

The recent stock levels of pearl oysters in this region have been low. Recovery management arrangements have already been implemented and minimal catches have been taken in recent years.

**Exmouth Gulf**

Captured Species	Aquatic zone	Ecological Risk
Prawns	Exmouth Gulf Ecosystem	MODERATE

The only commercial fishery that operates continuously in the Exmouth Gulf ecosystem is the Exmouth Gulf Prawn Managed Fishery (EGPMF). The Exmouth Gulf Beach Seine Fishery, which only has one licence holder, is very small scale and does not operate every year. The EGPMF is the second largest prawn trawl fishery in WA, with a landed value in 2011 of around \$ 11 million. The Fishery is located in the north/northwest waters of Exmouth Gulf. Currently, the two main target species of this fishery are the brown tiger prawn and western king prawn. A status report summarizing the condition of the EGPMF is included at the end of this chapter.

Management of the prawn fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls. Permanently closed nursery areas within the fishery prevent the fishing of small size prawns while spatio-temporal closures serve to maintain brown tiger prawn breeding stocks above the target abundance level. Of the 4000 km<sup>2</sup> waters contained within the Exmouth Gulf Prawn Managed fishery boundary, 1100 km<sup>2</sup> is closed to trawling and of the remainder only 1200km<sup>2</sup> is actually trawled. All the stocks of prawns are at acceptable levels.

**Zuytdorp**

In addition to the bioregional fisheries, the Zuytdorp ecosystem is also utilized by the West Coast Deep Sea Crustacean Managed Fishery which has been operating since the late 1990s.

**Shark Bay**

Captured Species	Aquatic zone	Ecological Risk
Prawns and Scallops	Shark Bay Ecosystem	MODERATE

There are four commercial fisheries that operate within Shark Bay. These are the Shark Bay Prawn and Shark Bay Scallop Managed Fisheries, which are both trawl-based and also capture blue swimmer crabs; the Shark Bay Crab Fishery, which is a trap-based fishery for blue swimmer crabs; and the Shark Bay Seine and Mesh Net Managed Fishery which targets whiting and mullet.

Management of the prawn and scallop fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls. Permanently closed nursery areas within the fishery prevent the fishing of small size prawns while spatio-temporal closures serve to maintain brown tiger prawn breeding stocks above the target abundance level.

Of the 41,500 km<sup>2</sup> waters legislated within the boundaries of the Shark Bay Prawn and Scallop Managed Fisheries, 10000 km<sup>2</sup> is closed to trawling and only approximately 3000 km<sup>2</sup> is actually trawled.

To ensure that sufficient stock remained for spawning, the fishing arrangements provide a threshold catch rate limit for the scallop fleet to cease fishing. All the stocks of prawns are at acceptable levels. The stock of scallops, however, declined significantly after the 2011 season had ended and this is likely to have been generated by the same set of environmental conditions that affected the crab stocks.

**Listed species**

A variety of endangered, threatened and protected<sup>1</sup> (ETP) species can be found within the Gascoyne Coast Bioregion, including cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish and sea/shore birds. These species are protected by various international agreements and national and state legislation. Primary pieces of legislation include the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the *Western Australian Wildlife Conservation Act 1950*, and the *Fish Resources Management Act 1994*.

Specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the region, to prevent the incidental entanglement of dugongs and turtles. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in all trawl nets in this bioregion have further increased the protection for sharks, rays and any turtles encountered on the trawl grounds. In a further effort to protect sharks and rays, line-fishery vessels are not permitted to use wire snoods.

<sup>1</sup> It must be noted that merely being on the listed species list does not automatically indicate that a species is either threatened or endangered.

**Fish**

Listed species	Risk
Fish	LOW

There are no listed fish species (including syngnathids) at risk in this region.

**Non-Fish**

Listed species	Ecological Risk
Turtles/seasnakes	LOW
Mammals	LOW

While listed species including dugongs, turtles and sea snakes occur in the Gascoyne region area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both of these species are typically returned to the sea alive.

Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. The number of turtles captured now is very low and most of these are returned alive. Turtle captures and their status at release are monitored and reported.

There are no recorded captures of mammals by the trawl fisheries in this bioregion.

## Introduced Pests Status Report

### Regional Monitoring and Research Update

The introduction and spread of marine pests in WA waters poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. There are two key vectors for marine pest translocation: ballast water and hull fouling. The Marine Biosecurity Research Group are implementing biosecurity related projects in the Gascoyne Coast Bioregion targeted at vessel risk analysis.

Due to prioritisation of risk and resources the Marine Biosecurity Research Group did not undertake any introduced marine pests monitoring in the Gascoyne Coast Bioregion in 2014/15. However, given the increase in vessel movements associated with the significant oil and gas mining activity offshore there is a real possibility of the introduction of marine pests into this bioregion.

From a biosecurity perspective the introduction of a marine pest to any region is based on multiple factors that can be grouped into two themes; the likelihood of inoculation and the likelihood of infection and establishment. Inoculation likelihood assumes that the greater the number of vessel visits from a source with introduced marine pests (IMP) the greater

the risk of IMPs being brought into the recipient port i.e. a positive linear relationship. The number of commercial vessels entering the Gascoyne Coast Bioregion has significantly increased (~12000%) over the past 12 years (2002 to 2014). As a result the group is analysing the change in numbers of commercial vessels as well as their visit and type profiles to better inform management processes of the domestic and international risks to the Bioregion.

The Marine Biosecurity Research Group is also quantifying the risk associated with recreational vessels for the potential introduction, harbouring and translocation of marine pests along our coast. This research focusses on surveying marina-based vessel owners about their vessel management practices and their vessel use profiles. The research outputs are designed to be applicable to biosecurity management across the state.

For further details on the above projects see the Appendix section entitled "Activities of the Marine Biosecurity Research Group during 2014/15".

## FISHERIES

## Shark Bay Prawn and Scallop Managed Fisheries Status Report

*E. Sporer, M. Kangas, S. Wilkin and P. Cavalli*

Main Features			
Status		Current Landings	
Stock level		King Prawns	1282 t
Prawn	Adequate	Tiger Prawns	625 t
Scallop	Environmentally limited	Endeavour Prawns	17 t
Fishing level		Scallops	Nil
Prawn	Acceptable		
Scallop	Acceptable		

## Fishery Description

The Shark Bay Prawn Managed Fishery (SBPMF) is the highest producing Western Australian fishery for prawns. It targets the western king prawn (*Penaeus latisulcatus*) and brown tiger prawn (*Penaeus esculentus*), but also takes a variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).

The Shark Bay Scallop Managed Fishery (SBSMF) catches the saucer scallop (*Amusium balloti*), and is usually WA's most productive scallop fishery.

These two fisheries are managed through limited entry, gear controls (both use low opening, otter trawls as the fishing method) and in-season real time management to ensure sustainability and maximise economic efficiency.

Both the area and timing of operation of the two fisheries overlap and vessels that operate within the prawn fishery are also licensed to retain scallops under the SBSMF.

### Governing legislation/fishing authority

*Shark Bay Prawn Managed Fishery Management Plan 1993*

Shark Bay Prawn Managed Fishery Licence

*Shark Bay Scallop Managed Fishery Management Plan 1994*

Shark Bay Scallop Managed Fishery Licence

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

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

### Consultation process

The Department is responsible for the statutory management plan consultation and undertakes consultation directly with licensees on operational issues and processes. The West Australian Fishing Industry Council (WAFIC) is also responsible for statutory management plan consultation under

a Service Level Agreement with the Department. Industry Annual Management Meetings are convened by the WAFIC.

### Boundaries

The boundaries of the SBPMF and the SBSMF are located in and near the waters of Shark Bay as presented in Shark Bay Prawn and Scallop Figures 1 & 2. These diagrams outline the boundaries of the two fisheries plus show all the area closures (both temporary and permanent) and the specific areas trawled in the 2014 season.

### Management arrangements

Management of the prawn and scallop fisheries is based on input controls, which include limited entry, seasonal and area openings and closures, gear controls and limits on crew numbers. Both fleets undertake trawl fishing using otter trawl systems. Each fleet has a separate standard net size and gear configuration. This system has specific effort controls based on maximum head-rope length and the maximum fishing days (season duration). These controls have allowed fleet rationalisation to occur in response to improvements in vessel and gear efficiency.

Bycatch reduction devices ('grids') are mandatory for all prawn and scallop trawl nets. In addition, secondary bycatch reduction devices (fish escape devices) are mandatory for nets of prawn boats because they fish with small size mesh codends. Dedicated scallop boats have larger 100 mm mesh codends resulting in only a small amount of bycatch being taken during trawl operations and therefore do not require the secondary devices.

The *Fish Resource Management Act 1994* (FRMA) is the overarching legislation for the SBPMF. The key object of the FRMA is to conserve develop and share the fish resources of the State for the benefit of present and future generations. The delivery of this management outcome is supported by the use of a sophisticated system of seasonal, spatial and

temporal closures (nursery and spawning area). These management controls, in particular, the spatial and temporal closures, are designed to ensure the maintenance of breeding stocks for all prawn species, optimise the size of the prawns at capture and minimize environmental impacts of the fishery.

The key harvest strategy for these fisheries is ‘constant escapement’ through the use of real-time management of spatial and temporal fishing effort. This is supported by the Research Division of the Department of Fisheries who carry out surveys and regular monitoring of the catch to provide advice on when to open/close areas. The Vessel Monitoring System (VMS) monitors the location of all activities by licensed fishing boats and adherence to closures.

The Commonwealth Government’s Department of the Environment (DotE), has assessed the fisheries under the provisions of the *Environmental Protection and Biodiversity Conservation Act 1999* and accredited both fisheries for a period of ten years (re-assessment in 2025), allowing product from the fisheries to be exported from Australia. The comprehensive Ecological Sustainable Development assessment of these fisheries found that the only material risks requiring direct management actions to ensure acceptable performance were the breeding stock levels of the targeted prawn and scallop species, bycatch species impacts, listed species interactions (including loggerhead turtles), habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance measures/indicators for each of these issues. The SBPMF commenced full MSC accreditation in 2014.

For the 2014 prawn season, the fishing arrangements included an opening date of 24 March and closing date of 31 October, providing a total of 176 nights fishing. During this season, the fishing strategy involved voluntary rolling area openings, based on assessments of the sizes and abundance of king and tiger prawns obtained through fishery-independent surveys.

The 2014 scallop season did not open because of environmentally-induced low scallop abundance and is the third successive year of no scallop fishing.

### Research summary

Research and monitoring activities in the Shark Bay region is separated into two regions, Northern Shark Bay and Denham Sound, as they represent separate stocks of prawns and scallops. In 2014 a standard for naming areas within Shark Bay was implemented and these area names will be referred to in this report (Shark Bay map showing area names Figure 1). Research activities continue to focus on stock assessment and annual monitoring of the target stocks, by fishery-independent surveys and commercial catch rates, particularly brown tiger prawns and scallop stocks.

#### Prawns

The seasonal operations of the prawn fishery are dynamic because they depend on the strength and timing of recruitment which, in turn, affects the opening and closing dates for the fishing season. These dates vary each year depending on moon phase and the results of fishery-independent surveys to estimate recruitment strength. The timing and spatial pattern of the fishing season allows the harvesting of the current season’s recruits and the large

residual prawns not caught in the previous fishing season. Permanently closed nursery areas within the fishery prevent the fishing of small prawns and provide habitat preservation, while spatio-temporal closures serve to target prawns at optimum sizes for market requirements and maintain brown tiger prawn breeding stocks above the threshold abundance level.

The fishery uses moon closure periods because western king prawns are sensitive to light, which makes them less active around the full moon and hence less catchable. Industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate. In 2014, the moon closures were; the first two, five days and the remaining five closure periods, seven days per month and these were set out in the season arrangements.

In addition to the permanent closures described above, there are two areas deemed as key spawning areas, the north Carnarvon/Peron Line (CPL) and the south CPL (Shark Bay Figure 1) that are closed during the key spawning period.

In 2014, the north CPL (NCPL) was closed to fishing on 10 June and the south CPL (SCPL) was closed 8 August. From early August onwards, the SCPL is generally closed to protect smaller prawns (primarily western king prawns) and provide protection as a buffer to the remaining brown tiger prawns during the key spawning period before they move onto the trawl grounds from the nursery area. Closure of the SCPL in early August was implemented in 1983 but the brown tiger prawn spawning stock abundance within this area was never assessed during the closure period until 2013.

Generally Denham Sound opens around July/August each year for prawn fishing, which gives protection to smaller prawns early in the season as well as allowing a higher spawning biomass in this region prior to fishing.

During August, trawling was permitted in a limited area below the Snapper Trawl Line (STL) in Denham Sound for a maximum period of 10 days and the opening was subject to prawn catch rate levels (western king and brown tiger prawns) and pink snapper numbers. Fishery-independent surveys undertaken in these waters prior to fishing indicated that the risk to juvenile pink snapper stock was very low due to low numbers of snapper being observed whilst prawn abundance was above the opening target level.

All prawn boats completed detailed daily log books, and these, together with pre-season fishery-independent recruitment surveys and in-season surveys of size composition and spawning stock, provide the information for monitoring the status of the stocks.

## Retained Species

### Commercial production (season 2014)

<b>Prawns</b>	<b>1924 tonnes</b>
<b>Scallops</b>	<b>Nil</b>
<b>Landings</b>	

#### Prawns

The total landings (whole weight) of major prawn species for this fishery was 1924 tonnes (t), comprising 1282 t of western king prawns, 625 t of brown tiger prawns and 17 t of

endeavour prawns (Shark Bay Prawn and Scallop Figure 3). Western king prawns were above last year’s total landings of 1139 t, whereas, the brown tiger prawns were slightly below last years total landing of 661 t. In addition, 100 t of coral prawns (various species, but mainly *Metapenaeopsis crassissima*) were landed. The total landings of major prawn species were within the target catch range of 1350 to 2150 t.

Western king prawn landings (1282 t) and brown tiger prawn landings (625 t) were within the historical target catch range.

**Scallops**

No landings of scallops were allowed in 2014 due to low scallop stock abundance in the fishery.

**Byproduct**

Byproduct landings from the prawn fleet included 196 t of blue swimmer crab (*Portunus armatus*), 13.5 t of squid, 42.7 t of cuttlefish, 4.1 t of bugs (*Thenus australiensis* and *T. parindicus*), 1 t of octopus and 40 t mixed finfish species.

**Fishing effort/access level**

The 2014 prawn season fishing arrangements had a season opening date of 24 March and closed on 31 October, providing a total of 176 nights fishing and all the nights available to fish were utilised. Eighteen prawn boats operated in 2014 with quad gear configuration (four, 10.1 m nets). The mean annual total effort recorded historically by 27 prawn boats between 1990 and 2004 inclusive is 44,864 hours, fishing with twin gear (prior to 1990, the fleet consisted of 35 boats). An adjustment was made to the current nominal effort for the increased headrope (37.5% per boat) towed by the 18 quad boats with the 2014 adjusted effort being 41,533 hours (twin-gear equivalent) (Shark Bay Prawn and Scallop Figure 3). This adjusted effort is 16% higher than last year and the highest level of effort since the introduction of quad gear.

**Scallops**

A target scallop catch level for Denham Sound and northern Shark Bay has also been set to determine if commercial fishing can commence in either area each season. The catch prediction from the annual pre-season survey in November 2013 indicated a very low scallop abundance that was well below the target catch level for fishing to commence in either region, therefore, the fishery remained closed for 2014.

**Recreational component:** Nil

**Stock Assessment**

**Assessment complete:** Yes

**Assessment level and method:**  
Level 4 - Direct survey/catch rate

**Breeding stock levels:**

**King prawns** Adequate

**Tigers prawns** Adequate

**Scallops:** Environmentally Limited

**Prawns**

The catch per unit of effort for the prawn fishery can be used as an indicator to monitor changes in stock levels from year-

to-year. Spawning stock and recruitment indices are derived from survey data and commercial catch rates from logbook data. Conservative brown tiger prawn target catch rate levels are in place to maintain spawning stock above acceptable levels. Logbooks provide information on the daily catch (kg) of target species and effort (hours trawled) expended in specific fishing areas. Catch per unit effort can then be derived for each fishing area by each boat by species.

Fishery-independent surveys are undertaken for western king and brown tiger prawn stocks, which are monitored and assessed for size and catch rates from recruit surveys in March and April, brown tiger prawn breeding stock surveys in June (NCPL only) and during August and September in both the NCPL and SCPL and western king and brown tiger prawn surveys in Denham Sound in August.

Fishery-independent recruitment surveys are undertaken as fishery-dependent data on key recruitment grounds are no longer available due to later start date of fishing. Each survey is conducted over two nights of sampling at 19 standardised sites east of the CPL where prawns have migrated from nursery areas onto the trawl grounds. The information is also used to forecast a catch range for brown tiger and western king prawns and to determine the extent of areas to be opened to fishing to meet market requirements.

The recruitment levels of brown tiger prawns during the 1980s were demonstrably affected by reduced spawning stock biomass. Management practices have subsequently been tailored to maintain the level of brown tiger prawn spawning stocks at sustainable levels. The implementation of a temporal closure of the CPL was aimed at reducing effort on brown tiger prawns early in the season. In addition, since 1982, the Extended Nursery Area (ENA) (now referred to as the SCPL) was closed to fishing from August each year and provided protection of brown tiger prawns as this area does not re-open to fishing after the closure. Also, the introduction of the brown tiger prawn spawning area (TPSA) closure (now referred to as the NCPL), in combination with all of the areas east of the CPL remaining closed until after the second recruitment survey appears to have had a favourable impact on the brown tiger prawn stock since its inception in 1996.

The breeding stock surveys are undertaken to verify brown tiger prawn catch rates. The first survey is undertaken in June or July after the NCPL is closed to fishing. Some of the western king prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys. Two additional standard breeding stock surveys are undertaken around the third moon phase in August and September, in the NCPL, and since 2013 the survey was also extended to include the SCPL to undertake an additional assessment of the spawning stock (spawning condition and abundance) for brown tiger and western king prawns around the same lunar phase as the NCPL. An adjustment of a spawning index time series will be undertaken in a few years to take into account the revised sampling months.

The NCPL was closed to fishing on 10 June to maintain a level of spawning stock of brown tiger prawns between 20 and 25 kg/hr (the target level is 25 kg/hr based on 22 fathoms net headrope length in quad gear configuration).

**Catch rate assessment**

The overall western king prawn catch rate of 30.9 kg/hr (for adjusted effort equivalent to twin gear units) was slightly lower than in 2013 (31.7 kg/hr), however, it was relatively

high when compared with the previous ten years mean catch rate (27.6 kg/hr). The overall brown tiger prawn catch rate of 15.1 kg/hr was lower than in 2013 (18.4 kg/hr) but higher than the previous 10 years mean catch rate (13.3 kg/hr). These catch rates show that the fishing fleet is fishing efficiently and abundance levels are acceptable.

#### Survey assessment and breeding stock levels

For 2014, the western king and brown tiger prawn mean survey catch rates during the combined recruitment surveys (March and April) were 49.3kg/hr and 53.3 kg/hr respectively and the catch predictions for western king and brown tiger prawns were 905 t (725 to 1085 tonnes) and 535 t (430 to 645 tonnes) respectively. The actual landed catch of western king prawns (1282 t) was above the predicted range with that of brown tiger prawns (625 t) being within the predicted range. The relationship between survey indices and landings will continue to be reviewed.

To control fishing effort and maintain adequate brown tiger prawn breeding stock levels, fishing is delayed on the brown tiger prawn stock by not opening the CPL at the commencement of the season. The aim is to close the NCPL at a target catch rate level of 25 kg/hr.

The survey catch rate for brown tiger prawns in the NCPL just after it was closed in June was 30.8 kg/hr, while in August it was 23.9 kg/hr with a mean catch rate of 27.4 kg/hr which was above the target level. The NCPL is an important area for brown tiger prawn spawning stock from June, the early stages of the key spawning period, to maintain adequate stock abundance because it is significant for egg production at this time. The catch rate had declined to 13.0 kg/hr by September which was expected as prawns migrate through this area and recruitment declines to a low level therefore the tiger prawn abundance at this time of year is not appropriate for measuring the entire spawning stock.

Conversely, the SCPL becomes an important area for spawning after it closes from August. This area retains both brown tiger and western king prawns (including spawning stock) throughout the latter part of the key spawning period. The surveys conducted in June, August and September 2014 showed brown tiger prawn catch rates of 35.4 kg/hr, 24.5 kg/hr and 19.9 kg/hr respectively. The overall catch rate from the north and south CPL combined may better represent the total spawning stock level of brown tiger prawns but these cannot be directly compared to previous spawning stock surveys at this stage. In the future a revised index will be determined for these two areas combined and will be used in stock assessment and developing the harvest strategy.

The western king prawn catch rates during the spawning stock survey in the NCPL in June, August and September were 46.3 kg/hr, 58.2 kg/hr and 30.9 kg/hr respectively. Western king prawn spawning stock remains above the level (25 kg/hr) where it may significantly affect the recruitment and is therefore adequate. Fluctuations in the annual western king prawn catches are most likely to have resulted from varying effort levels and environmental effects on recruitment, not from the spawning stock abundance. The surveys conducted in June, August and September 2014 in SCPL showed western king prawn catch rates of 81.5 kg/hr, 29.6 kg/hr and 25.1 kg/hr respectively.

An additional survey was undertaken in both the north and south CPL in November as part of the annual 'scallop' survey. The catch rate of brown tiger prawns in the NCPL

had declined to 1.5 kg/hr, and to 4.9 kg/hr in the SCPL. The western king prawn catch rates also declined to 4.7 kg/hr in the NCPL and 7.9 kg/hr in the SCPL.

The survey results for both species showed that catch rates decreased from July to September, indicating very little migration into these areas during the latter part of the season. At the same time, migration out of the areas is clearly evident. Two other in-season surveys were also carried out during May and June to obtain size (grade) information of western king and brown tiger prawns to determine if part of the area within the CPL remains closed. These surveys assisted with in-season harvesting strategies and optimising returns to fishers.

Variable quantities of minor penaeids (predominantly coral prawns) are retained, depending on the catch of the target species. Owing to the small size of these species, it is likely that the majority of the stock is able to pass through the trawl mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate. Due to the low market prices received for these minor species their retention is low.

#### Projected prawn catch range next season (2015):

<b>King prawns</b>	<b>905-1360 tonnes</b>
<b>Tiger prawns</b>	<b>410-615 tonnes</b>

The recruitment survey results for March-April 2015 showed a slight increase in western king prawn abundance and a slight decrease in brown tiger prawn abundance.

*The main performance measures for the prawn fishery relate to the maintenance of breeding stocks for each of the major target prawn species. The survey catch rate for tiger prawns in the NCPL just after it was closed in June was 30.9 kg/hr, while in August it was 23.9 kg/hr with a mean catch rate of 27.4 kg/hr. It is therefore highly likely that the mean catch rate of brown tiger prawns in the NCPL would have been above the 25 kg/hr catch rate level. Furthermore, the mean catch rate of brown tiger prawns in the SCPL was 24.5 kg/hr in August.*

*The SCPL provides an additional level of protection for both species during the key spawning period as it closed early August. Sampling of this area will be incorporated into future surveys for a combined spawning stock index.*

*The western king prawn annual landing was within the acceptable catch range and the mean catch rates in NCPL was 46.3 kg/hr 58.2 kg/hr in June and August respectively well above the target level.*

#### Scallops

Scallops mature at about one year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the key spawning season (April to July) for generating the forthcoming season's recruits.

A stock-recruitment-environment relationship has been developed in northern Shark Bay and Denham Sound to assess the cause of the decline. The series of poor recruitment since 2010/11 heat wave has resulted in the



spawning stock falling to historic low levels which may also be affecting the recruitment.

The 2013 survey indicated that there was inadequate recruitment in both northern Shark Bay and Denham Sound and the fishery remained closed in 2014 to provide full protection to the breeding stock. In addition, a small area was closed to prawn trawling in Denham Sound in 2013 and 2014 to provide increased protection for a few sites with a higher concentration of scallops that were identified in the annual November scallop surveys in 2012 and 2013. When these sites were re-sampled in November 2014 they showed: i) an increased abundance of residual scallops compared to areas outside the closure; and ii) higher abundance of recruit scallops compared to other sites outside the closure area. Based on the average abundance inside and outside the closed area from the 2014 survey, about 30% of the scallop abundance in Denham Sound is in the area that was closed, but significantly, 48% of the residual scallops reside in this small area. The survey also showed increased abundance for two sites in the area open to trawling due south of the closed area.

A plausible hypothesis for the increased abundance of scallops (particularly recruits) in 2014 compared to last three years is that there may have been some direct benefit of this closure to the recruitment of scallops by maintaining higher abundance of scallops undisturbed during the spawning period and for the entire fishing season of 2013 and 2014. An alternative hypothesis is that the increase in abundance observed is only driven by improved environmental conditions which has resulted in higher survival of both residual scallops and resultant recruits and/ that the area where the closure area was located ‘naturally’ attracts or retains a higher concentration of recruits.

*The performance measure is to ensure adequate breeding stock levels. This is normally achieved by cessation of fishing at the appropriate catch rate target. However as the catch predictions were below the minimum abundance level for fishing, breeding stocks were protected in 2014 through a full closure of the fishery. In addition, in Denham Sound a small area was completely closed from all trawling to protect the main aggregation of scallops found within Denham Sound as a further precautionary measure. The November 2014 showed that the spawning stock in Denham Sound had returned to acceptable levels but in Northern Shark Bay spawning stock abundance was still inadequate.*

**Projected scallop catch next season (2015):  
500 tonnes (whole weight)**

The catch projection for the 2015 season is based on the fishery-independent November 2014 annual survey results. The mean index for Denham Sound indicates that approximately 100 t meat weight (a precautionary level to allow the residual stock to improve) is available for harvest in Denham Sound. To assist in continued stock recovery fishing should not be undertaken prior to August after the peak spawning time (April to July). The catch prediction for Northern Shark Bay is approximately 40 tonnes meat weight, which is well below the limit reference level required for the fishery to open and this part of Shark Bay will remain closed to scallop fishing for 2015.

## Non-Retained Species

**Bycatch species impact: Low**

### Prawn trawlers

Bycatch composition for the prawn fishery is dominated by dead wire weed, which breaks off from the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small size fish species mostly not taken by other sectors. Small blue swimmer crabs and other crustacean species are also taken in significant quantities but are generally returned to the sea alive. Overall bycatch taken in trawl nets are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Grid and secondary bycatch reduction devices (square mesh panels in cod-ends) are fully implemented and further reduce the quantity of small fish retained in trawls. A comprehensive research survey found no significant difference in invertebrate or finfish abundance or diversity between trawled and untrawled areas.

*The two performance measures for the fishery relate to: (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed. Data analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.*

### Scallop trawlers

Generally the total bycatch of fish and other fauna is minimal for the scallop fishery owing to the legislated design of the nets (which use 100 mm mesh) and the relatively short duration of the fishery. No fishing occurred in 2014.

**Listed species interaction: Low**

Although listed species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay generally, only sea snakes are seen regularly in the trawl catches in certain areas, and these are mostly (~90%) returned to the sea alive. There has been a focus on improved reporting of interaction and fate of listed species. The full implementation of bycatch reduction devices (grids) in the fishery since 2002 has generally eliminated the occasional capture of turtles in trawl nets.

*For the 2014 prawn fishing season, 27 turtles were recorded as caught in nets in the prawn fishery with all being recorded as returned to the sea alive. With improved reporting of listed species interactions, 564 sea snakes were reported as caught with 511 returned to the sea alive. Thirty syngnathids were reported as captured. No scallop fishing was undertaken in 2014.*

## Ecosystem Effects

### Food chain effects: Low

Although the harvest rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively small proportion of the 'fish' biomass on the trawl grounds. Thus, most prawn and scallop predators are opportunistic due to these natural variations in prawn and scallop populations. Consequently, it is considered unlikely that the commercial take of prawns and scallops impacts significantly on the upper trophic levels within the Shark Bay ecosystem. The reduced levels of effort now used by the fishery, combined with the modifications to gear to reduce unwanted catch, will have further reduced the potential for indirect food chain impacts to occur.

### Habitat effects:

#### Prawn fishery Moderate

#### Scallop fishery Low

There are extensive permanent and temporary closures in the Shark Bay trawl fisheries. The total area inside Shark Bay is 4652 nm<sup>2</sup> and represents 38% of the total fishery area (including closed areas) (Shark Bay Prawn and Scallop Figure 1).

#### Prawn trawlers

The prawn fleet operates in approximately 7% of the overall fishery boundaries. The permitted trawl area inside Shark Bay is 1768 nm<sup>2</sup> and represents 38% of inner Shark Bay (excluding the closed areas) but trawling does not occur across this whole region. Trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay, north and northeast of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

#### Scallop trawlers Nil

*Performance measures for habitat impact relate to the spatial extent of prawn trawling within Shark Bay's sand/shell and coral/sponge habitats. Both the prawn and scallop fleet permitted trawl areas are below the 40% level of the inner Shark Bay area. Most sponge/coral habitats in Shark Bay are now protected by fishery permanent closures, which will limit the actual trawl area below 40% at any time. In 2014 the performance measure was met as the total area trawled within inner Shark Bay by the prawn fleet was approximately 808 square nautical miles or 17.4% of inner Shark Bay.*

## Social Effects

These industries are a major contributor to regional employment. During 2014, approximately 100 skippers and other crew were employed in the prawn fishery. There are also approximately 55 processing and support staff directly employed at Carnarvon. Nor West Seafood is based in Carnarvon with administration, wharf and engineering staff based at the small boat harbour and a processing factory at Babbage Island. Approximately 70% of their work force is permanent. The prawn sector also utilises, wherever possible,

Western Australian service companies providing engineering supplies, packaging, transport logistics, ship stores and fuel.

## Economic Effects

### Estimated annual value of major prawn and scallop for 2014:

**Prawns Level 5 - > \$20 million (\$25.1 million)**

**Scallops Level 0 - Nil**

The value of the fishery including coral prawns, cuttlefish, squid and bugs to the prawn fleet is \$25.4 million (excluding blue swimmer crabs). Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time, and average ex-boat prices were as follows:

Western king prawns	\$12.49/kg
Brown tiger prawns	\$13.86/kg
Coral prawns	\$3.50/kg
Endeavour prawns	\$6.50/kg

## Fishery Governance

### Target catch range:

**Prawns (New range) 1350 – 2150 tonnes**

**Scallop 1250 – 3000 tonnes whole weight**

Under previous effort levels, normal environmental conditions and based on catches in the 1990s following the restructuring of the fishery to 27 licences, the target catch range had been set for major penaeids at 1350 – 2150 t. Similarly, the target catch ranges for individual species were western king prawns 950 – 1450 t, brown tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t. Western king prawn and brown tiger prawn annual landings were both within the target ranges.

The scallop target catch range, under normal environmental conditions, remains at approximately 1250 – 3000 t whole weight, based on catches over the five-year period 1995 – 1999. This period exclude the high catches of the early 1990s (Shark Bay Scallop Figure 4), apparently created by an unprecedented four years of El Niño conditions. The projected scallop catch for 2014 (<10 t whole weight), based on a pre-season survey, is below the target catch range and the fishery remained closed.

### New management initiatives (2014)

The pre-assessment phase for the Marine Stewardship Council approval system has been completed for both fisheries, with the Shark Bay Prawn Managed Fishery undergoing full assessment during 2014-15. This is scheduled for completion in late 2015.

## External Factors

Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and locally aquacultured small prawns, has focussed harvesting practices

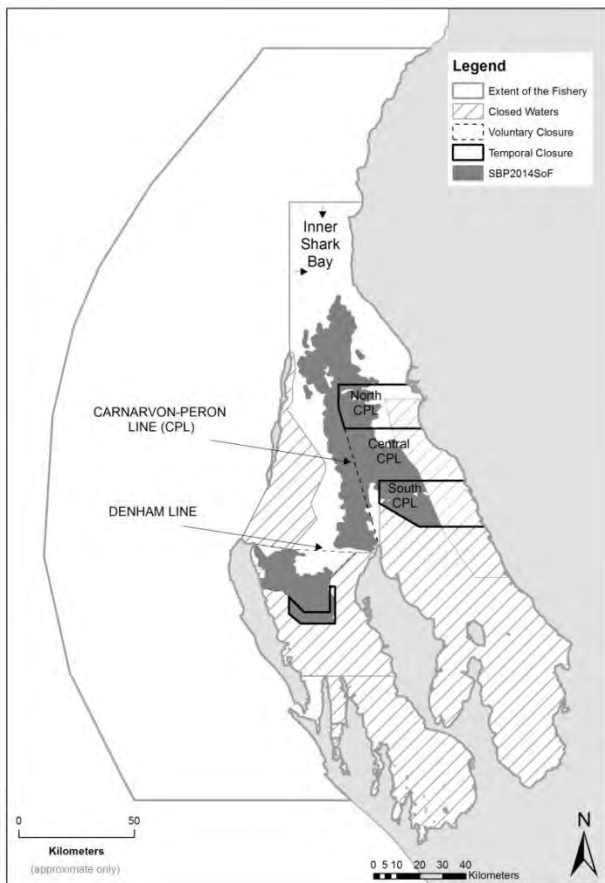
on targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets rather than export markets. This has also provided the prawn industry the opportunity to maximise the return from all species taken in the fishery where possible, particularly scallops and blue swimmer crabs. Fishing in the early part of the season and short moon closure periods at this time tends to increase the take of smaller size and soft prawns (particularly western king prawns) and to some extent, reduces the value of the fishery.

The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment. A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The higher current flows increase water temperatures, which may increase the growth and catchability

of the prawns. A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels corresponding to strong Leeuwin Current (and warmer water temperatures) correlate with poor recruitment.

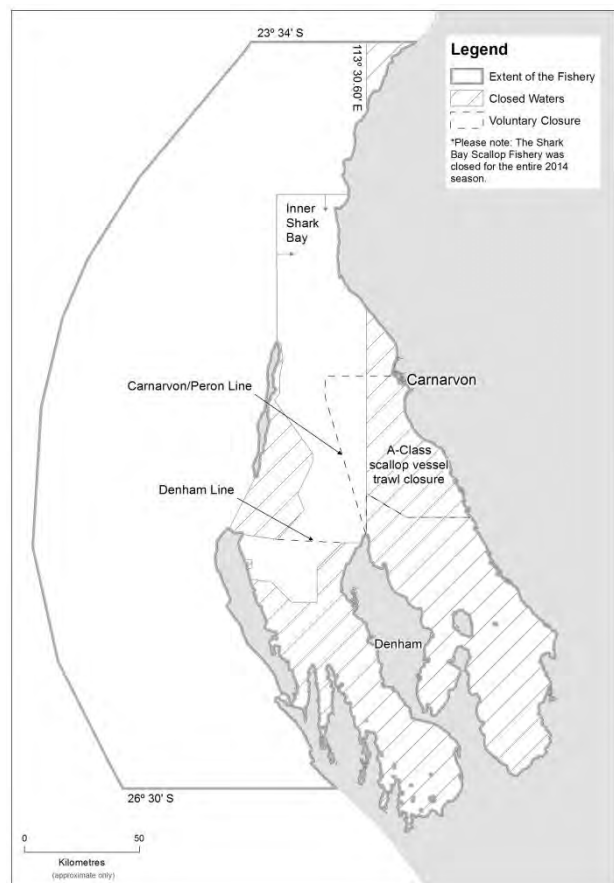
The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs and the unprecedented low scallop stock levels observed between 2012 and 2014.

Brown tiger prawns and scallops were ranked as high risk to climate change effects while western king prawns were ranked as medium-high risk.



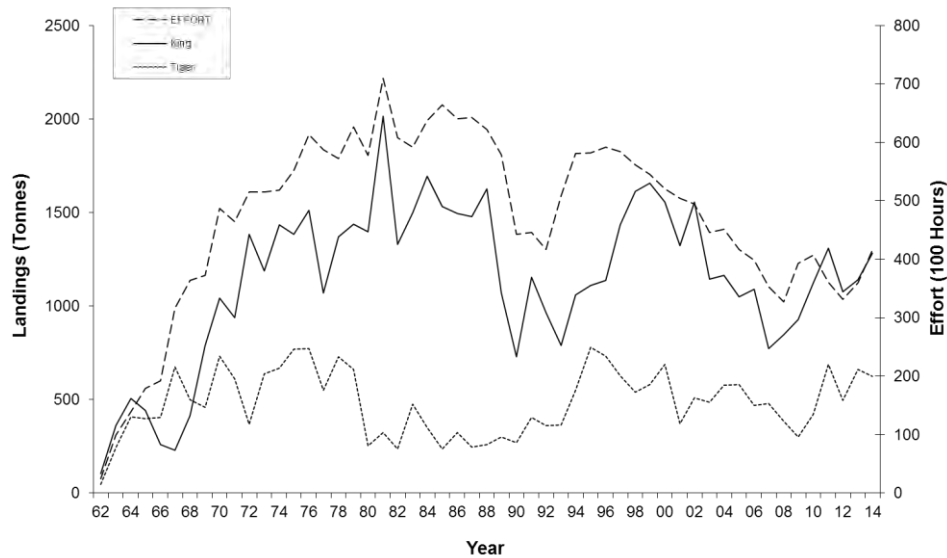
**SHARK BAY PRAWN AND SCALLOP FIGURE 1**

The main boundaries of the Shark Bay Prawn Managed Fishery, Inner Shark Bay, North CPL, Central CPL, South CPL, trawl closures, permitted trawl area (extends out to the 200m isobath) and area trawled in 2014.



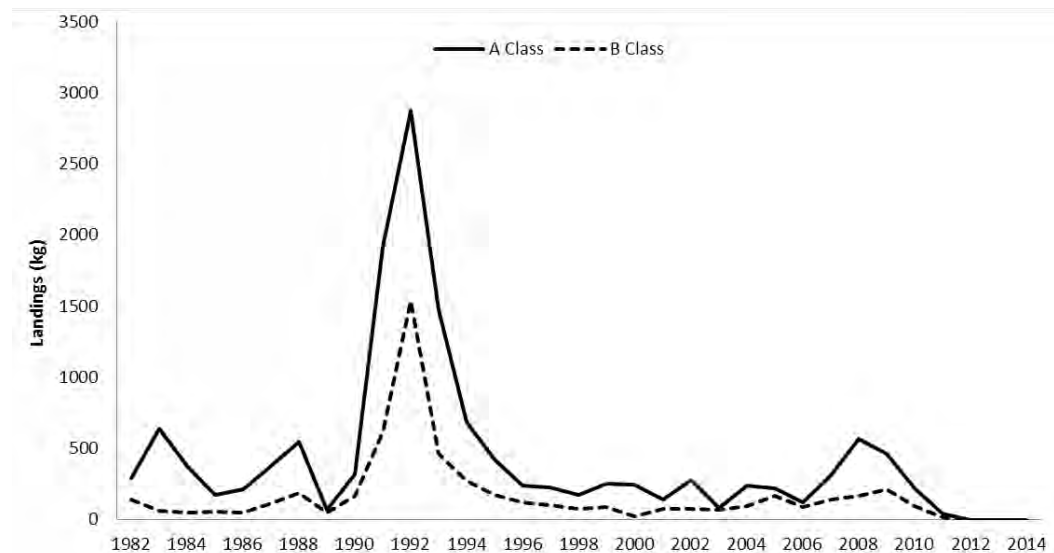
**SHARK BAY PRAWN AND SCALLOP FIGURE 2**

The main boundaries of the Shark Bay Scallop Managed Fishery permitted trawl area (extends out to the 200 m isobath).



**SHARK BAY PRAWN AND SCALLOP FIGURE 3**

Shark Bay Prawn Managed Fishery annual landings and effort (adjusted to twin gear units) 1962 – 2014.



**SHARK BAY PRAWN AND SCALLOP FIGURE 4**

Shark Bay Scallop Managed Fishery annual landings 1983 – 2014.

## Exmouth Gulf Prawn Managed Fishery Status Report

*E. Sporer, M. Kangas, S. Wilkin and N. Blay*

Main Features			
Status		Current prawn Landings	
Stock level	Adequate	Brown tiger	162 t
Fishing level	Acceptable	Western King	171 t
		Endeavours	101 t
		Banana	29 t

## Fishery Description

The Exmouth Gulf Prawn Managed Fishery uses low opening, otter prawn trawl systems within the sheltered waters of Exmouth Gulf to target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and banana prawns (*Penaeus merguensis*).

### Governing legislation/fishing authority

*Exmouth Gulf Prawn Managed Fishery Management Plan 1989*

Exmouth Gulf Prawn Managed Fishery Licence Exemptions under Section 7 of the Fish Resources Management Act 1994

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

### Consultation process

Meetings between the Department of Fisheries 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. These are designed to protect smaller prawns and allow access to the various target species, primarily brown tiger and western king prawns, at appropriate times.

### Boundaries

The main boundaries for the Exmouth Gulf Prawn Managed Fishery are shown in Exmouth Gulf Figure 1. This diagram outlines the boundaries of the fishery, the areas where trawling is permitted, the areas actually trawled in 2014, the Brown Tiger Prawn Spawning Area (TPSA) which is closed for part of the season, and the areas permanently closed to trawling.

### Management arrangements

Management of this fishery is based on input controls, including limited entry, seasonal and area openings and closures, moon closures and gear controls. Management arrangements are designed to keep fishing effort at levels that will maintain a sufficient spawning biomass of prawns (particularly brown tiger prawns). Within this fishery, effort is primarily controlled through the maximum headrope units (capacity of the fishery) and the duration of the season. The maximum headrope allocation for the fleet is set at 394.8 m (216 fathoms), which is a 10% reduction of the original headrope allocation since the change to the more efficient quad gear configuration was approved. This has resulted in a reduction in the number of boats with the headrope allocation being redistributed among the remaining boats. The reduction of boat numbers and overall net allocation has allowed industry to maximise economic efficiency, whilst maintaining stock sustainability. These measures will continue to be applied, while incorporating a flexible fishing regime to optimise size and value of prawns.

The process for in-season fishing area opening/closing is dynamic and involves real-time management between the

Department's Research Division and the industry. Opening and closing dates vary each year, depending on environmental conditions, moon phases and the results of fishery-independent pre-season surveys that provide a catch prediction. The Department's Vessel Monitoring System (VMS) monitors the activities of all boats during the season.

Bycatch reduction devices (BRDs) are mandatory in this fishery, with all boats required, by a condition on the managed fishery licences, to fish with a 'grid' and a secondary fish escape device (FED) fitted in each net. Industry, in association with the Department, successfully gained certification from the US Department of State in 2008 and was re-certified in 2012 and reviewed in 2014. This certification allows licensees to export product to the US market. A review of the conditions, of its BRD-compliance, for reducing the potential for turtle captures by the US Department of State was undertaken in 2014. Because of the increase in the size of the net headrope and the body of the net to accommodate the reduction of boat numbers (from 9 to 6) the actual size of the grids and the grid escape opening were required to be increased in line with the U.S standards. The grids are required to be modified by the commencement of the 2015 season. Since 2002 industry has also used 'hopper' in-water sorting systems which provide an improved quality of prawns and reduced mortality for some bycatch species.

The Commonwealth Government's Department of the Environment (DotE), assessed the fishery in 2015 under the provisions of the *Environmental Protection and Biodiversity Act 1999* (EPBC Act), and has accredited the fishery for a period of ten years (re-assessment in 2025), allowing product from the fishery to be exported from Australia. The comprehensive ESD assessment of this fishery made a number of recommendations that required management action to ensure adequate performance, including status of the target stock, listed species interaction and bycatch monitoring. Boxed text in this status report provides the annual assessment of performance measures/indicators related to these issues.

### Research summary

Research activities focus on stock assessment and surveys to monitor annual recruitment of prawns and spawning stock levels of brown tiger and western king prawns. The prawn season start date is set on the historical understanding of prawn biology and migration onto the trawl grounds, which includes consideration of the lunar phase. The objective of the start date is to protect small (pre-spawning) prawns and ensure flow-through to the breeding stock for sustainability purposes (particularly for protection of pre-spawning brown tiger prawns). When fishing actually commences, the extent of area to fish each season is based on pre-season and within season surveys. These surveys also provide prawn size structure information to assist with harvesting strategies (detailed above in the management arrangements) and understanding of prawn movement in this fishery. An annual catch prediction for both species is also provided using an index derived from the recruitment surveys and this catch prediction informs the level of overall fishing effort required to harvest the available catch in any year.

In 2014, three fishery-independent pre-season recruitment surveys were undertaken. These surveys showed low catch rates and small size prawns for both species, therefore, a follow up survey was undertaken in May and these results indicated that fishing could commence this month based on prawn size structure and catch rates obtained from the survey.

The stocks of western king prawns in Exmouth Gulf are assessed throughout each fishing season and at the end of each fishing season, noting that the annual assessments are based on all of the stock status information collected using fishery-dependent information throughout the year. Due to lower than target catch levels in some of the recent years, the status of the western king prawn stock has been more closely monitored to provide a better understanding of environmental factors influencing recruitment.

Monitoring of fishing activity is undertaken in real time and using target catch rates to determine the specific timing of the closure of the brown tiger prawn spawning area. All boats complete detailed daily logbooks, which, together with survey data and catch unload records, provide a major source of information for managing the fishery. The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing.

Funding has been obtained from Fisheries Research and Development Corporation for a three year project (commencing July 2015) to examine, through remote sampling methods, seagrass/algal habitats in Exmouth Gulf. These habitats are important brown tiger prawn nursery areas and which may have been affected by the heat wave in 2010/11 and subsequent higher than average water temperatures in 2012 and 2013.

## Retained Species

**Commercial production (season 2014): 463 tonnes**

### Landings

The total landings of major penaeids for the 2014 season were 463 t, comprising 162 t of brown tiger prawns, 171 t of western king prawns, 101 t of endeavour prawns and 29 t banana prawns (Exmouth Gulf Prawn Figure 2). The brown tiger prawn landings were well below the normal catch range (250-550 t). The trend in recovery is in line with past years when the brown tiger prawn stock declined but presently it is recovering from an unprecedented extremely low stock abundance level (46 t annual landings) in 2012 with a slight improvement of annual landing in 2013 (95 t).

The western king prawn landings were also well below the target catch range (350-500 t) and only half of that caught in 2013. The decline in the annual catches is mainly attributed to the environmental conditions.

Endeavour prawn landings were also below the normal catch range of 120-300 t but were an increase on the previous two years. Endeavour prawns are primarily caught incidentally when fishing brown tiger prawns and with lower targeted effort on brown tiger prawns, the low endeavor landings are expected. The banana prawn landings declined compared to 2013, but landings were within expectations for this species.

Recorded landings of byproduct were; 2 t of blue swimmer crab (*Portunus armatus*), 3 t of squid, 1 t of bugs (*Thenus australiensis*), 5 t of coral prawns, 2 t of cuttlefish and <1 t of

octopus. Landings of blue swimmer crabs were slightly below the historical range (8 to 58 t). The coral prawn catch was low and is primarily because coral prawn abundance was low in areas where they are normally taken in the northern part of the fishery. Crabs and other byproduct are taken incidentally and are variable depending on abundance available on the trawl grounds each year and the level of trawl effort.

### Fishing effort/access level

In recent seasons, management arrangements have provided for a fishing period of about 200 nights with a minimum of 28 non-fishing nights for moon closures during the period. For the 2014 season, official opening and closing dates were set at 1 April and 29 November, providing a maximum of 185 nights fishing. This is a flexible arrangement and the season actually commenced on 20 May based on results from pre-season surveys and fishing ceased 15 November, 5 days later than in 2013 for a total of 146 days fishing. There were spatio-temporal closures during the entire fishing season to avoid fishing on small prawns to maximise the value of the limited brown tiger and western king prawn stocks available in 2014.

In 2014 six boats operated towing a total of 292.6 m (160 fathoms) of net headrope, well below the maximum allocation of 395 metres (216 fathoms). There were two different net headrope sizes towed, four boats towing 10.97 m (6 fathom nets) and two boats towing 14.63 m (8 fathom nets).

Total nominal effort for the 2014 season was 9433 hours, slightly lower than 2013. The adjusted effort (to twin gear) in 2014 was 16,841 hours in 2014 which was the second lowest in 40 years (Exmouth Gulf Prawn Figure 2), and reflects the low prawn abundance. Generally the effort on western king prawns is targeted at the latter part of the season when their abundance peaks during late August to end September. Fishing effort normally continues into November, and also did in 2014 year mainly because of the late start to the season and low effort during the early part of the season shifting effort onto western king prawns in the latter part of the season.

## Stock Assessment

**Assessment complete:** Yes

**Assessment level and method:**

**Level 4 - Direct survey/catch rate**

**Breeding stock levels:** Adequate

**Projected catch next season (2015):**

**275 (220-330) tonnes brown tiger prawns**

**155 (125-185) tonnes western king prawns**

The stock status of brown tiger prawns and western king prawns in the EGPMF is assessed annually through monitoring of fishery-independent and fishery-dependent catch rates for the two species (used as indices of recruitment and spawning stock levels) relative to specified reference points. Each year, the total catch of each species is also compared to a target catch range calculated from catches

observed in the fishery during periods considered to be sustainable. The adjusted commercial catch per unit effort (CPUE) data from the fishery is an indicator of abundance, and can be used to monitor changes in stock levels from year to year.

#### **Catch assessment**

The preliminary adjusted annual catch rate of 9.6 kg/hr for brown tiger prawn was close to the reference catch rate of 10 kg/hr. This catch rate was maintained, however, by conservatively fishing brown tiger prawns. The likely cause of the continued low overall abundance (low recruitment levels) may be a result of three years of very high water temperatures since the marine heat wave in the summer of 2011 (highest observed in 2013) and its possible continued impact on the spawning stock and/or inshore structured habitats.

During 2014 not all of the Central area was open to fishing and fishing for brown tiger prawns was undertaken from 20 May, which was the commencement of the season, to 20 July after which the TPSA closed. There were five subsidiary openings in the Central area whilst the Eastern area remained closed for the entire season. The TPSA was re-opened to fishing for two periods, 2 to 4 August and 30 October to 13 November.

The mean adjusted catch rate of 10.1 kg/hr for western king prawns is slightly below the reference catch rate level of 11.7 kg/hr but effort was commensurate with the recruitment level maintaining overall catch rate at a reasonable levels.

Western king prawns were fished conservatively during the early part of the season and effort in the northern area (the main western king prawn fishing grounds) was focused mainly in the latter part of the season (after 1 July). Also when fishing commenced on the western king prawn grounds, areas where small-size prawns were located were closed to fishing to ensure that size and quality were maintained. Overall, fishing ceased in 2014 because of the fishing protocol set out in the season arrangements related to western king prawn size composition.

#### **Survey assessment**

The brown tiger and western king prawn stocks are assessed each year using standardised surveys, which permits variations to the management plan using flexible real-time arrangements within the season to optimise catch and size grades and ensure sustainability.

For brown tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are assessed against the spawning stock recruitment relationship. The catch prediction for brown tiger prawns is based on the relationship between recruitment survey indices (early and late March and early April) and the season's landings (April–November of the same year). The brown tiger prawn breeding stock levels are maintained at adequate levels by monitoring the brown tiger prawn commercial catch rates to cease fishing at levels that will maintain the survey spawning index above the target reference level. The harvest strategy provides a set of transparent and verifiable measures which one can and report on the performance of the fishery and demonstrate its sustainability. The present target reference point is 25 kg/hr based on 6-fathom nets in quad gear configuration (which is reduced to 19 kg/hr after 1 November).

Three brown tiger prawn recruitment surveys were carried out in March and April 2014. The survey indices provided brown tiger prawn catch prediction of 275 t (range of 220 to 330 t). For the 2014 season the annual total landings (162 t) were below the prediction range,

For the 2014 season it was difficult (as it was in 2012 and 2013) to monitor the brown tiger prawn catch rates because of the intermittent nature of fishing between the brown tiger prawn area and the northern western king prawn area as well as, the presence of banana prawns in the Central area which fishers targeted instead of brown tiger prawns. Also, the low number of boats (6) in the fishery does not provide a full coverage of all the fishing areas with only hot spots being primarily fished during low abundance years.

Three standardised brown tiger prawn breeding stock surveys are carried out in August, September and October each year. The 2014 survey results showed an average quad gear CPUE for all three surveys of 21.5 kg/hr and 33.7 kg/hr in the spawning areas (Q1 and Q2 respectively) with an overall mean catch rate of 27.6 kg/hr (Exmouth Gulf Prawn Figure 3). This is an increase on the spawning stock abundance observed in 2012 and 2013 and is well above the limit (10 kg/hr) and is slightly above the target level (25 kg/hr).

Western king prawn breeding stock levels in the fishery are maintained at adequate levels through controls on fishing effort. Western king prawns are regarded as having a lower risk for recruitment overfishing compared to brown tiger prawns. Furthermore, the species is widely dispersed and has significant unfishable (economically) populations in the general Exmouth area and has a history of recruitment being unaffected by the level of fishing. Within this broad distribution there are several areas (the "Gutters" area [trawl ground R1] and around Sunday Island [trawl ground S2]) where the offshore migration related to spawning results in the prawns accumulating in sufficient numbers to allow economically viable trawling. Adult densities decrease further offshore and decrease as the stock disperses over time. While these offshore areas do not have viable fishable abundances, these large areas in total, at low densities, are likely to hold a spawning biomass significantly larger than that which occurs in the main fishery.

Before fishing commences, the western king prawn stock status is also assessed on the basis of fishery-independent recruitment surveys. These surveys were undertaken in the northern part of the fishery and provided prawn size structure and abundance information. The combined pre-season surveys (March and April) provided a catch prediction of 125 t with a range between 100 and 150 t which was well below the target (historical) catch range.

Fishery-independent spawning stock surveys have not previously been undertaken specifically for the western king prawns and the mean commercial (fishery-dependent) catch rate of western king prawns in fishing grounds R1 and S1 during August and September is considered to represent an appropriate index of spawning stock abundance. These catch rates are derived from key western king prawn fishing grounds during the spring spawning period at a time when the fleet is focusing their fishing effort on western king prawns. This index is assessed annually, against reference points and in 2014 the mean western king prawn commercial catch rate was 31.6 kg/hr above the target level (25 kg/hr). In addition, in 2014 a fishery-independent survey of western king prawn

fishing grounds (in areas where historically most fishing effort for western king prawns has occurred) was undertaken the night after the entire fishery closed to fishing, to provide a measure of the remaining western king prawn spawning stock at the end of the key spawning period. It is planned to sample these sites in August, September and October to provide additional information to supplement the fishery-dependent catch rate information used for stock assessment and in the longer term may provide a fishery-independent spawning stock index for western king prawns. Towards the end of the season for western king prawns the cessation of fishing this species is based on size structure (i.e. to prevent fishing on new 0+ recruits).

There is no formal stock assessment for endeavour prawns whose distribution overlaps that of brown tiger prawns however, data on catch rates of endeavour prawns during fishery independent surveys are available and will be analysed in the future. Endeavour prawns - are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable brown tiger prawns. The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the brown tiger prawns and the brown tiger prawn closures also protect a significant portion of the endeavour prawn breeding stock each year. In addition, endeavour prawns are also considered to be more resilient to fishing pressure due to their smaller size and lower catchability and less targeting than the brown tiger and western king prawns.

*The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. The strategy for brown tiger prawns is to maintain the spawning biomass above the historically determined biological reference points with the present target of 25 kg/hr with a limit of 10 kg/hr. The mean brown tiger prawn spawning stock catch rate of 27.6 kg/hr was above the target level. The strategy for western prawns is to maintain the spawning biomass above mean historical commercial catch rates during August and September in key western king prawn fishing grounds with the present target of 25 kg/hr with a limit of 15 kg/hr. The mean western king prawn spawning stock catch rate of 31.6 kg/hr was above the target level. Stocks of western king prawns are also monitored using catch levels which were below the target catch range. However, there is a conservative harvesting strategy in place for this species. The lower banana prawn annual landings corresponded to the relatively low rainfall experienced by this region over the summer months.*

## Non-Retained Species

### **Bycatch species impact:** **Low**

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. All boats used hoppers (in-water catch sorting systems), which add another level of improvement for bycatch survival and product quality. Fishing effort in 2014 slightly decreased compared to the 2013 season and was the second lowest since 1970.

*The two performance measures for the fishery relate to (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). Analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort (with only six boats now operating) and implementation of BRDS in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.*

### **Listed species interaction:** **Low**

While listed 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 are now compulsory, which has largely eliminated the capture of any turtles or other large animals. In addition, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. There has been a focus on correct reporting of interactions with listed species by fishers. In 2014 twenty turtles (all unidentified) were reported as captured in nets and returned to the sea alive. Sixty sea snakes (unidentified) were reported as captured and fifty were reported as returned to the sea alive. Three sawfish were reported as captured one returned alive, two dead and one seahorse and one pipefish were reported as captured in nets.

## Ecosystem Effects

### **Food chain effects:** **Low**

Although the prawn species are managed to 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.

### **Habitat effects:** **Low**

Historically, the fishery has impacted on some shallow water areas (less than 12 m in depth) containing sponge habitats, but the refocusing of the fishery into deeper waters to take larger prawns since the early 1980s has reduced this interaction. The trawling effort is now focused in the deeper central and north-western sectors of Exmouth Gulf. Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of this particular trawl fishery and the very tight controls on effort indicate that its environmental effect is now likely to be low. The spatial extent of area fished in the previous three years has also been reduced with the area trawled below 25% of the fishery compared to around 30% in past years. There was some additional searching for western king prawns in the northern area to ensure that the western king prawns available were fished. Also more endeavour prawns migrated into the northern grounds. For these reasons there was a slight increase in the area trawled in 2014 compared to past three years.



*Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2014 the performance measure was met as the total area trawled, at approximately 302 square nautical miles (26.5%) per cent of Exmouth Gulf, was below the 40% level.*

## Social Effects

The estimated employment in the fishery for the year 2014 was 18 including skippers and other crew. Twenty three additional support staff are based in Exmouth Gulf and additional support staff in Fremantle for refitting of boats. Within the Exmouth area, the fishery is an important regional employers contributing to the economic viability of the Exmouth township.

## Economic Effects

### Estimated annual value of major prawns for 2014:

**Level 3 - \$5 - 10 million**  
**(\$6.1 million including byproduct)**

Ex-vessel prices for prawns vary, depending on the type and quality of product and the market forces operating at any one time. In this fishery there is a high degree of vertical integration, with the fishing company, which own the boats undertaking direct marketing of the product into overseas markets. For this reason, the prices quoted for prawns and byproduct are provided by the company based on an overall average price taking into account each grade abundance landed. The total estimated value of the fishery includes byproduct (\$6.1 million). Although there was a decline in the prawn total landings it was compensated by a slight increase in the prawn prices received in 2014 compared to 2013. It is, however, below the expected value of the fishery under normal environmental conditions. Estimated prices for prawns were as follows:

Western king prawns	\$14.45/kg
Brown tiger prawns	\$14.51/kg
Banana prawns	\$10.75/kg
Endeavour prawns	\$9.49/kg
Coral prawns	\$3.41/kg

## Fishery Governance

**Target catch range:** 721 – 1,410 tonnes

**Current fishing level:** Acceptable

Under current fishing effort levels, the target catch range for major penaeids is 721–1,410 t so the total catch of 463 t is below the range due to low recruitment this season. The long-term target catch ranges for individual species are western king prawns 350–500 t, brown tiger prawns 250–550 t,

endeavour prawns 120–300 t and banana prawns 1–60 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are generally based on a 10-year average (1989–1998). Brown tiger prawns and western king prawns were below their target range. Endeavour prawn landings were also below the target catch range, however, the effort in 2014 was very low. Banana prawn landings (29 t) were within the target catch range.

### New management initiatives (2015)

The fishery completed the Marine Stewardship Council pre-assessment during mid-2013 and underwent full assessment in 2014/15 which is scheduled for completion late-2015.

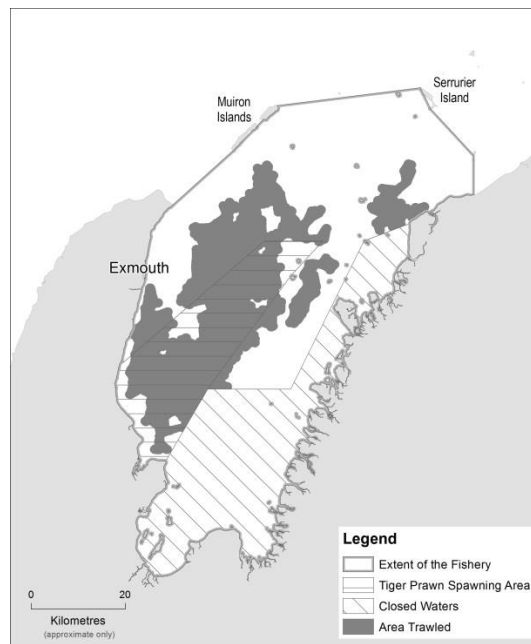
## External Factors

Increasing costs of fishing and lower returns due to the global economic climate and competition from imported and Australian aquacultured small prawns, has focussed fishing harvesting strategies about targeting larger prawns during efficient catch rate periods and shifting the emphasis to domestic markets, however, product to the export markets are maintained but at lower profit margins.

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Cyclone impacts can be either positive or negative. Early (December to January) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. The positive effect is that the water becomes turbid and prawn mortality reduces and prawns are triggered to move out into the trawl grounds. It is considered likely that there will be other environmental effects of cyclones, related to the destruction of shallow seagrass nursery areas. Other environmental factors such as water temperature, may also impact on recruit survival, but have yet to be fully investigated.

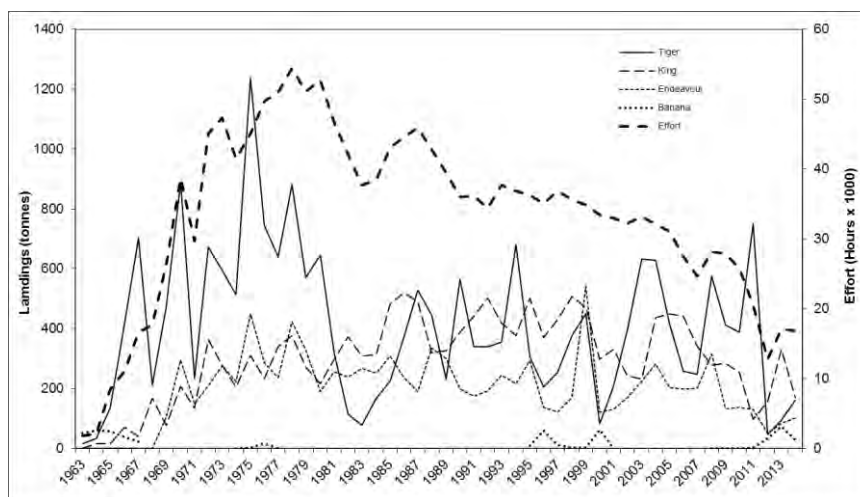
The heat wave event may have contributed to the recent extremes in abundance of brown tiger prawns in Exmouth Gulf. In 2011, the brown tiger prawn recruitment and landings were one of the highest recorded which led to a very high spawning stock abundance. However in 2012, the lowest recruitment was observed resulting in the lowest catch. This in turn has resulted in low spawning stock in 2012 although it is at levels that have historically resulted in moderate recruitment. In 2013 there was some improvement in recruitment. The cause of the low recruitment is being investigated in regard to sea temperatures and a project will commence in 2015 to further investigate impacts on inshore habitats.

Brown tiger prawns were ranked as a high risk to climate change effects and western king prawns as a medium-high risk so therefore both species need to be monitored closely.



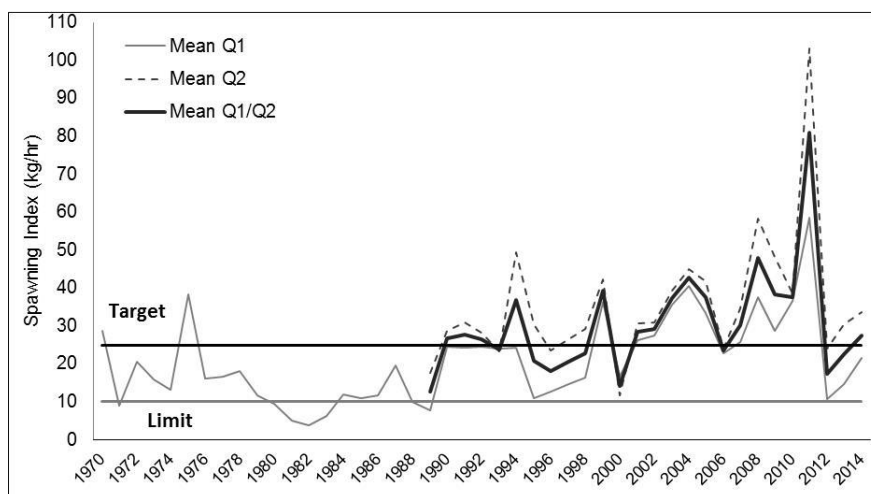
**EXMOUTH GULF PRAWN FIGURE 1**

The main boundaries of the Exmouth Gulf Prawn Fishery, extent of fishery closed waters, TPSA (Q1 and Q2), and area trawled in 2014.



**EXMOUTH GULF PRAWN FIGURE 2**

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear) 1963 – 2014.



**EXMOUTH GULF PRAWN FIGURE 3**

Exmouth Gulf Prawn Managed Fishery mean brown tiger prawn spawning stock index (kg/hr) in areas Q1 and Q2 relative to the target and limit reference points (25 and 10 kg/hr respectively) between August and October 1970 – 2014. Note that prior to 1989 the mean value reflects the catch rates in area Q1 only.

# West Coast<sup>1</sup> Deep Sea Crustacean Managed Fishery Status Report

*J. How and K. Nardi*

## Main Features

Status		Current Landings	
Stock level	Adequate	Crystal Crabs	140 t
Fishing Level	Acceptable	Giant Crabs	1.5 t

## Fishery Description

The West Coast Deep Sea Crustacean Managed Fishery targets Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the shelf edge waters (>150m) of the West Coast and Gascoyne Bioregions.

### Governing legislation/fishing authority

*West Coast Deep Sea Crustacean Managed Fishery Management Plan 2012*

West Coast Deep Sea Crustacean Managed Fishery Licence

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

### Consultation process

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

### Boundaries

The boundaries of this fishery include all the waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone.

### Management arrangements

The West Coast Deep Sea Crustacean Managed Fishery is a quota-based 'pot' fishery. The fishery mostly operates in depths of 500-800 metres, with the only allowable method for capture being baited pots ('traps'). These are operated in 'long-lines', which have between 80 and 180 pots attached to a main line marked by a float at each end.

The Department of Fisheries has minimum size limit and specific regulations to protect breeding females (berried

females must not be retained). A minimum carapace length of 120 mm applies for the principal target species Crystal Crab, and 92 and 140 mm carapace minimum lengths applying respectively for the lesser targeted species-Champagne and Giant crabs.

The fishery transitioned from an interim managed fishery to a managed fishery on 1 January 2013. Within the new management plan, there was unitisation of the licences (which replaced permits in the previous interim management plan). Unitisation allowed greater transfer of units between licence holders. Catch of Giant and Champagne crabs were previously retained as 'byproduct' of a permit. They are now unitised as "B" class units which allowed these to be transferred onto a single licence to permit these species to be specifically targeted while still retaining a "B" class quota of 14 t.

### Research summary

Research for this fishery has involved assessing the current status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch. The annual total Crystal crab catch from 2000 to 2008 have been historically used to monitor this fishery for ecologically sustainable development assessment. However, since the quota system has come into operation in 2008, performance measures are now based on whether the quota is achieved and the standardised catch rate used to achieve quota.

A recent assessment of the fishery for Marine Stewardship Certification has been the focus of the research for this fishery. It has resulted in the development of a harvest strategy and control rules framework, and a re-assessment of the model for standardisation of the catch rates. There has also been considerable work undertaken to gain a better understanding of the catches, particularly undersize and berried females, which are currently estimates by fishers recorded through the volunteer logbook program. This assessment includes remote video / on-board monitoring and industry catch sampling. All methods are currently being assessed for future monitoring protocols.

<sup>1</sup> Note: This is the official name of the fishery. Boundaries include Gascoyne, see above.

## Retained Species

### Commercial landings (season 2014):

<b>Crystal crab</b>	<b>139.8 tonnes</b>
<b>Giant crab</b>	<b>1.5 tonnes</b>
<b>Champagne crab</b>	<b>&lt;0.1 tonnes</b>

The catch of 139.8 tonnes of Crystal crab in 2014 was similar to all years since the introduction of 140 t. quota in 2008 (Deep Sea Crab Figure 1). There was a small catch of 'B' class quota (Champagne or Giant crab). The very small Champagne crab catch is due to low market demand, with the majority of "B" class quota being some targeted fishing for Giant crabs. The catch of Giant crabs above the threshold level of 0.8 t has resulted in a review of the management arrangements for this species. The catch records are based on mandatory monthly catch and effort returns prior to 2008, with the more accurate trip catch disposal records from 2008 onwards.

**Recreational catch estimate (season 2014)** Nil

### Fishing effort/access level

Nominal commercial effort increased by 4 % from an estimated 53,178 pot lifts in the 2013 season to 55,203 pot lifts in the 2014 season. The standardised commercial effort similarly increase from 58,341 pot lifts in the 2013 season to 60,669 pot lifts for the 2014 season, a 4% increase. The catch of the fishery (see above) is divided by the average logbook catch rates to provide an estimate of nominal effort for the fishery and the standardised catch rate for the standardised effort.

## Stock Assessment

**Assessment complete** Yes

**Assessment level and method:** Level 2 - Catch rate

**Breeding stock levels** Adequate

The fishery effectively achieved the quota for crystal crabs with landings of 139.8 t, which is within the target catch range (90% of the TAC; 126-140 t). The standardised catch rate of legal crabs decreased by 3% in 2014 to 2.31 kg/pot compared with 2.39 kg/pot in 2013 (Deep Sea Crab Figure 2). The 2013 standardised catch rate represented the highest in a decade (Deep Sea Crab Figure 2), and the 2014 value is above the threshold reference point with a large degree of certainty.

Crystal crabs are known to be very slow growing as are most other deep-water species. Preliminary estimates suggest that the males attain maturity at around 12 years and reach legal minimum size at about 14 years. Ageing estimates are not available for females, but size at maturity information shows that they mature well below the legal size limit and probably moult once after reaching maturity, which means that their contribution to the fished biomass is small and that egg production in the fishery is well protected by the legal size limit provided that there are sufficient males. There is a current FRDC project which is attempting to directly age

crystal crabs, and will provide more information on crystal crab age and growth.

The standardised catch rate of berried female crystal crabs has remained relatively stable since 2003, noting fluctuations from 2009 to 2012 (Deep Sea Crab Figure 3a). Over the last three seasons the standardised catch rate of berried female crabs has regained stability, ranging from a high of 3.46 (in 2012) to 3.08 berried female crabs in 2014. This catch rate is still well above the threshold reference point of 1.74 (Deep Sea Crab Figure 3a).

There was a progressive decline in the standardised catch rate of undersized crabs with the catch rate reaching a low in 2010. Since then the standardised catch rate has increased and in 2014, the level is above the threshold level (Deep Sea Crab Figure 3b).

*The performance measures for the fishery are that: a) quota has been achieved (>90% TAC caught), b) the standardised catch rate of legally-retainable crabs is within the target range; and c) the standardised catch rates of sublegal crabs and berried females are above the threshold levels. All of these measures were met.*

## Non-Retained Species

The fishery is undergoing a Marine Stewardship Certification assessment, and all aspects associated with non-retained species were scored such that they pose little or no effect on the bycatch or listed species.

**Bycatch species impact** Low

The gear used in this fishery generates minimal bycatch and the design of the pots is such that they do not 'ghost fish' if lost.

**Listed species interaction** Negligible

The pots and ropes used in crab longlines have minimal capacity to interact with listed species in this fishing area. One humpback whale was entangled in deep sea crustacean gear in 2014, and was successfully disentangled and released. This is the first recorded interaction with a cetacean in this fishery since records began in 1990

*The performance measures for the fishery are that: a) Less than three interactions with any particular ETP species in a year; and b) Fishing impacts are considered to generate an acceptable level of risk to all ETP species' populations, i.e. moderate risk or lower. Both of the measures were met.*

## Ecosystem Effects

The fishery is undergoing a Marine Stewardship Certification assessment, and all aspects associated with ecosystem effects were scored such that they pose little-no effect on the ecosystem.

**Food chain effects**

**Negligible**

Total landings of the 3 species of deep sea crabs represent a very small biomass, and any impact of fishing on the general food chain is expected to be minimal. Most of the commercial crystal crab catch is taken in depths between 500 to 800 metres. An estimate of the amount of ground between 500–1,000 m over the distributional range of Crystal crabs is about 50,600 km<sup>2</sup>. Assuming that all the ground is equally productive, at catch levels experienced in the past seasons about 3 kilograms of crabs are being removed each year per square kilometre of ground.

*The performance measures for the fishery are that: a) Fishing impacts are considered to generate an acceptable level of risk to ecological processes within the ecosystem, i.e. moderate risk or lower; and b) Fishing impacts on each ecological resource / asset impacts are considered to generate an acceptable level of risk, i.e. moderate risk or lower. Both of the measures were met.*

**Habitat effects**

**Low**

Crab potting is considered to have a low impact on the largely soft mud habitat over which the fishery operates. Effort levels and the spatial extent of fishing remain well below historical levels, indicating any impact, however small, has further reduced

*The performance measures for the fishery are that: a) The area fished is ≤ 113 (10' x 10') blocks; and b) Fishing effort is ≤ 169 000 trap lifts. Both of the measures were met.*

**Social Effects**

This fishery is based on mobile vessels that employ a skipper and two or three crew. The product is landed live at ports between Carnarvon and Fremantle, generating some

additional economic activity and benefits. There were three vessels operating in 2014.

**Economic Effects**

**Estimated annual value (to fishers) for 2014**

**Level 2 - \$1 - 5 million (\$3.1 million)**

The beach value of the fishery was about \$3.1 million in 2014 with the majority of the catch sold live to Asian markets both locally and internationally.

**Fishery Governance**

**Target catch range** **126-140 tonnes**  
**Standardised Catch Rate** **1.34-2.54 kg / pot lifts**  
**Current fishing (or effort) level** **Acceptable**

A harvest strategy which was adopted by industry resulted in a formalisation of reference levels for a range of performance measures including those associated with stock assessment.

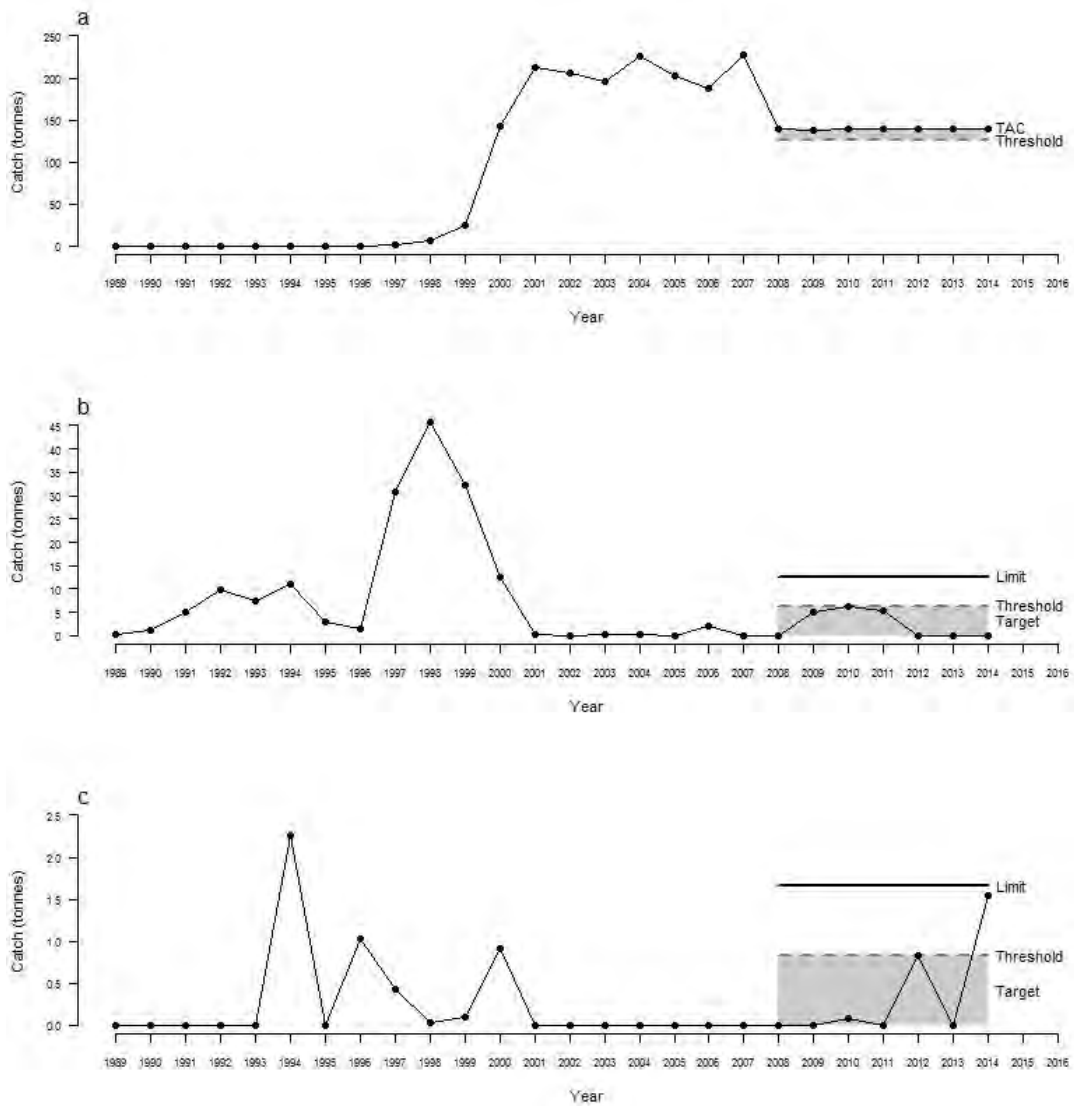
**New management initiatives (2015)**

The *West Coast Deep Sea Crustacean Managed Fishery Management Plan 2012* will be amended during 2015, to increase the annual Total Allowable Catch (TAC) for Crystal Crab by 14 tonnes, to 154 tonnes.

**External Factors**

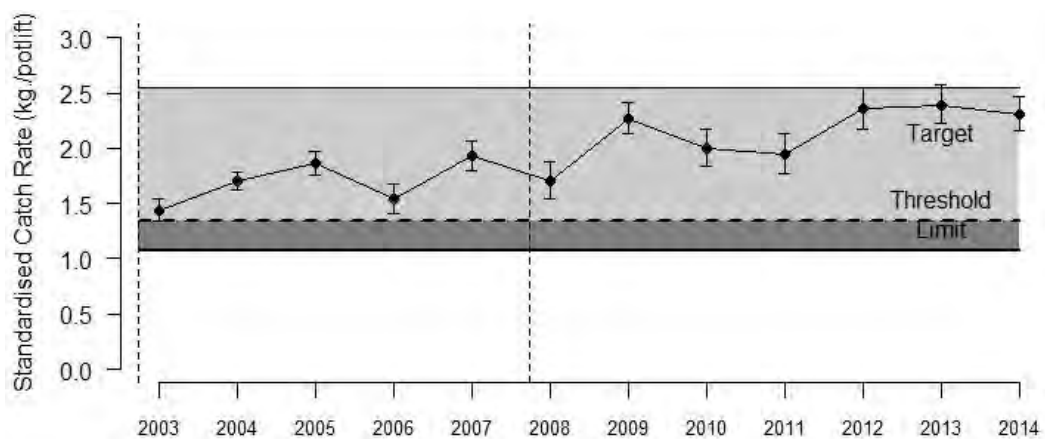
Given product is exported; fluctuation in the Australian dollar can have impacts on the economic performance of the fishery.

The fishery is thought to be relatively robust to environmental change due to the depth of fishing operations.



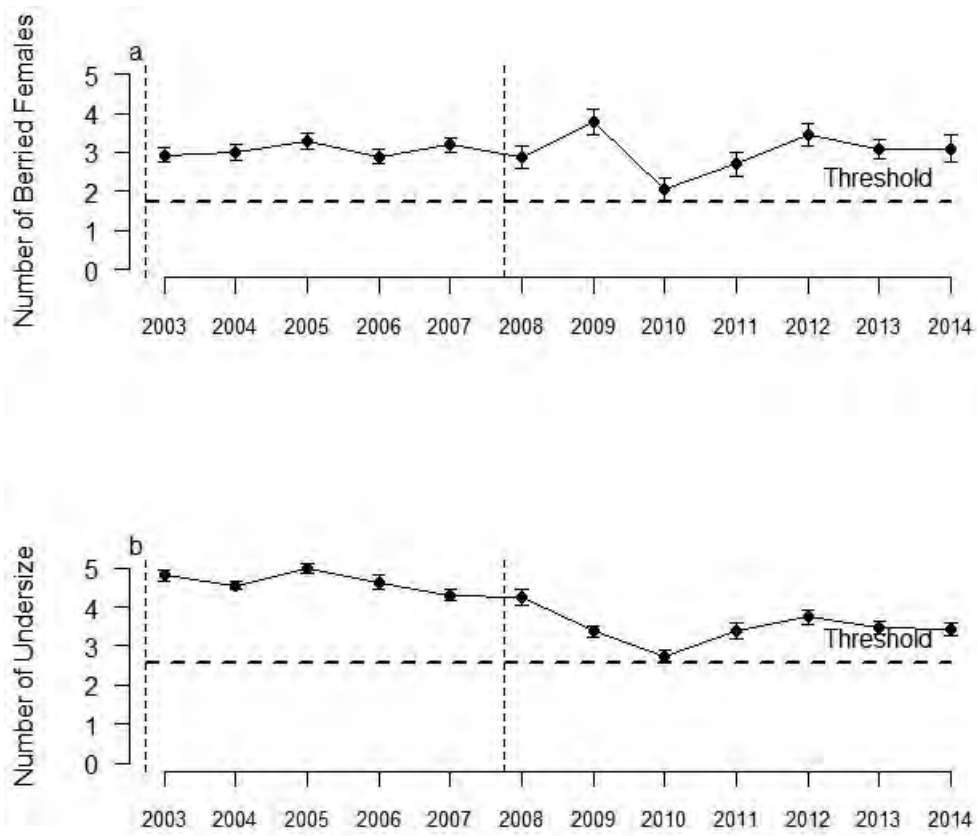
**WEST COAST DEEP SEA CRUSTACEAN FIGURE 1**

Annual catches of a) crystal b) champagne and c) giant crabs since 1989. Target regions (grey), threshold (dotted) and limit (solid line) are indicated for each species



**WEST COAST DEEP SEA CRUSTACEAN FIGURE 2**

Standardised catch per unit effort ( $\pm 95\text{CI}$ ) since 2003 for crystal crabs. Area between vertical dashed lines indicate period when management required fishing in all zones. Horizontal lines represent the threshold (dashed heavy line) and limit (solid heavy line) reference points for crystal crabs in the fishery. The target standardised catch rate area is denoted by the light grey filled area. The method of standardizing catch rates was revised this year which has resulted in minor changes to the annual values.



**WEST COAST DEEP SEA CRUSTACEAN FIGURE 3**

Standardised catch per unit effort (±95CI) since 2003 for a) berried and b) undersized crystal crabs relative to their respective threshold reference point.

## Gascoyne Demersal Scalefish Fishery Status Report

*G. Jackson, S.J. Newman, S. Turner and H. Zilles*

Main Features			
Status		Current Landings (2014)	
Stock level		Pink snapper:	
Pink snapper	Adequate	Commercial	240 t
Goldband snapper	Adequate	Recreational	21 t
Spangled emperor	Adequate	Charter	11 t
Fishing Level		Goldband snapper:	
Pink snapper	Acceptable	Commercial	54 t
Goldband snapper	Acceptable	Recreational	15 t
Spangled emperor		Charter	8 t
	North Gascoyne - Unacceptable	Spangled emperor:	
	South Gascoyne - Acceptable	Commercial	2 t
		Recreational	17 t
		Charter	4 t

## Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational (line) fishing for demersal scalefish in the continental shelf waters of the Gascoyne Coast Bioregion (Gascoyne Demersal Scalefish Fishery Figure 1).

Since 1 November 2010, the Gascoyne Demersal Scalefish Managed Fishery (GDSF) has incorporated the pre-existing pink snapper quota system from the Shark Bay Snapper Managed Fishery (SBSF) plus the previously open access area south of Coral Bay.

Commercial vessels in these waters historically focussed on the oceanic stock of pink snapper (*Chrysophrys auratus*) during the winter months. The GDSF licensed vessels fish throughout the year with mechanised handlines and, in addition to pink snapper, catch a range of other demersal species including goldband snapper (*Pristipomoides multidens*), rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Epinephelidae including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).

A limited number of licensed charter vessels and a large number of recreational vessels fish out of Denham, Carnarvon and around the Ningaloo area (Gnaraloo Bay, Coral Bay, Tantabiddi and Exmouth) and catch a similar range of demersal species.

### Governing legislation/fishing authority

#### Commercial

*Gascoyne Demersal Scalefish Management Plan 2010*

Gascoyne Demersal Scalefish Managed Fishery Licence

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

#### Recreational

*Fish Resources Management Act 1994*, *Fish Resources Management Regulations 1995* and subsidiary legislation

### Consultation process

#### Commercial

The Department undertakes consultation directly with licensees on operational issues. Industry Annual General 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 facilitated by Recfishwest under a Service Level Agreement although the Department undertakes direct consultation with the community on specific issues.

### Boundaries

#### Commercial

The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S (Gascoyne Demersal Scalefish Fishery Figure 1). GDSF vessels are not permitted to fish in inner Shark Bay. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'30"S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels to operate in Gascoyne waters up to the southern boundary of the GDSF (26°30'S).

#### Recreational (including Charter)

The recreational fishery (which includes activities by licensed charter vessels) operates in all Gascoyne waters with the exception of Sanctuary Zones, Marine Nature Reserves and Conservation Areas within the Ningaloo and Shark Bay Marine Parks.

### Management arrangements

#### Commercial

The *Gascoyne Demersal Scalefish Management Plan 2010* (the Plan) was implemented on 1 November 2010. The Plan superseded the *Shark Bay Snapper Management Plan 1994* and provides a more effective management framework for the sustainable use of all demersal scalefish stocks in the Gascoyne Coast Bioregion. The 'open-access' wetline fishing operations that were previously undertaken in waters between 23°34'S and 23°07'30"S (Gascoyne Demersal Scalefish Fishery Figure 1) are also incorporated within the Plan (see Fisheries Management Paper No. 224 for further details).

Pink snapper within the GDSF are managed through the use of output controls based on an Individual Transferable Quota system. The 'quota-year' for pink snapper runs from 1 September to 31 August, with a total of 5,142 units in the fishery. There is a requirement to hold a minimum of 100 units of pink snapper entitlement to be able to operate within the fishery. This requirement was carried over from the *Shark Bay Snapper Management Plan 1994*.

Demersal scalefish other than pink snapper are currently managed using an interim effort cap of 30 fishing days per 100 units of pink snapper quota which restricts total fishing effort and is applied as a non-transferable licence condition. A dedicated non pink snapper demersal scalefish entitlement system is being developed by the Department in consultation with WAFIC and licensees.

An Environmental Protection and Biodiversity Conservation Act (EPBC Act) assessment for the SBSF was first completed in 2003, and the fishery was re-accredited in 2009 for a further 5 years (next scheduled review will be in late 2015). This fishery underwent Marine Stewardship Council (MSC) pre-assessment in 2013.

Minimum legal lengths apply to many of the commercial target species (e.g. pink snapper, red emperor and emperors).

#### Recreational (including Charter)

The recreational fishery (including charter vessels) is managed using maximum and minimum legal lengths, daily



bag and possession limits, and limitations on the use of certain fishing gears. Daily bag limits in the Gascoyne were revised in 2013 as a result of a statewide recreational fishing review which was designed to simplify recreational fishing rules across the state. Key changes included the introduction of a mix species bag limit of five demersal finfish as well as limits for individual species that include: three pink snapper; three cods; three emperors and one coral trout. Recreational fishers can no longer transport fish by unaccompanied means (e.g. courier).

All persons fishing from a powered boat anywhere in the state are required to hold a Recreational Fishing from Boat Licence or fish in the company of a licence holder.

**Research summary**

Catch and effort monitoring for this fishery includes analyses of commercial ‘daily/trip’ returns for GDSF licensed vessels, catch-disposal records (only for pink snapper, to monitor individual quotas), ‘monthly’ catch and effort returns for charter vessels, and various recreational survey data.

The commercial catch and effort data reported here are for GDSF licensed vessels fishing between 23°07’30”S and 26°30’S. The reporting period used for commercial catches is the 2013-14 licence period for the GDSF, i.e. 1 September 2013 – 31 August 2014 (referred to as ‘season 2014’). Charter catches are reported for the calendar year. For recreational fishing, the most recent catch estimates for goldband snapper and spangled emperor were derived from data obtained from the second statewide integrated survey of recreational boat-based fishing undertaken between 1 May 2013 and 30 April 2014 (Ryan *et al.* 2015)<sup>1</sup>. Because the integrated surveys only provide Bioregional-level catch estimates, the catch estimates for pink snapper are also informed based on the second Gascoyne wide boat-fishing survey (based on boat ramp interviews) that was undertaken between April 2007 and March 2008 (Marriott *et al.* 2012)<sup>2</sup>.

Research undertaken by the Department of Fisheries on the retained species in each Bioregion is focussed on selected indicator species. In the Gascoyne Coast Bioregion, pink snapper, goldband snapper and spangled emperor are the indicator species for the inshore demersal suite with ruby snapper and eightbar grouper (*Epinephelus octofasciatus*) the indicator species for the offshore demersal suite (DoF 2011<sup>3</sup>).

**Pink snapper:** Detailed research on the oceanic snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. Commercial catches are sampled throughout the year to provide representative catch-at-age data. An integrated stock assessment model has been used to determine stock status since 2003 and is updated every 3 years (most recently in 2014).

**Goldband snapper:** Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. Goldband snapper in

the Gascoyne Coast Bioregion are managed as a single biological stock (there are separate biological stocks in each of three management regions in Western Australia (Kimberley, Pilbara and Gascoyne)). Marriott *et al.* (2012) assessed the stock status of the Gascoyne biological stock of goldband snapper based on a ‘weight of evidence’ assessment approach that included deriving estimates of fishing mortality from catch curve analysis from representative samples of the age structure from the GDSF. These fishing mortality-based assessments use reference levels that are based on ratios of natural mortality for each species, such that  $F_{target} = 2/3M$ ,  $F_{threshold} = M$  and  $F_{limit} = 3/2M$ . The fishing mortality-based assessments indicated that the estimated fishing level on goldband snapper in this biological stock was below the target level in 2006 and 2008. This indicates that fishing is not having an unacceptable impact on the age structure of the population. The biological stock is not considered to be recruitment overfished (Marriott *et al.* 2012). Monitoring of catches from the commercial, recreational and charter sectors and population age structure is on-going and further research is planned to refine estimates of the key biological parameters.

**Spangled emperor:** Comprehensive research on spangled emperor commenced in 2007 also as part of the Gascoyne IFM project. Spangled emperor in the Gascoyne Coast Bioregion is managed as a single biological stock. Marriott *et al.* (2012) assessed the stock status of spangled emperor in the Gascoyne Bioregion on a ‘weight of evidence’ assessment approach that included deriving estimates of fishing mortality from catch curve analysis from representative samples of the age structure from two areas (North and South Gascoyne). In addition to the monitoring of commercial, recreational and charter catches, limited biological monitoring of recreational catches landed at fishing tournaments and public fish cleaning stations for this species is on-going.

**Retained Species**

**Commercial landings (season 2014):**

<b>Total</b>	<b>373 tonnes</b>
<b>Pink snapper</b>	<b>240 tonnes</b>
<b>Goldband snapper</b>	<b>54 tonnes</b>
<b>Spangled emperor</b>	<b>2 tonnes</b>
<b>Other species</b>	<b>77 tonnes</b>

The total commercial catch taken by the GDSF in the 2014 season was 373 t which is similar to the catch level in 2013 (Gascoyne Demersal Scalefish Fishery Figure 2). The catch comprised 240 t of pink snapper (oceanic stock, TACC = 277 t), plus 133 t of other species including 54 t of goldband snapper, 2 t of spangled emperor and 77 t of other scalefish species (Gascoyne Demersal Scalefish Table 1).

**Recreational catch estimate (includes charter sector):**

<b>Pink snapper</b>	<b>ca. 30 tonnes</b>
<b>Goldband snapper</b>	<b>ca. 25 tonnes</b>
<b>Spangled emperor</b>	<b>ca. 20 tonnes</b>

1 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

2 Marriott *et al.* (2012). Biology and stock status of demersal indicator species in the Gascoyne Coast Bioregion. Fisheries Research Report No. 228, Department of Fisheries, Western Australia, Perth.

3 DOF (2011). Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85, Department of Fisheries, Perth.

In 2014 the recreational catch of pink snapper (oceanic stock) reported by licensed charter boats was 11 t (same as in 2013). In 2013/14, an estimated 21 t (se 2.3 t) of pink snapper (oceanic stock) was taken by boat-based recreational fishers in Gascoyne waters (excluding inner gulfs of Shark Bay). The total catch of this stock of pink snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 30 tonnes.

The recreational catch of goldband snapper reported by charter boats in 2014 was 8 t (same as in 2013). The recreational catch of goldband snapper in 2013/14 is estimated to have been 14.7 t (se 3.7). The total catch of goldband snapper taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 25 tonnes.

The recreational catch of spangled emperor reported by charter boats in 2014 was 4 t (same as in 2013). The recreational catch of spangled emperor in 2013/14 is estimated to have been 16.8 t (se 2.4). The total catch of spangled emperor taken by recreational and charter vessels in the Gascoyne is therefore assumed to be approximately 20 tonnes.

**Fishing effort/access level**

**Commercial**

There were 55 licences with pink snapper quota in the 2014 season with 17 vessels actively fishing (16 in 2013). These vessels (all are required to hold a minimum of 100 units of pink snapper quota to be able to operate in the waters of the GDSF) fished for a total of 729 days (748 days in 2013). The level of overall effort in this fishery is the lowest on record and approximately 50% of that in the early 2000s (Gascoyne Demersal Scalefish Fishery Figure 2). The level of effort targeted at pink snapper varies on a seasonal basis, historically peaking in June–July, when the oceanic stock aggregates to spawn. Pink snapper catch rates are assessed annually using ‘standard boat days’, i.e. days fished by quota-holding vessels that caught more than 4 t each of pink snapper by line during the period June–July. GDSF vessels fished for 195 boat days during June–July in 2014 (was 181 in 2013).

**Recreational**

Total recreational boat fishing effort across the entire Gascoyne between 1 May 2013 and 30 April 2014 was estimated at approximately 54,000 fisher days (equates to approximately 212,000 hours fished) (Ryan *et al.*, 2015).

**Stock Assessment**

**Assessment complete:**

<b>Pink snapper</b>	<b>Yes</b>
<b>Goldband snapper</b>	<b>Yes</b>
<b>Spangled emperor</b>	<b>Yes</b>

**Assessment level and method:**

<b>Pink snapper</b>	<b>Level 2 - Catch Rates (annual)</b>
	<b>Level 5 - Composite Assessment (2013)</b>
<b>Goldband snapper</b>	<b>Level 1 - Catch (annual)</b>

**Level 3 - Fishing Mortality (2007/08)**

**Spangled emperor** **Level 1 - Catch (annual)**

**Level 3 - Fishing Mortality (2007/08)**

**Breeding stock levels:**

<b>Pink snapper</b>	<b>Adequate</b>
<b>Goldband snapper</b>	<b>Adequate</b>
<b>Spangled emperor</b>	<b>Adequate</b>

**Pink snapper:** An integrated stock assessment model was developed for this stock in 2003 and indicated that the spawning biomass of the oceanic stock was at a depleted level (< target level in 2002-2003). The most recent assessment using this method (completed in 2014) indicated that the spawning biomass in 2013 was above the threshold level (30% of the unexploited spawning biomass) and just below the target level (40% of the unexploited spawning biomass).

Prior to the development of the integrated assessment model, the breeding stock was assessed using a pink snapper annual threshold catch rate based on catch and effort information from the peak of the spawning season (June–July). It is recognised that the use of catch rate as an index of pink snapper abundance must be treated with caution, due to the aggregating behaviour of the stock during the winter spawning period.

This indicator was used in the original EPBC Act assessment of the SBSF with an inaugural threshold level set at a minimum of 500 kg pink snapper/standard boat day. Since the reductions in quota were implemented in the mid-2000s, the pink snapper catch rate (GDSF vessels fishing in June–July only) has fluctuated around 550 kg/day. In the 2014 season, the pink snapper catch rate was 658 kg pink snapper/standard boat day (Gascoyne Demersal Scalefish Fishery Figure 3) (see also box below).

*The current performance measure for the Gascoyne Demersal Scalefish Fishery is that the pink snapper catch rate for the peak months (June–July) should not fall below a minimum threshold level of 500 kg pink snapper/standard boat day.*

*The catch rates in the early 2000s declined to a low of 450 kg pink snapper/standard boat day. After the TACC was reduced significantly in 2004 and again in 2007, catch rates have increased to an average value of about 550 kg/day. In 2014, the catch rate at 658 kg pink snapper/standard boat, while slightly lower than in 2013, remained well above the threshold and at the highest levels not seen since the late 1990s.*

**Goldband snapper:** Historical monthly catch rate data from the SBSF cannot be used as an index of relative abundance for this species. Several more years of daily trip logbook data (implemented in January 2008) will provide the minimum basis of a time series of catch rates for examining trends in relative stock biomass. A research project is underway to evaluate daily catch rate data for pink snapper and goldband snapper. A risk-based ‘weight of evidence’ approach, based on an assessment of fishing mortality (*F*), has been used to assess the stock. Sufficient data from

sampling the commercial fishing catches in both the 2006 and 2008 quota years were available for this analysis. Estimates of *F* for both years were within the target range, indicating that fishing was not having an unacceptable impact on the age structure of the population at that time. As the commercial targeting of goldband snapper has only occurred since ca. 2000, the flow through effects of these catches to its sampled population age structures used for 2008 stock assessments many not have been detectable. Therefore, ongoing monitoring was advised to confirm this low risk profile.

The total goldband snapper catch in 2014 remained below the preliminary maximum commercial catch limit recommended for this species in the Gascoyne Coast Bioregion (100-120 t, see Marriott *et al.* (2012) for details). Breeding stock levels and fishing level are currently assessed as adequate.

**Spangled emperor:** Historical monthly commercial catch rate data for spangled emperor cannot be used as an index of abundance because the species has never been consistently targeted by commercial vessels. A risk-based ‘weight of evidence’ approach, based on an assessment of fishing mortality, was used to assess stock status based on data collected primarily in 2007. Estimates of fishing mortality (*F*) indicated that in the South Gascoyne, *F* was close to the target level while in the North Gascoyne, *F* was above the limit level, suggesting that localised over-fishing was occurring north of Point Maud. Relatively few individual spangled emperor older than 10 years old were sampled from the North Gascoyne in 2007, indicating that older fish had been removed by fishing, at least from areas outside of sanctuary zones of the Ningaloo Marine Park. That *F* exceeded the limit level indicated that the current level of fishing on the spangled emperor population in the North Gascoyne exceeded sustainable levels and were higher than from a previous assessment done in 1989-91 (Moran *et al.* 1993<sup>1</sup>). The spangled emperor breeding stock was estimated to be at an acceptable level for the Bioregion overall noting significant reductions in the relative numbers of older (breeding age) spangled emperor in the North Gascoyne due to localised depletions (see Marriott *et al.* (2012) for further details). A reduction in the Bioregion-wide catch for this species in 2013/14 (21% less than estimated in 2011/12) is expected to increase levels of spawning biomass and assist in reducing *F*. There is a need for an updated assessment of spangled emperor in the North Gascoyne.

## Non-Retained Species

### Bycatch species impact Negligible

The commercial catch consists of a large number of demersal species of medium to high market value; therefore there are few species captured by the fishery that are not retained.

Commercial operators must return any sharks caught and are not permitted to use wire trace, in order to minimise interactions with sharks.

### Listed species interaction Negligible

As line fishing is highly selective, interactions with listed species by commercial, charter and recreational fishers in the GDSF are low. Commercial GDSF and charter fishers are required to record all listed species interactions in their logbooks. During 2014, commercial fishers in the GDSF reported no interactions with listed species. No interactions were reported in 2014 by the charter fishery in the Gascoyne Coast Bioregion.

## Ecosystem Effects

### Food chain effects Low

Pink snapper and other species in this suite are generalist feeders and are just some of a number of such species inhabiting the continental shelf waters in this Bioregion. Food chain effects due to fishing for species within this suite are considered to be low because the quota system restricts overall GDSF catches to a relatively small percentage of the total biomass. The juvenile components of these stocks are likely subject to large, mostly-environmentally driven fluctuations in abundance even in the absence of fishing, resulting in significant variability in annual recruitment strength. A study by Hall and Wise (2011)<sup>2</sup> of finfish community structure in this Bioregion found no evidence of material changes.

### Habitat effects Negligible

The nature of the fishery, targeting aggregations of adult pink snapper and other demersal scalefish using hooks and lines, means that the commercial fishery has virtually no direct impact on benthic habitats.

## Social Effects

The pattern of fishing by GDSF vessels in 2014 was similar to previous years and reflects the focus on pink snapper during the peak season and fishing in deeper waters offshore for other species at other times of the year.

In 2014, 17 vessels fished during the entire season, 10 of which fished for more than 10 days during the peak season, typically with a crew of 2-3. Commercial fishing and associated fish processing are important sources of local employment in Denham and Carnarvon.

Shark Bay and Ningaloo are popular recreational fishing destinations and both locations are major tourist attractions especially during the winter months and school holidays.

## Economic Effects

### Estimated annual value (commercial sector) for

**2013:** **Level 2 - \$1 - 5 million**

The gross value of production (GVP) of the commercial component of the Gascoyne Demersal Scalefish Fishery was

1 Moran, M. Edmonds, J., Jenke, J., Cassels, G. & Burton, C. (1993). Fisheries biology of emperors (Lethrinidae) in North-West Australian coastal waters. FRDC Project 89/20 Final Report. Department of Fisheries, Western Australia.

2 Hall, N.G. & Wise, B.S. (2011). Development of an ecosystem approach to the monitoring and management of Western Australian fisheries FRDC Report 2005/063. Fisheries Research Report 215 Department of Fisheries, Western Australia. 112 pp.

in the range \$1-5 million in 2013. While a dollar value is difficult to assign to recreational and charter catches at this stage, the availability of demersal target species underpins the local recreational fishing-based tourism industry and generates significant income for the regional economy.

## Fishery Governance

### Commercial:

#### Current effort level Pink snapper (season 2014):

**Acceptable**

#### Current catch level Goldband (season 2014):

**Acceptable**

#### Target catch (and effort) range:

**Pink snapper**                      **277 tonnes/380-540 days**

**Goldband snapper**            **100-120 tonnes (preliminary  
maximum catch limit)**

In 2014, GDSF vessels with pink snapper quota required 364 boat days to catch 240 t of pink snapper (oceanic stock, TACC = 277 t). The available TACC was not entirely taken due to quota being left in the water for a range of operational factors affecting a small number of vessels.

The average catch rate at 658 kg pink snapper/boat day during the peak season for the 2014 was again well above the threshold level (500 kg/standard boat day). This catch rate-based performance measure will be re-assessed when results from analyses of higher resolution (daily/trip catch and effort returns) data become available. The catch of goldband snapper in 2014 was again below the preliminary maximum commercial catch limit.

### Recreational:

#### Current effort level (2013/14):

**Pink snapper**    **Acceptable**

**Goldband snapper**                                      **Acceptable**

**Spangled emperor**    **Unacceptable (North Gascoyne)  
Acceptable (South Gascoyne)**

Estimates of fishing mortality (based on data from 2007/08) indicate localised depletion of spangled emperor was occurring north of Point Maud outside of the sanctuary zones. The estimated boat-based catch of spangled emperor in 2013/14 had decreased by approximately 21% on the estimated catch in 2011/12.

## New management initiatives (2015/16)

The *Gascoyne Demersal Scalefish Management Plan 2010* (the Plan) was implemented on 1 November 2010, superseding the *Shark Bay Snapper Management Plan 1994*. The Plan provides the Department with the ability to manage all demersal scalefish stocks in the Gascoyne Coast Bioregion.

Phase one of the Plan has been implemented, and includes a formal entitlement system, in the form of individual transferable quota, for pink snapper. A second form of formal entitlement is required to be introduced into the Plan to explicitly regulate the take of all other demersal scalefish species. The development of an entitlement framework with the capacity to regulate catches of these other 'non-pink snapper' scalefish species that can work in combination with the existing ITQ system for pink snapper is scheduled for implementation in 2015.

The GDSF underwent Marine Stewardship Council pre-assessment in 2013.

## External Factors

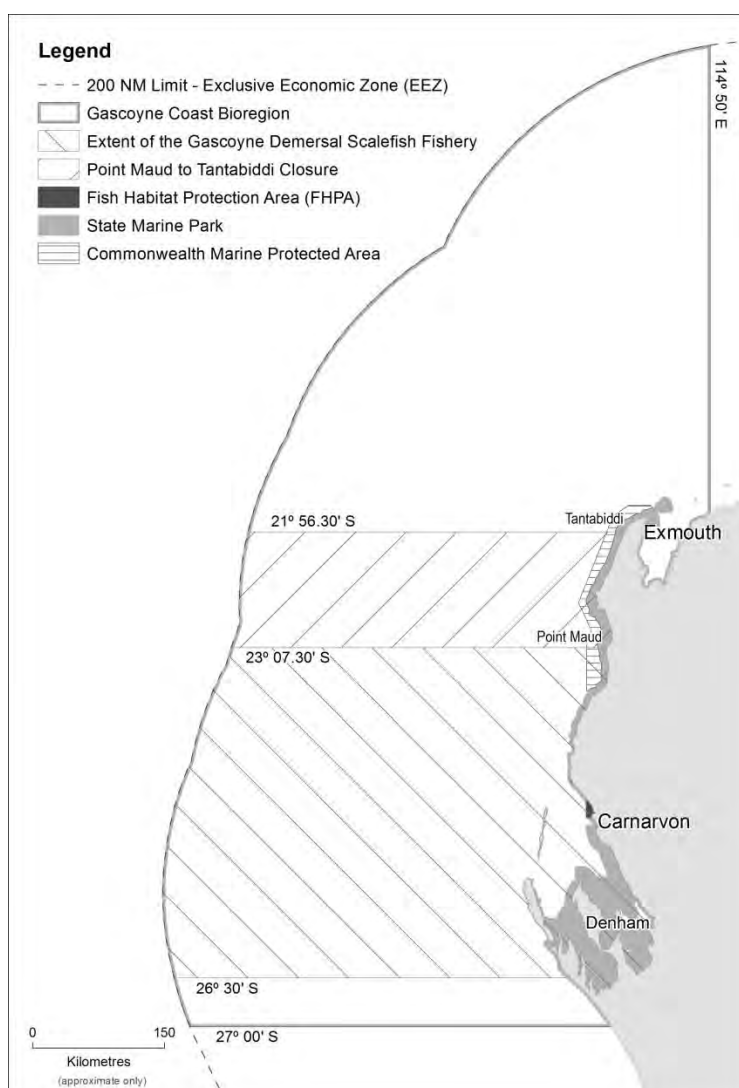
Under the Offshore Constitutional Settlement, commercial vessels licensed by the Commonwealth may operate in state waters off the Gascoyne coast, outside the 200 m isobath, as part of the Western Deepwater Trawl Fishery. In the 2014 season, total effort in this fishery was very low (around 110 hours, AFMA unpublished data), as has been the case in recent years..

Climate change has the potential to impact fish stocks through increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), rising sea level and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, an FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2014). Pink snapper was considered in some detail as a case study species within this project with potential impacts of climate change likely to include a southward shift in the centre of geographic distribution; changes to spawning patterns; changes in individual growth and stock productivity, and through projected impacts on the Leeuwin Current, changes in egg and larval dispersal.

**GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1**

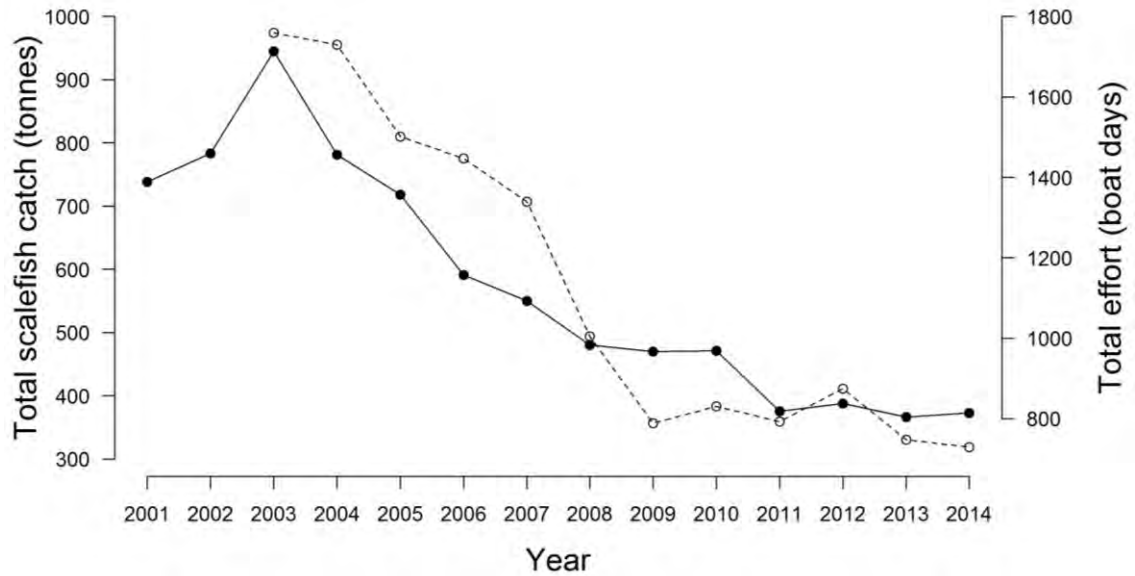
Total commercial catch of demersal scalefish species other than pink snapper taken in Gascoyne waters between 2005/06 and 2013/14 (excludes mackerels, sharks and tunas). Units are tonnes.

Species	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Goldband snapper	105.8	107.2	121.1	143.8	104.6	53.2	64.2	73.2	<b>54.4</b>
Red emperor	19.4	17.0	12.8	11.7	9.8	8.2	13.1	7.9	<b>10.1</b>
Spangled emperor	18.1	7.0	7.0	3.3	3.8	3.7	4.3	2.3	<b>2.0</b>
other emperors	29.2	34.3	26.8	13.8	9.2	10.4	11.6	5.1	<b>6.4</b>
Cods	21.9	21.5	15.0	9.5	13.4	11.4	21.1	14.0	<b>15.6</b>
Other	78.1	77.1	65.8	64.8	72.9	50.7	38.9	30.8	<b>51.2</b>
<b>Total</b>	<b>272.5</b>	<b>264.1</b>	<b>248.5</b>	<b>246.9</b>	<b>213.7</b>	<b>137.5</b>	<b>153.0</b>	<b>133.4</b>	<b>133.2</b>



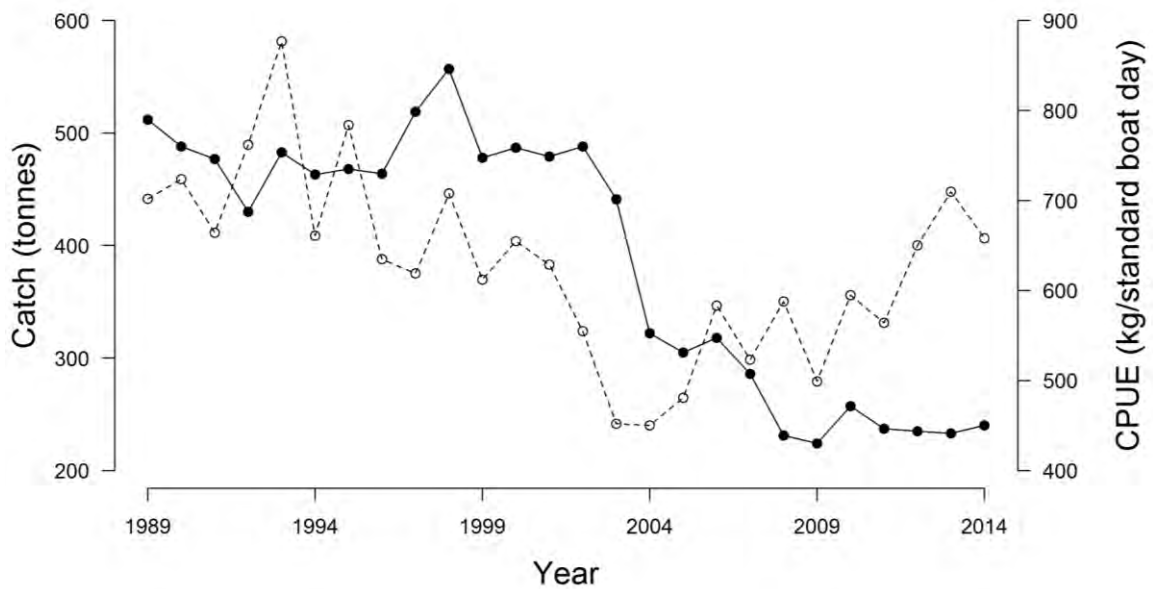
**GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1**

Waters of Gascoyne Coast Bioregion including Gascoyne Demersal Scalefish Fishery and 'Point Maud to Tantabiddi Well' fishing closure.



**GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2**

Gascoyne demersal scalefish catch (all species including pink snapper, tonnes) (solid line) and total fishing effort (days) (hatched line) from 2001 to 2014.



**GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 3**

Gascoyne pink snapper catch (solid line) and catch per unit effort (hatched line) by quota year from 1988/89 (equates to 1989) to 2013/14 (equates to 2014). Units are kg whole weight of pink snapper per standard boat day. The CPUE for vessels line fishing for snapper in June-July (peak season) is incorporated in the stock assessment model used to assess the oceanic pink snapper stock.

# Inner Shark Bay Scalefish Fishery Status Report

G. Jackson, J. Brown and H. Zilles

## Main Features

Status		Current Landings	
Stock level:		Commercial (2014)	
Whiting	Adequate	Whiting	118 t
Sea mullet	Adequate	Sea mullet	51 t
Tailor	Adequate	Tailor	8 t
Western yellowfin bream	Adequate	Western yellowfin bream	19 t
Pink snapper	Eastern Gulf - Adequate	Pink snapper	0.4 t
	Denham Sound – Adequate	Recreational (Pink snapper only)	
	Freycinet Estuary – Adequate	Eastern Gulf	4 t (2010)
Fishing Level:		Charter	<0.5 t (2014)
Whiting	Acceptable	Denham Sound	6 t (2010)
Sea mullet	Acceptable	Charter	1.5 t (2014)
Tailor	Acceptable	Freycinet	1.5 t (2010)
Western yellowfin bream	Acceptable	Charter	<0.5 t (2014)
Pink snapper	Eastern Gulf – Acceptable		
	Denham Sound – Acceptable		
	Freycinet Estuary – Acceptable		

## Fishery Description

The Inner Shark Bay Scalefish Fishery encompasses commercial and recreational fishing for scalefish species within the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay (Inner Shark Bay Fishery Figure 1). This includes the activities of the Shark Bay Beach Seine and Mesh Net Managed Fishery (SBBSMNF) and the Inner Shark Bay Recreational Fishery.

The SBBSMNF operates from Denham and uses beach seine and mesh net gears to mainly take four species/groups: whiting (mostly yellowfin, *Sillago schomburgkii*, with some goldenline, *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and western yellowfin bream (*Acanthopagrus morrisoni*).

Most recreational fishing in Shark Bay is boat-based using rod & line or handline with some netting for bait and sea mullet. The key recreationally caught species are pink snapper (*Chrysophrys auratus*), grass emperor (black snapper or blue-lined emperor, *Lethrinus laticaudis*), western butterfish (*Pentapodus vitta*), whiting (*Sillago* spp.), school mackerel (*Scomberomorus queenslandicus*), tailor, blackspot tuskfish (bluebone, *Choerodon schoenleinii*) and goldspotted rockcod (estuary or slimy cod, *Epinephelus coioides*). A limited number of licensed charter vessels operate out of Denham and Monkey Mia.

### Governing legislation/fishing authority

#### Commercial

*Shark Bay Beach Seine and Mesh Net Limited Entry Fishery Notice 1992*

Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

#### Recreational

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

### Consultation process

#### Commercial

The Department undertakes consultation directly with licensees on operational issues. 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.

## Boundaries

The areas covered by this report are shown in Inner Shark Bay Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Nature Reserve or in sanctuary zones, recreational zones or special purpose zones within the Shark Bay Marine Park.

## Management arrangements

### Commercial

The SBBSMNF is managed through input controls in the form of limited entry, gear restrictions (e.g. vessel size, net length and mesh size) and permanently closed waters (e.g. Hamelin Pool, Big Lagoon, the Denham foreshore). A unit in this fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum fishing team of three individual fishers. Commercial line fishing for pink snapper has not been permitted in these waters since 1996 (see ‘Gascoyne Demersal Scalefish Fishery’).

### Recreational

The recreational fishery in Shark Bay is managed using a combination of daily bag, possession, size and gear limits. Boat-based fishers also require a statewide Recreational Fishing from Boat Licence while net fishers require a statewide Recreational Net Fishing Licence. For pink snapper more complex management arrangements apply within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1), including seasonal closures and a quota tag system. These stocks are managed separately with explicit Total Allowable Catch (TAC) targets. In 2014, the TACs for pink snapper were as follows:

Eastern Gulf	15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)
Denham Sound	15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)
Freycinet Estuary	5 tonnes (approx. 1,400 fish, i.e. 1,050 recreational and 350 commercial)

## Research summary

The Department of Fisheries uses an indicator species approach to monitor and assess the status of the finfish resources throughout the State (DoF 2011<sup>1</sup>). These indicators were selected to represent the finfish suites of nearshore/estuarine (waters of 0-20 m depth), inshore demersal (waters of 20-250 m depth), offshore demersal (waters greater than 250 m depth) and pelagic using a risk-based approach based on the relative vulnerability of the species/stock to fishing activities.

In the Gascoyne Coast Bioregion, tailor and yellowfin whiting are indicators for the nearshore suite while pink snapper is one of three indicators for the inshore demersal suite. While not indicators, the status of sea mullet, western yellowfin bream and grass emperor is also reported here because these species are significant components of the commercial and recreational catch in inner Shark Bay.

The status of the four SBBSMNF target species (whiting, sea mullet, tailor, western yellowfin bream) are monitored each year using data from commercial catch returns coupled with the extensive scientific knowledge gained from research dating back to the 1960s. Level 2 assessments based on trends in commercial catch and catch rates (CPUE) are assessed against reference points (target catch ranges and threshold catch rates) which have been determined on a reference period (1990-2002) when catch and effort in the fishery were considered stable. The SBBSMNF underwent Marine Stewardship Council (MSC) pre-assessment in 2013. A Level 3 assessment of yellowfin whiting that involved age-based sampling of the commercial catch to determine fishing mortality ( $F$ ) was undertaken in 2014.

The stocks of pink snapper in the inner gulfs have been the focus of a comprehensive research program since 1996/97. Since 2002, integrated stock assessment models (Level 5) have been used to separately assess the status of the Eastern Gulf, Denham Sound and Freycinet Estuary stocks, and to determine appropriate levels of TAC. These assessments are updated every 3 years (most recently in 2015). A Level 3 assessment of grass emperor was undertaken in 2005.

Research on pink snapper in the inner gulfs in recent years has been limited to a monitoring level that involves trawl surveys to monitor juvenile recruitment each year and daily egg production method (DEPM) surveys to estimate spawning biomass. Catches of pink snapper taken by licensed commercial and charter vessels are derived from compulsory monthly catch returns.

Estimates of recreational catch and effort in the inner gulfs were derived each year between 1998 and 2010 (no surveys in 1999 and 2009) using ‘on-site’ recreational fishing surveys involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps (Wise *et al.* 2012)<sup>2</sup>. The first and second statewide surveys of boat-based recreational fishing in WA were undertaken in 2011/12 and 2013/14 (Ryan *et al.* 2013<sup>3</sup>, 2015<sup>4</sup>). This survey method was developed to provide statewide and bioregional level catch estimates; estimates at the finer scale required for the management of inner gulf snapper stocks are not currently available from these survey data.

## Retained Species

### Commercial landings (season 2014):

<b>Whiting</b>	<b>118 tonnes</b>
<b>Sea mullet</b>	<b>51 tonnes</b>
<b>Tailor</b>	<b>8 tonnes</b>
<b>Western yellowfin bream</b>	<b>19 tonnes</b>
<b>Pink snapper</b>	<b>0.4 tonnes</b>

2 Wise *et al.* (2012) Long-term monitoring of boat-based recreational fishing in Shark Bay, Western Australia; providing advice for sustainable fisheries management in a World Heritage Area. *Marine and Freshwater Research* 63: 1129-1142

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

4 Ryan, K.L., Hall, N.G., Lai, E.K., Smallwood, C.B., Taylor, S.M., Wise, B.S. 2015. State-wide survey of boat-based recreational fishing in Western Australia 2013/14. Fisheries Research Report No. 268, Department of Fisheries, Western Australia. 208pp.

1 Department of Fisheries (DoF). 2011. Resource Assessment Framework (RAF) for Finfish Resources in Western Australia. Fisheries Occasional Publication No. 85. Department of Fisheries, Perth.



The total catch taken by SBBSMNF licensed vessels in 2014 was 212 t (was 219 t in 2013). This total catch comprised 118 t of whiting, 51 t of sea mullet, 8 t of tailor, 19 t of western yellowfin bream and 16 t of other mixed scalefish species. Of the other mixed scalefish species category, the majority (9.4 t) comprised of two species of garfish (three-by-two garfish, *Hemirhamphus robustus* and longtail garfish, *Hyporhamphus quoyi*). A small amount (0.4 t) of pink snapper was also taken as byproduct in the net fishing gears.

**Recreational catch estimates**

(including charter, 2014)

<b>Pink snapper</b>	<b>Eastern Gulf ca. 4-5 tonnes</b>
	<b>Denham Sound ca. 7-8 tonnes</b>
	<b>Freycinet Estuary ca. 2-3 tonnes</b>
<b>Grass emperor</b>	<b>ca. 10 tonnes</b>

As a direct result of management intervention for pink snapper in Shark Bay, including the introduction of TAC-based management in 2003, contemporary recreational catches of pink snapper are much lower than were taken in the 1980s and 1990s.

Based on results of the most recent ‘on-site’ recreational fishing survey in 2010, the estimated recreational catch of pink snapper was approximately 4-5 tonnes in the Eastern Gulf, approximately 6-7 tonnes in Denham Sound and approximately 1-2 tonnes in the Freycinet Estuary. The estimated recreational catch of grass emperor in 2010 was approximately 10 tonnes (all areas combined). There are no more recent estimates of recreational catch in inner Shark Bay for both species.

In 2014, licensed charter vessels landed approximately 1.5 t of pink snapper in Denham Sound and <0.5 t in both the Eastern Gulf and Freycinet Estuary. Less than 0.5 t of grass emperor (all three areas combined) was reported by charter vessels in 2014.

**Fishing effort/access level**

**Commercial**

In 2014, of the 10 SBBSMNF licences, eight vessels were actively involved in fishing (seven in 2013). During 2014, the total effort in the fishery was 620 boat days (646 boat days in 2013) which represents the lowest effort level on record for the fishery.

**Recreational**

In 2010, boat-based recreational fishing effort in the inner gulfs was estimated at approximately 37,000 boat fisher hours (compared to an estimated 33,000 fisher hours in 2007). More recent estimates of recreational fishing effort in inner Shark Bay are currently not available from the statewide integrated survey of recreational boat-based fishing.

**Stock Assessment**

**Assessment complete**

<b>Whiting</b>	<b>Yes</b>
----------------	------------

<b>Sea mullet</b>	<b>Yes</b>
<b>Tailor</b>	<b>Yes</b>
<b>Western yellowfin bream</b>	<b>Yes</b>
<b>Pink snapper</b>	<b>Yes</b>
<b>Grass emperor</b>	<b>Yes</b>

**Assessment level and method:**

<b>Whiting</b>	<b>Level 3 - Fishing Mortality (2014)</b>
<b>Sea mullet/Tailor/Western yellowfin bream</b>	<b>Level 2 - Catch, Catch Rate (2014)</b>
<b>Pink snapper</b>	<b>Level 5 - Composite Assessment (2013)</b>
<b>Grass emperor</b>	<b>Level 3 - Fishing Mortality (2005)</b>
	<b>Level 1 - Catch (2010)</b>

**Breeding stock levels**

<b>Whiting</b>	<b>Adequate</b>
<b>Sea mullet</b>	<b>Adequate</b>
<b>Tailor</b>	<b>Adequate</b>
<b>Western yellowfin bream</b>	<b>Adequate</b>
<b>Pink snapper</b>	<b>Eastern Gulf - Adequate</b>
	<b>Denham Sound - Adequate</b>
	<b>Freycinet Estuary - Adequate</b>
<b>Grass emperor</b>	<b>Adequate</b>

**Whiting, Sea mullet, Tailor, Western yellowfin bream:**

Assessment of the four main SBBSMNF target species is based on annual analysis of the commercial catch and effort data. Target catch ranges and threshold catch rates (CPUE) have been determined for the total catch overall (not shown) and for each target species (Inner Shark Bay Fishery Table 1). In addition, a Level 3 assessment of yellowfin whiting was undertaken in 2014.

In 2014, the total commercial catch (all species) taken by the SBBSMNF was 212 tonnes, a decrease of 7 tonnes from 2013, was the lowest reported level for the fishery on record (Inner Shark Bay Scalefish Fishery Figure 2).

In 2014, the catch of whiting (118 t) was within the target catch range and the CPUE (191 kg/boat day) well above the threshold catch rate at the second highest level observed since 1990 (Inner Shark Bay Scalefish Fishery Figure 3). Recent increases in both catch and catch rate can be attributed to an increase in availability of whiting and greater time spent targeting this species rather than other lower-value species such as sea mullet. The estimates of fishing mortality (*F*) for yellowfin whiting in 2014 were around the target ( $F \approx \frac{2}{3}M$ , natural mortality) and below the threshold reference level ( $F=M$ , natural mortality) and were considered acceptable (sustainable).

In 2014, the catch of sea mullet was 51t, an increase of 19 t from 2013, although still 50 t below the long-term average (1990-2013). This continues three consecutive years of sea mullet catch below the acceptable target range. The CPUE (83 kg/boat day) in 2014, however, is above the threshold level and around the long-term average (Inner Shark Bay Scalefish Fishery Figure 4). The decrease in the sea mullet catch is partly explained by a lower market demand with the

fleet targeting the higher-value whiting species, but may also be attributable to a change in the distribution ('latitudinal shift') of sea mullet due to warming waters; lower catches have been observed in the northern fisheries (i.e. SBBSMNF and Exmouth Gulf Beach Seine Fishery) and increased catch rates in the southern fisheries (i.e. West Coast Nearshore Net Fishery, Peel-Harvey Estuarine Fishery, South West Beach Seine Fishery and the South Coast Estuarine Fishery – see reports in the West Coast and South Coast Bioregions sections).

In 2014, the tailor catch (8 tonnes) was the lowest on record and continues the declining trend for this species with catches since 2004 below the target range. The CPUE (12 kg/boat day) was below the threshold level and is the lowest value since 1987 (Inner Shark Bay Scalefish Fishery Figure 5). The low landings of tailor that have become a feature of the fishery in recent years are mostly attributed to local processing restrictions.

The catch (18 tonnes) and CPUE (30 kg/boat day) of western yellowfin bream in 2014 were similar to in 2013 and above the target catch range and the threshold catch rate, respectively (Inner Shark Bay Scalefish Fishery Figure 6). These increases can likely be attributed to another strong year class entering the fishery, as was previously observed during the period 2002-2007.

**Pink snapper:** DEPM surveys that directly estimate snapper spawning biomass were conducted annually in the Eastern Gulf, Denham Sound and Freycinet Estuary during the period 1997-2004 and periodically since. Most recently, DEPM surveys were conducted in the Eastern Gulf in 2012 and in Denham Sound and Freycinet Estuary in 2013. Research trawl surveys, to monitor variation in juvenile recruitment, have been conducted each year since 1996. Integrated assessment models have been used to assess the status of the three stocks in relation to the management target (40% of the unexploited spawning biomass) since 2002. The most recent assessments estimated that the spawning biomass of the Eastern Gulf pink snapper stock in 2015, and its lower 95% confidence limit, lay above the target level (40%). For the Denham Sound pink snapper stock, the spawning biomass in 2015, and its 95% confidence limits in 10 out of 16 model runs, lay above the target level (40%). For the Freycinet Estuary pink snapper stock, while the majority of the point estimates of the spawning biomass in 2015 lay above the target level, the point estimates for 2 of the 16 runs fell below the target level (40%). The lower 95% confidence limit exceeded the target reference point in 5 of the 8 trials, and fell just below in the other 3 trials, while the 80<sup>th</sup> percentiles exceeded the target reference point in all 8 trials.

**Grass emperor:** Based on age-structure data collected in 2005, fishing mortality (F) was estimated to be around the threshold level (F=M, natural mortality). More recent information on F for this species is not available but there are no trends in recent catch data that would suggest the situation has significantly changed.

## Non-Retained Species

### Bycatch species impact

**Low**

Bycatch is minimal in the SBBSMNF because netting operations selectively target specific schools of fish. Based on experience, fishers can determine the species and size of the school, and the size of individual fish within the school, before deploying the net. Fish are readily observed in the very shallow near-shore waters of Shark Bay. Non-target species and under-sized fish are avoided in most cases.

### Listed species interaction

**Negligible**

As nets are actively set and hauled, if any listed species such as dugongs, dolphins or marine turtles are caught (rare events) they are immediately released. Commercial fishers are required to report any interactions with endangered, threatened and protected (ETP) species. In 2014, no interactions with ETP species were reported.

## Ecosystem Effects

### Food chain effects

**Low**

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that recruitment of the main target species has not been significantly affected by fishing mortality. The total biomass of the key target species appears sufficient to maintain trophic function in these waters.

### Habitat effects

**Negligible**

Seine nets are set and hauled over shallow sand banks, including intertidal areas. Sand habitats are naturally dynamic environments with resident infauna adapted to cope with regular physical disturbances. Combined with the low frequency of fishing in any one location, this indicates that the fishery is unlikely to have a lasting effect on the habitat.

## Social Effects

### Commercial

Currently around 18 commercial fishers are employed in the SBBSMNF based on eight fishery licences operating in 2014. Fishing and associated fish processing is an important source of local employment - the fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community.

### Recreational

Shark Bay is a popular tourist destination, especially during the winter months and school holidays: data indicate that approximately 30% of all visitors participate in recreational fishing during their stay.

## Economic Effects

### Estimated annual value (commercial sector) for 2014

**Level 2 - \$1 - 5 million**

#### Commercial

The gross value of production (GVP) of the SBBSMNF in 2014 was estimated in the range \$1-5 million.

#### Recreational

While a dollar value is difficult to assign to recreational and charter catches, the availability of quality fishing underpins the tourism industry in Shark Bay and generates significant income for the regional economy.

## Fishery Governance

#### Commercial

**Current effort level (2014):** **Acceptable**

**Target catch range (2014):**

**All species (ex pink snapper)** **235–335 tonnes**

**Pink snapper** **Eastern Gulf 3 tonnes**

**Denham Sound 3 tonnes**

**Freycinet 1.2 tonnes**

Total fishing effort in the SBBSMNF was 620 boat days in 2014 and was the lowest level reported for the fishery. The total commercial catch in 2014 at 212 t was below the lower limit of the target catch range (235–335 tonnes), however, this needs to be viewed against the background of the historically low levels of effort. At this time, this fishery is considered to present a low risk to the sustainability of the finfish and other ecological resources of inner Shark Bay, and as a consequence is a low research/management priority.

Commercial catches of pink snapper taken as byproduct by SBBSMNF vessels in 2014 were either nil or significantly below their allocation within the respective pink snapper TACs (0.4 tonnes in Denham Sound, nil catch in Eastern Gulf and Freycinet Estuary).

#### Recreational

**Target catch range (2014):**

**Pink snapper** **Eastern Gulf 12 tonnes**

**Denham Sound 12 tonnes**

**Freycinet Estuary 3.8 tonnes**

Recreational catches of pink snapper were assumed to be similar to those estimated in 2010 (no 'on-site' surveys were undertaken in 2011-2014) and therefore within the respective TACs in each area.

In 2014, a total of 727 applications (first and second rounds) were received for Freycinet Estuary pink snapper quota tags with all the tags available (total 1,050) allocated to recreational fishers.

## New management initiatives (2015/16)

As an outcome of the 'Wetline Review' (see Fisheries Management Paper No. 224 for details), a management review is proposed. The review will incorporate the existing SBBSMNF, the Exmouth Gulf Beach Seine Fishery and commercial net fishing in the Carnarvon area.

All commercial fisheries in the Gascoyne Coast Bioregion, including the SBBSMNF, have been through a Marine Stewardship Council (MSC) pre-assessment in 2013.

## External Factors

While the inner Shark Bay system has been considered relatively stable as a result of its typically low-rainfall and arid environment, the region is occasionally affected by cyclone-related flood events such as occurred in the Gascoyne and Wooramel Rivers in late 2010 and again in early 2011. Combined with this, the marine heatwave in the summer of 2010/11 had significant impacts on some marine habitats (e.g. temperate seagrasses) and invertebrate species (e.g. blue crabs and scallops) (see Fisheries Research Reports 222<sup>1</sup> & 250<sup>2</sup>). The impact of these events on key scalefish species in inner Shark Bay has not been determined.

Climate change has the potential to impact fish stocks through increasing sea surface temperatures, changes in major ocean currents (e.g. Leeuwin Current), rising sea level and ocean acidification. A review of the impacts and responses to marine climate change in Australia was undertaken by CSIRO in 2009. More recently, an FRDC-funded project assessed the effects of climate change on key fisheries in Western Australia (Caputi *et al.* 2014<sup>3</sup>). Pink snapper, yellowfin whiting, sea mullet and tailor are temperate species and Shark Bay is near their low-latitude range limit and forecasted increases in ocean water temperature associated with climate change may result in a contraction of the species' ranges southwards in the longer term.

1 Pearce *et al.* (2011). The "marine heatwave" off Western Australia during the summer of 2010/11. Fisheries Research Report No 222. Department of Fisheries, Western Australia, Perth.

2 Caputi *et al.* (2014). The marine heatwave off Western Australia during the summer of 2010/11 - 2 years on. Fisheries Research Report No 250. Department of Fisheries, Western Australia, Perth.

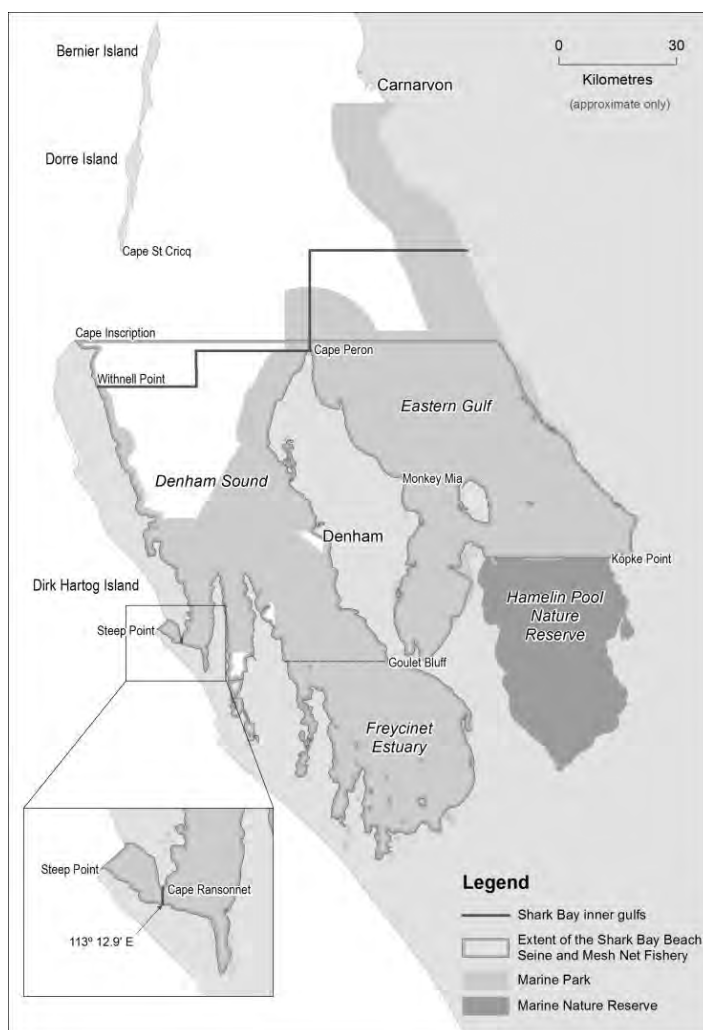
3 Caputi *et al.* (2014). Management implications of climate change effect on fisheries in Western Australia: Parts 1 & 2. FRDC Project 2010/535 Final Report. Department of Fisheries, Western Australia, Perth.

**INNER SHARK BAY SCALEFISH FISHERY TABLE 1**

Annual catch and target catch range (tonnes) (upper), and annual CPUE and threshold level (kg/boat day) (lower) for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2005-2014

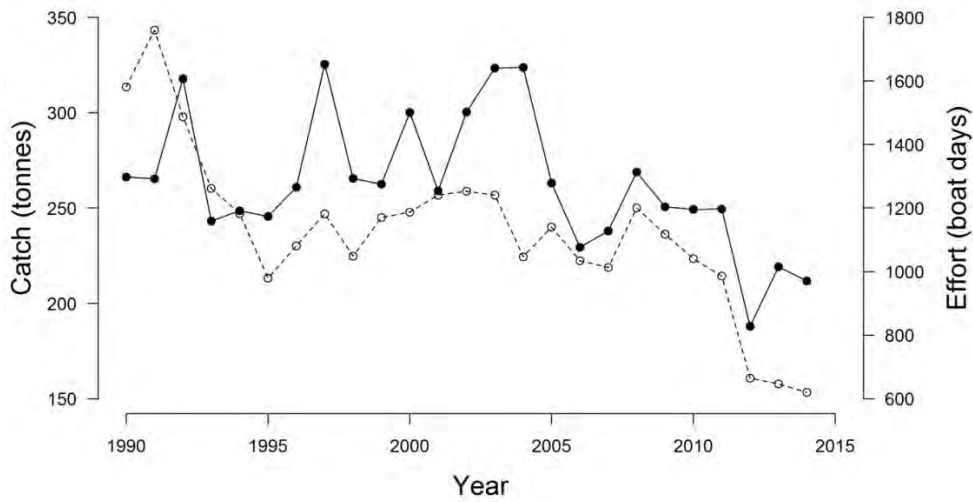
Species	Acceptable catch range	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Whiting	93-127	116	113	102	117	115	118	105	116	142	118
Mullet	77-144	85	62	91	107	124	117	116	40	32	51
Tailor	25-40	19	21	23	23	19	19	17	16	15	7
Bream	7-15	27	23	14	8	8	10	9	9	18	18

Species	Trigger level	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Whiting	75	102	110	100	98	100	112	105	175	220	191
Mullet	62	74	60	90	89	106	107	116	61	50	83
Tailor	21	17	20	22	19	16	17	17	25	23	12
Bream	5	23	22	14	6	7	10	9	14	28	30



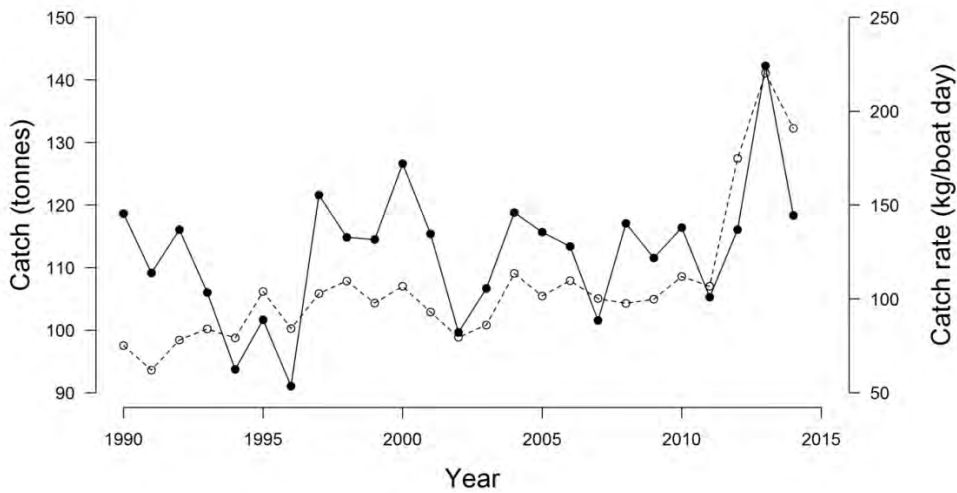
**INNER SHARK BAY SCALEFISH FISHERY FIGURE 1**

The commercial (scalefish) and recreational fishing areas of inner Shark Bay.



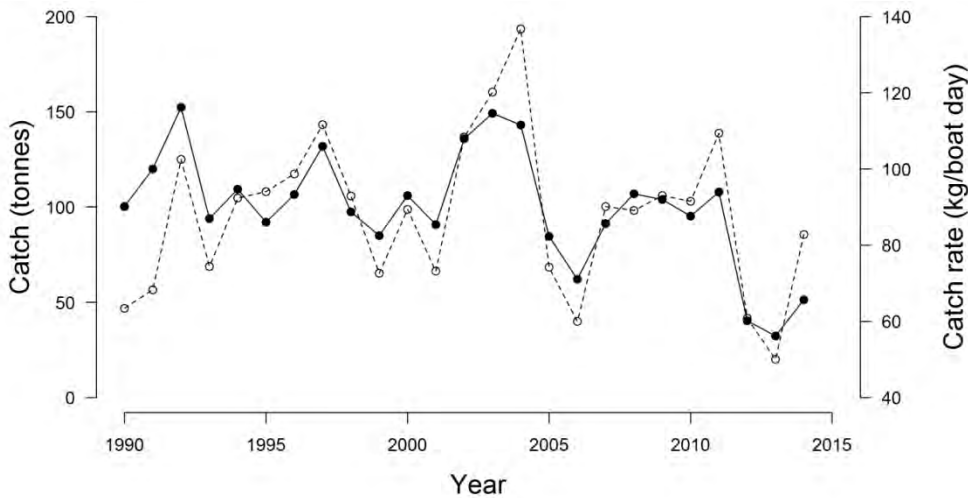
**INNER SHARK BAY SCALEFISH FISHERY FIGURE 2**

The total annual catch (solid line) and effort (hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



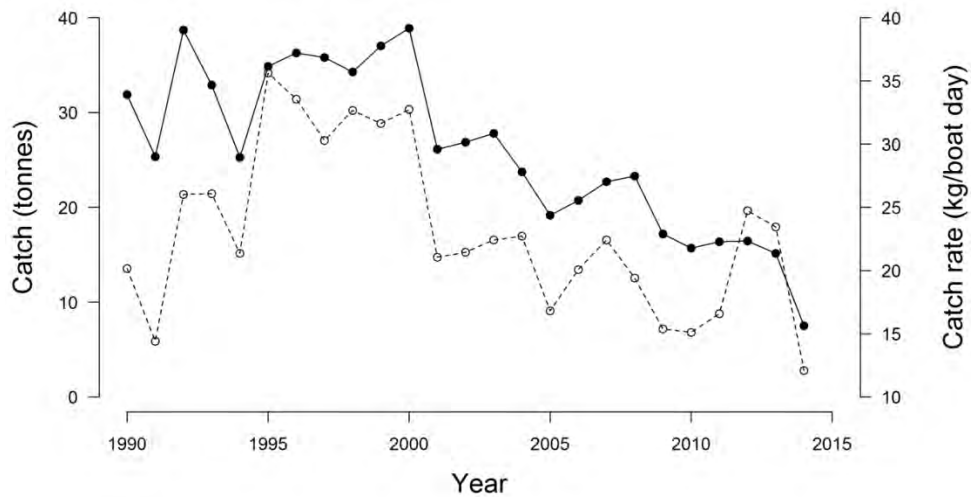
**INNER SHARK BAY SCALEFISH FISHERY FIGURE 3**

The annual whiting catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



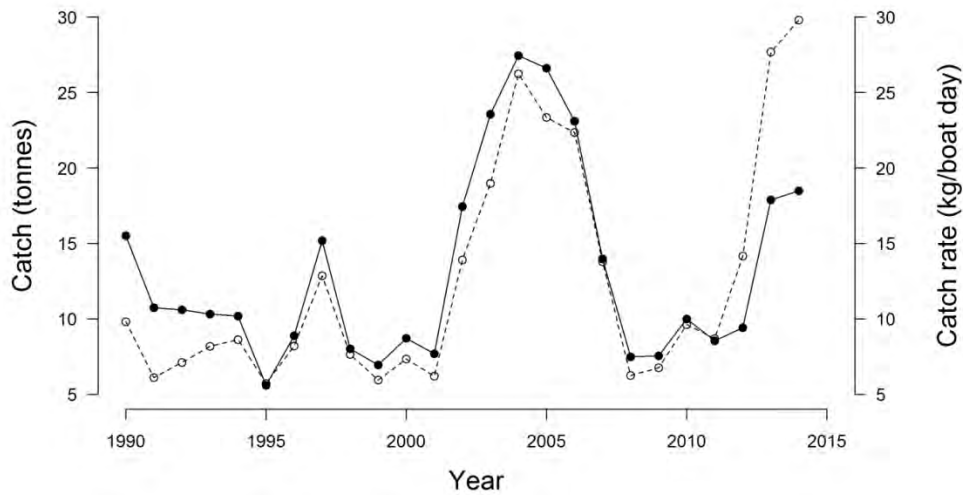
**INNER SHARK BAY SCALEFISH FISHERY FIGURE 4**

The annual sea mullet catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



**INNER SHARK BAY SCALEFISH FISHERY FIGURE 5**

The annual tailor catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.



**INNER SHARK BAY SCALEFISH FISHERY FIGURE 6**

The annual western yellowfin bream catch (solid line) and catch per unit effort (CPUE, hatched line) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990–2014.

## Shark Bay Blue Swimmer Crab Fishery Status Report

*A. Chandrapavan, E. Sporer, S. Blazeski and S. O'Donoghue.*

### Main Features

Status	Current Landings	
Stock level	Recovering	Commercial catch 371 t
Fishing level:	Acceptable	Shark Bay trap fleet 175 t
		Shark Bay trawl fleet 196 t
		Recreational catch ~ 2.2 t (Gascoyne bioregion estimate)

## Fishery Description

The blue swimmer crab (*Portunus armatus*) resource in Shark Bay is harvested commercially by the Shark Bay crab trap, Shark Bay prawn trawl and Shark Bay scallop trawl fisheries. This crab stock also supports a small (~2.2 t) but important recreational fishery. Prior to 2012, this was Australia's highest producing blue swimmer crab fishery. However, between July and December 2011, commercial catch rates declined rapidly due to significantly low stock abundance across the region that appeared to be caused by environmental conditions generated by an unprecedented marine heat wave, combined with multiple flooding events during the summer of 2010/11. Commercial fishing for blue swimmer crabs in Shark Bay ceased in April 2012 on a voluntary industry-agreed basis to facilitate stock rebuilding. Since the closure, intensive monitoring of the resource has been undertaken using a combination of trawl and trap based surveys. The fishery reached a partial stock recovery status in late 2013 and this provided some confidence for the resumption of commercial fishing for crabs in Shark Bay. A precautionary TACC of 400 tonnes was set for the 2013/14 season.

### Governing legislation/fishing authority

#### Commercial

*Shark Bay Crab Fishery (Interim) Management Plan 2005*

Exceptions to the *Fish Traps Prohibition Notice 1990* and *Fish Traps Restrictions Notice 1994*

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

*Shark Bay Prawn Management Plan 1993*

*Shark Bay Scallop Management Plan 1994*

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Shark Bay Interim Managed Fishery only)

#### Recreational

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

### Consultation process

#### Commercial

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

#### Recreational

Recreational consultation processes are now facilitated by Recfishwest under a Service Level Agreement although the Department continues to undertake direct consultation with the community on specific issues

### Boundaries

The Shark Bay Crab Interim Managed Fishery covers the waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point (Shark Bay Blue Swimmer Crab Figure 1). In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.

The boundaries of the Shark Bay Prawn and Scallop Managed Fisheries, which also retain blue swimmer crabs, are described in the relevant status reports specific to the trawl fisheries elsewhere within this document.

### Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries were managed under an input control system, through the regulation of licence and trap (hourglass) numbers or length of headrope of trawl net. However, since the resumption of commercial fishing for crabs in 2013, an appropriate TACC with clear stock monitoring and decision points has been used as the key management tool for the Fishery. The management arrangements for the Fishery are currently based on a notional quota system where licensees were allowed to trade quota between sectors. The Shark Bay crab resource is allocated across the prawn trawl, scallop trawl and trap sectors based upon the proportional catch history of each sector between 2007 and 2011, resulting in the following allocations: trap sector – 66.00%; prawn trawl sector – 33.80%; and scallop trawl sector – 0.20%.

Supplementary controls cover what species can be retained, associated minimum size limits, gear specifications, and area, seasonal and daily time restrictions. The principal management tool employed to ensure adequate breeding stock involves having minimum size limits well above the size at sexual maturity. Male blue swimmer crabs in Shark Bay become sexually mature at 97 mm carapace width, while females become sexually mature below 92 mm carapace width. Setting the commercial minimum size at 135 mm carapace width (as per a voluntary industry agreement) is designed to ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

There are five crab trap permits with combined total of 1,500 units of entitlement (currently valued at 1 trap each) in Shark Bay under the *Shark Bay Crab Fishery (Interim) Management Plan 2005*. The Plan sets the number of traps that can be fished, fishery specific spatial closures, gear specifications and other controls. These permits are consolidated onto three active vessels. Two permit holders who have a long standing history of crab fishing south of Cape Peron (south of the existing waters of the Shark Bay Crab Interim Managed Fishery [SBCIMF]), have a Fishing Boat Licence (FBL) condition that allows them to fish in these waters but with no more than 200 traps. At no time, however, may they each use more traps than authorised under their respective Permits across all of the waters of Shark Bay.

There are currently 29 trawl (18 prawn and 11 scallop) licences that are excepted from the *Shark Bay Crab Fishery (Interim) Management Plan 2005* to the extent that they can take blue swimmer crabs in Shark Bay. Management controls for the trawl fisheries that retain blue swimmer crabs in the Gascoyne Coast Bioregion, namely the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop Managed Fishery, are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices (grids) and these are fully described in the relevant status reports within this document. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all trawlers in these fleets.

A third comprehensive ESD assessment of the Shark Bay fishery was completed in June 2011. The Commonwealth Department of the Environment (DotE) approved the fishery to export product for a further five years until September 2016, subject to several conditions and recommendations - for details refer to:

<http://www.environment.gov.au/coasts/fisheries/wa/shark-bay/index.html>.

Recreational fishing for blue swimmer crabs in WA is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock is a minimum size limit well above the size at sexual maturity. A minimum legal size limit of 127 mm carapace width applies in the waters of the Gascoyne Coast Bioregion, along with a bag limit of 20 crabs per person or 40 crabs per boat. Recreational crab fishers mainly use drop nets or scoop nets.

### Research summary

Historically data for the assessment of blue swimmer crab stocks in the Gascoyne bioregion are obtained from trap fishers' statutory monthly catch and effort returns and voluntary daily logbooks, and trawl fisher's statutory daily logbooks. Since the fishery closure, rigorous fishery-independent trap and trawl based data collections have been undertaken to address knowledge gaps in some of the biological and life-history parameters, spatial distribution of stock and recovery rates and patterns and models to determine sustainable harvest levels. A preliminary harvest strategy and control rules have been developed for evaluation of the stock and the management of the fishery.

## Retained Species

**Commercial landings (season 2013/14): 371 tonnes**

**Shark Bay trap fleet 175 tonnes**

**Shark Bay prawn trawl fleet 196 tonnes**

**Shark Bay scallop trawl fleet 0 tonnes**

A precautionary TACC of 400 tonnes was set for 2013/14 season (27 September 2013 to 31 October 2014) and in accordance with the catch share arrangement between the trap and trawl sectors, the TACC provides for a harvest of up to 264 tonnes by the trap sector (66%) and up to 135.2 tonnes by the prawn trawl sector (33.8%) and 800 kg by the scallop trawl sector (0.2%). In August 2014, a private leasing

arrangement resulted in 75 646 kg of quota being transferred from the trap to the trawl sector.

The total catch achieved for the 2013/14 season was 371 t (~93% of the TACC) with a total of 28.7 tonnes of unfished quota allocation. The trap sector's total catch was 175 t over a total of 388 fishing days (all taken in the northern fishing grounds). This represented 47% of the total landings for this season.

The prawn trawl sector's total catch was 196 t which represented 53% of the total landings. Approximately 43 tonnes of the catch was taken in the Denham Sound fishing grounds (Western Gulf). There was no retention of crabs by the scallop trawl sector due to the closure of the Shark Bay Scallop Managed Fishery.

**Recreational catch: < 1 % of total**

The 2013/14 state-wide recreational fishing from boat surveys found only 4% of the state's blue swimmer recreational catches came from the Gascoyne region. The total number of blue swimmer crabs that were kept was 8 716 ± 2312 crabs which is approximately 2.2 tonnes by weight. Within Shark Bay, blue swimmer crabs were the most common invertebrate recreational species.

## Stock Assessment

**Assessment complete: Yes**

**Assessment level and method:**

**Level 4 - Direct survey/Catch rate/Size Distributions**

**Breeding stock levels: Recovering**

The standardised trap CPUE was 1 kg/traplift which is on par with the proposed threshold level for this stock.

Fishery-independent trawl surveys established in 2012, continue to monitor the recovery of the crab stock in Shark Bay. Four surveys are undertaken in February, April, June and November which provide indices of legal, sublegal, spawning and recruitment catch rates.

Research data suggests an approximate 18-month life cycle from spawning to commercial sized crabs. The cohorts of legal-sized crabs (> 135 mm CW) that were fished during the 2013/14 season would have spawned between June 2012 and April 2013. The juveniles (new recruits) are detected between November 2012 and June 2013, approximately 5-6 months later (30 – 60 mm CW). Within the next 12 months crabs attain sexual maturity (between 100 - 110 mm CW) and reach commercial sizes.

Stock-environment relationships also continue to be monitored since the heat-wave event, where the cause of the low recruitment to the fishery in 2011/12 was a combination of a very cool winter in 2010 followed by the heat wave in the summer of 2010/11. This relationship can be used to foreshadow low, average or high abundance based on environmental conditions around the time of spawning and recruitment. It provides an early warning to potential climate driven changes to stock abundance and allow appropriate management actions to be considered.

The summer SST in 2013/14 have returned to within historic average levels but the winter 2013 SST is slightly cooler than



average. The predicted trap catch rate for 2013/14 was 1.05 kg/traplift and the actual catch rate was 0.97 kg/traplift. The predicted trap catch rate for the 2014/15 fishing season is 1.2 kg/traplift.

The TACC determination for the 2013/14 season was based on improved indices from 2013 surveys in comparison to 2012 which suggested partial recovery of the stock. This was substantiated by a short-term commercial crab fishing trial that was undertaken in June 2013 to assess the effect of limited commercial fishing on the recovering crab stock. The average trap CPUE from the fishing trial was 1.95 kg/traplift and in general, daily catch rates were above the historical June daily catch rates (logbook data) and there was no clear sign of stock depletion over this time period. This led to resumption of commercial fishing for 2013/14 season based on a conservative TACC of 400 t with clear stock review points. Commercial catch and catch rates were used to evaluate the progress of the fishing season in conjunction with ongoing stock monitoring surveys.

The TACC for the 2014/15 season was increased to 450 t to reflect the stronger recruitment and sublegal indices associated with this cohort.

A number of indices of stock performance are currently being developed for the assessment and TACC determination of the Shark Bay crab fishery. Indices of spawning, juvenile, sublegal and legal crabs from fishery-independent trawl surveys will be assessed after each survey and reviewed annually, and when sufficient time-series of data is available, reference levels will be developed for these indices. The annual trap catch rate will also be reviewed annually and this year is on par with the proposed threshold reference level of 1.0 kg/traplift. The proportion of the TACC achieved will also serve as an additional indicator.

## Non-Retained Species

### Bycatch species impact

**Negligible**

Hourglass traps are purpose-designed to minimise the capture of undersized blue swimmer crabs and 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.

On-board sampling by Departmental staff has indicated low numbers of bycatch species of mainly finfish (e.g. Snapper spp.), and other invertebrates (e.g. seastars, cephalopods and other crab species). The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks. Impacts from discarded bycatch from trawl fisheries that retain crabs as a byproduct is dealt with in those sections of this report specific to the trawl fisheries.

Bycatch from the prawn and scallop trawl fleets are described in the relevant status reports specific to the trawl fisheries elsewhere within this document.

### Listed species interaction

**Negligible**

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 or injuries to endangered, threatened or protected

species and avoids or minimises impacts on threatened ecological communities.

## Ecosystem Effects

### Food chain effects

**Low**

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

### Habitat effects

**Negligible**

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

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

## Social Effects

Prior to the closure, the trap sector employed approximately 15 people as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast Bioregion and additional employment for some 30-35 workers through the development of post-harvest processing of the crab catch were inactive. The closure of the Shark Bay crab fishery during 2012/13 had a significant socio-economic impact on both the trap and trawl sectors. Resumption of fishing has relieved some economic pressure but there are ongoing logistical issues with retaining crew and staff.

## Economic Effects

### Estimated annual value (to fishers) for 2013/14

**Level 2 - \$1 - 5 million (\$1.9 million)**

The average beach price for uncooked crabs across WA was \$5.24/kg. The estimated value of the commercial blue swimmer crab resource from Shark Bay was \$1.9 million which was a combination of \$1 million from the prawn trawl sector and \$0.9 million from the trap sector.

## Fishery Governance

### Current fishing (or effort) level:

**Acceptable**

### Target catch (or effort) range:

**400 tonnes (TACC)**

A precautionary TACC of 400 t was set for the 2013/14 season of which approximately 93% was achieved (371t). Harvest control rules based on standardised catch rates have also been proposed.

**New management initiatives (2014/15)**

Approval was given by the then Minister to develop a managed fishery management plan that would incorporate an Individual Transferable Quota system of entitlement to apply across all three commercial sectors in Shark Bay. The current Shark Bay Crab Interim Management Plan expires on 31 August 2015. The development of the new management plan is in progress with consultation regarding the key components of the legislation ongoing. It is envisaged that

the new management plan will be implemented in November 2015.

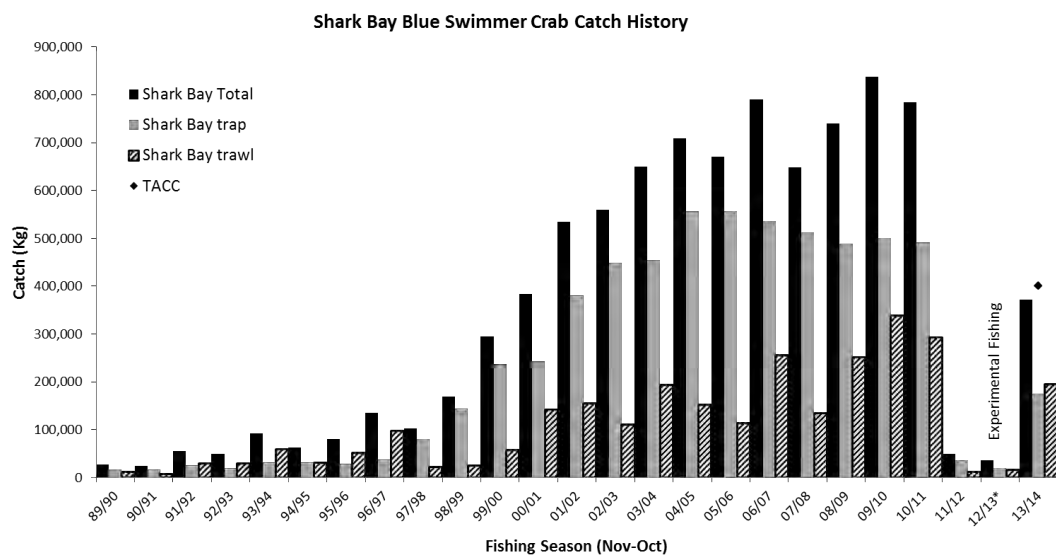
**External Factors**

Environmental factors have been identified as having a major effect on the recruitment of crabs throughout their distribution in WA, including Shark Bay. They were also ranked as a high risk to climate change and therefore need to be carefully monitored in the future.



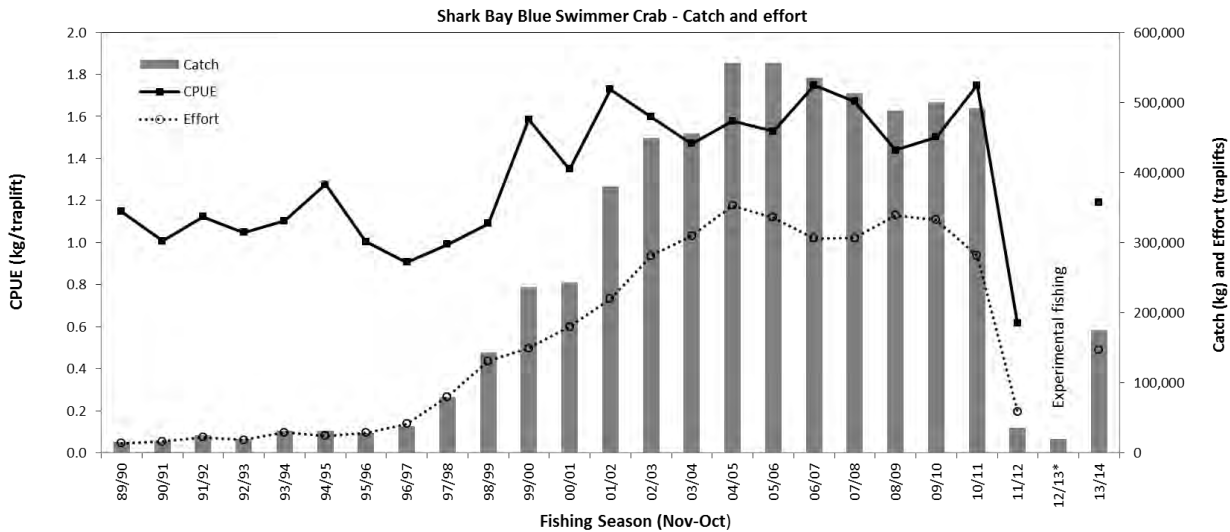
**SHARK BAY BLUE SWIMMER CRAB FIGURE 1**

Extent of the Shark Bay Crab (Interim) Managed Fishery. Two additional 200-trap exemptions allow for fishing in the western and eastern gulfs south of Cape Peron.



**SHARK BAY BLUE SWIMMER CRAB FIGURE 2**

Commercial catch history for the blue swimmer crab (*Portunus armatus*) between trap and trawl sectors since 1989/90. \*The catch for 2012/13 is generated from the experimental commercial fishing trial. A TACC of 400 tonnes was set for the 2013/14 fishing season.



SHARK BAY BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab trap catch (t), effort (traplifts x 1,000) and nominal catch per unit effort (kg/traplift) in Shark Bay since 1988/89. \*The catch for 2012/13 is generated from the experimental commercial fishing trial.

## AQUACULTURE

### Regional Research and Development Overview

For aquaculture in the Gascoyne, the Department of Fisheries continues to focus on the regulation of the regional pearling industry, including the blacklip oyster *Pinctada margaritifera* and Akoya pearl oyster *Pinctada imbricata*. These now complement the major State oyster industry sector which has been centred on the silver lip pearl oyster (*Pinctada maxima*).

The Department of Fisheries is also focusing on the management and regulation of an emerging local aquaculture sector, which is producing aquarium species that include coral and live rock. This developing sector is regulated

according to the policy entitled *The Aquaculture of Coral, Live Rocks and Associated Products*.

A land-based facility near Exmouth is in the process of being modified to operate as a biosecure hatchery for marine prawns. The licence holder’s aquaculture licence has been varied accordingly and an associated conditional translocation authorisation has been granted, subject to inspection of the facility by the Department of Fisheries before the movement of any prawns.

## COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services in the Gascoyne Coast Bioregion are delivered by Fisheries and Marine Officers (FMOs) with associated management and administrative support staff based at District Offices in Denham, Carnarvon and Exmouth. During 2013/14 the three district offices supported a total of six FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine parks, bio-security, pearling and aquaculture operations and fish habitat protection areas. The region covers approximately 2700 kilometres of the Western Australian (WA) coastline, some 13% of the WA coast. The various coastal landscapes represent some of the most remote, isolated, pristine and dangerous marine and terrestrial environments in the State.

A significant aspect of the regions work is the provision of compliance services to the State’s Marine Parks. The

Gascoyne Coast Bioregion has two of WA’s most iconic and significant Marine Parks, Ningaloo Marine Park and the associated Commonwealth Marine Park, Shark Bay Marine Park and the associated World Heritage Area. These two Marine Parks occupy just over 70% of the Gascoyne Coast Bioregion. In partnership with the Department of Parks and Wildlife (DPAW), FMOs monitor and deliver compliance and education programs covering some 30 Sanctuary Zones and Marine Managed Areas and other protected areas.

As a result of using a compliance delivery model based on a risk assessment process and subsequent operational planning framework, FMOs undertake regular land, and sea patrols and occasionally undertake aerial surveillance, A high visibility Recreational Fishing Mobile Patrol is also an integral part of the Gascoyne pool of compliance resources, as this dedicated education and compliance team has the

ability to patrol coastal areas from Onslow through to Denham.

Based in Exmouth is a 13-metre Patrol Vessel (PV) the PV *Edwards*. This vessel is utilised to conduct compliance activities throughout the Gascoyne bioregion and the lower parts of the Northern bioregion. With services provided within Shark Bay and its associated islands, throughout the Ningaloo Coast and Exmouth Gulf, and north through the Mackerel, Barrow and Monte Bello Islands. FMOs in Carnarvon and Denham use an 8 metre rigid inflatable boat and a 7.3-metre rigid inflatable boat respectively. Both vessels are used to conduct at-sea inspections in Shark Bay and within the Southern aspects of the Ningaloo Marine Park and Commonwealth Marine Park. Collectively, all 3 Districts FMOs spend approximately 90 days a year at sea on patrol duties.

In addition to the afore mentioned maritime assets, Gascoyne FMO's also engage the services of a large patrol vessel the PV *Houtman* to conduct at sea compliance inspections of vessels operating the Shark Bay and Exmouth Gulf Prawn Fisheries and Gascoyne Demersal Scalefish fishery .

Other compliance activities undertaken are intelligence based investigations into offences by commercial and recreational fishers, catch inspections, licence checks, gear inspections and marine safety inspections.

#### Activities during 2013/14

During 2013/14, a reduced number of Fisheries and Marine Officers delivered a total of 6,036 hours of compliance and community education services in the field (Gascoyne Bioregion Compliance Table 1). This represents a slight increase in field compliance over the previous year. Contact numbers increased, but the numbers of warnings, infringements and prosecutions remained similar to previous years.

Other activities undertaken within the Gascoyne have included

- Commencement of the West Coast Deep Sea Crustacean Fishery Marine Stewardship Council certification
- Further development of the Gascoyne Demersal Phase II management plan amendments to move from an ITQ regime for Pink Snapper and ITE for other non- Pink Snapper demersal species to ITQ for both pink and non pink demersal scalefish.
- Progression of the Shark Bay Crab fishery from an “interim” management plan to management plan

- Recruitment of a Supervising Fisheries and Marine Officer into Carnarvon

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections. A number of investigations resulting from suspected breaches detected via the Vessel Monitoring System and intelligence based operations were also conducted. Management and FMO effort was again directed at building stronger relationships with industry through higher levels of contact both at sea and in port and through meeting with Licence Holders and Masters. During 2013/14 the Marine Stewardship Council (MSC) and the DoF continued progression of the assessment process to the final stages for the Shark Bay Prawn Fishery and the Exmouth Gulf Fishery.

The monitoring of marine park sanctuary zones and activities with respect to recreational fisheries has divided the recreational fishing compliance program from a stand-alone program into two distinct programs, one with a marine park focus. FMOs delivered compliance activities in relation to both Ningaloo Marine Park and Shark Bay Marine Park in line with the increased importance and focus of government on marine parks across the State.

#### Initiatives in 2014/15

For the 2014/15 year a number of initiatives across the Gascoyne Bioregion have been planned. These include:

MSC certification of Shark Bay Prawn and Exmouth Gulf Prawn fisheries.

Full assessment of West Coast Deep Sea Crustacean Fishery by the Marine Stewardship Council.

Implementation of a new Management Plan for the Gascoyne Demersal Scalefish Fishery

Implementation of a new Management plan for the Shark Bay crab Fishery

Introduction of a quota based fishery management framework for Shark Bay Scallop

Renewal and implementation of new state-wide marine park Collaborative Operational Plans with the Department of Parks and Wildlife

Recruit FMOs into Exmouth, Carnarvon and Denham

Amalgamate the Gascoyne and Midwest Regions

**GASCOYNE COAST COMPLIANCE TABLE 1**

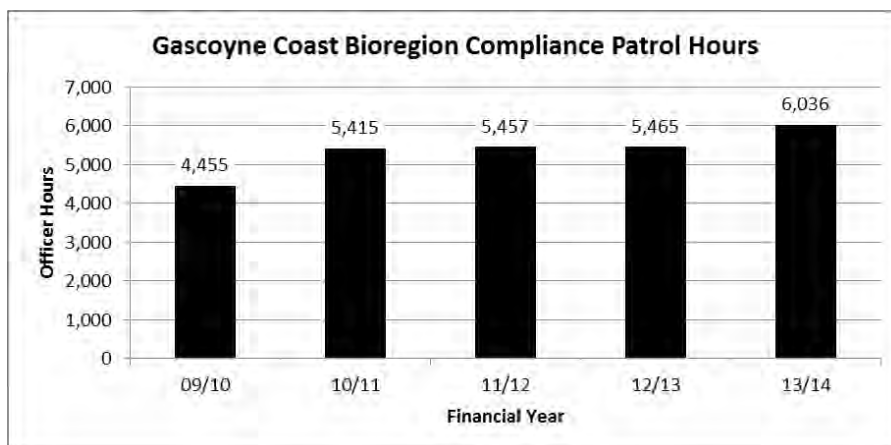
Summary of compliance and educative contacts and detected offences within the Gascoyne coast bioregion during the 2013/14 financial year.

<b>PATROL HOURS DELIVERED TO THE BIOREGION</b>		<b>6,036 Officer Hours</b>
<b>CONTACT WITH THE COMMERCIAL FISHING COMMUNITY</b>		
Field Contacts by Fisheries & Marine Officers		135
Infringement warnings		10
Infringement notices		11
Prosecutions		0
Fishwatch reports**		0
VMS (Vessel Days)***		7,606
<b>CONTACT WITH THE RECREATIONAL FISHING COMMUNITY</b>		
Field Contacts by Fisheries & Marine Officers		20,268
Infringement warnings		69
Infringement notices		137
Prosecutions		20
Fishwatch reports		41
<b>OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*</b>		
Field Contacts by Fisheries & Marine Officers		2,722
Fishwatch reports		0

\*Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "Other" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of these contacts are recreational in nature (e.g. personal contacts in Marine Parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises etc. are also included in this category.

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

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



**GASCOYNE COAST COMPLIANCE FIGURE 1**

"On Patrol" Officer Hours showing the level of compliance patrol activity delivered to the Gascoyne Coast Bioregion over the previous five years. The 2013/14 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. (The totals exclude: time delivered by the Department's large patrol vessels PV Walcott PV Houtman and PV Hamelin; time spent on other compliance related tasks e.g. travel time between patrol areas, preparation and planning time etc.. Time spent in Marine Park sanctuary zones is also excluded because this time may overlap field time outside a sanctuary zone and as a result, the historic data is slightly lowered compared to that reported in previous reports).