Western Australian Marine Stewardship Council Report Series
No. 1, 2015

Exmouth Gulf Prawn Managed Fishery

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Government of **Western Australia**
Department of **Fisheries**

Fish for the future

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Overview

This report provides a comprehensive description of the Exmouth Gulf Prawn Managed Fishery (EGPMF) in Western Australia and contains information relevant to assist the assessment of this fishery against the Marine Stewardship Council (MSC) standard (v1.3) for sustainable fishing. The EGPMF uses demersal otter trawl gear to target predominantly brown tiger prawns (*Penaeus esculentus*) and western king prawns (*Penaeus latisulcatus*).

The first part of this report (Sections 1 – 5) provides an overview of the EGPMF and the aquatic environment in which it operates, including information on the development of the fishery, fishing methods and gear used, the management system in place, an overview of the biology of the target species and external factors that may influence fishery operations and / or target species populations. The remainder of document provides more detailed information relevant to assessing the fishery against the performance indicators under MSC Principles 1, 2 and 3.

MSC Principle 1 (Sections 6 – 8) provides information to assess the condition of the target species' stocks. These sections provide information on the current stock status of brown tiger and western king prawns in Exmouth Gulf and includes a detailed description of the stock assessment approach and harvest strategy employed for ensuring the future sustainability of these stocks.

MSC Principle 2 (Sections 9 – 13) relates to the impact of the fishery on the marine environment in which it operates. These sections include, or point to, all currently-available information on the catch of retained non-target species, bycatch, interactions with endangered, threatened or protected (ETP) species, as well as a detailed description of the habitats and ecosystem within Exmouth Gulf and all fishery-related impacts on habitat and ecosystem structure and function. Where detailed quantitative data are not available, a risk assessment approach has been used to assess the level of risk associated with any identified fishery-specific issues. The issues identified and their associated risk ratings are provided throughout the Principle 2 sections, where relevant.

MSC Principle 3 (Sections 14 – 15) provides information to assess the governance and management in place for the fishery. Governance information provided includes an overview of the local, national and international legal frameworks relevant to the management of the fishery, a description of the roles, responsibilities and consultation processes undertaken with fishery stakeholders, the long-term objectives and the incentives in place for sustainable fishing. These sections also include information on the fishery-specific management system, including fishery-specific objectives, the decision-making process, compliance and enforcement, ongoing research and an evaluation of the performance of this management system in recent years.

Although this document has been divided into MSC Principle-specific sections, it should be considered in its entirety as many sections provide supporting and complementary information. While this document is intended to provide a comprehensive account of the fishery, it is by no means meant to be the only source of information for assessing the fishery.

If there is uncertainty regarding any parts of the descriptions and information herein, stakeholders should contact the Department so that any such issues can be addressed in subsequent updates of this document. This document should also be read in conjunction with the *EGPMF Harvest Strategy 2014 – 2019* and the *EGPMF Bycatch Action Plan 2014 – 2019*.

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Acronyms and Abbreviations

AAC	Aquatic Advisory Committee
AFMA	Australian Fisheries Management Authority
ALC	Automatic Location Communicator
ARMA	Aquatic Resources Management Act
BAP	Bycatch Action Plan
BRD	Bycatch Reduction Device
CALM	Conservation and Land Management (Act 1984)
CAMBA	China-Australia Migratory Bird Agreement
CITES	Convention on International Trade in Endangered Species
CEO	Chief Executive Officer
CI	Confidence interval
CL	Carapace length
CoA	Commonwealth of Australia
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSMPA	Composite Square Mesh Panel Aft
DoF	Department of Fisheries (Western Australia)
DotE	(Commonwealth) Department of the Environment
DPaW	Department of Parks and Wildlife (Western Australia)
EEZ	Exclusive Economic Zone
EGPMF	Exmouth Gulf Prawn Managed Fishery
EOI	Expression of Interest
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened or Protected (Species)
FAS	Fisheries Adjustment Scheme
FED	Fish Exclusion Device
FMO	Fisheries and Marine Officers

FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act (1994)
FRMR	Fish Resources Management Regulations (1995)
GIS	Geographical Information Systems
GVP	Gross Value of Production
ICU	Industry Consultation Unit
IFM	Integrated Fisheries Management
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
KPI	Key Performance Indicators
LOW	Letter of Warning
MAC	Management Advisory Committee
MCS	Monitoring, Control and Surveillance
MFL	Managed Fishery Licence
MSC	Marine Stewardship Council
NBPMF	Nickol Bay Prawn Managed Fishery
NPWC	National Parks and Wildlife Conservation (Act 1975)
NTA	Native Title Act
OCS	Offshore Constitutional Settlement
OCP	Operational Compliance Plan
OPMF	Onslow Prawn Managed Fishery
PSA	Productivity-Susceptibility Analysis
PSM Act	Public Sector Management Act
RMAD	Research, Monitoring, Assessment and Development (Plan)
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRAMF	Ranked Risk Assessment for Multiple Fisheries
SAT	State Administration Tribunal
SLA	Service Level Agreement

SRR	Stock-recruitment relationship
TED	Turtle Excluder Device
TPSA	Tiger Prawn Spawning Area
UoC	Unit of Certification
VFAS	Voluntary Fishery Adjustment Scheme
VMS	Vessel Monitoring System
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WAMSI	Western Australian Marine Science Institution
WC Act	Wildlife Conservation Act
WTO	Wildlife Trade Operation

1. Aquatic Environment

The Exmouth Gulf Prawn Managed Fishery (EGPMF) operates in the waters of Exmouth Gulf, a major tropical gulf within the Gascoyne Coast Bioregion of WA immediately east of the Cape Range Peninsula approximately 1100 km north of Perth (Figure 1.1). The Gulf is a marine embayment open to the north covering approximately 2200 km^2 (White 1975) and extending approximately 40 km east to west and 80 km north to south.

The Gascoyne Coast Bioregion represents a transition between the fully tropical waters of the northern coast and the temperate waters of the southwest region. The waters off the Gascoyne Coast are strongly influenced by the southward-flowing Leeuwin Current, generated by flow from the equatorial Pacific south through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area around Exmouth Gulf and flows south along the continental shelf (Fletcher & Santoro 2013).

Water depths in Exmouth Gulf range from intertidal flats along the southern and eastern shores to ~ 20 m in the northern and western regions. Rainfall in the region is extremely low and, coupled with minimal river flow entering the Gulf, creates a relatively stable hydrological environment (Penn & Caputi 1986). This changes, however, with the seasonal occurrence of tropical summer cyclones, which can bring extreme winds, heavy rainfall and increased runoff, altering salinity and turbidity within the Gulf.

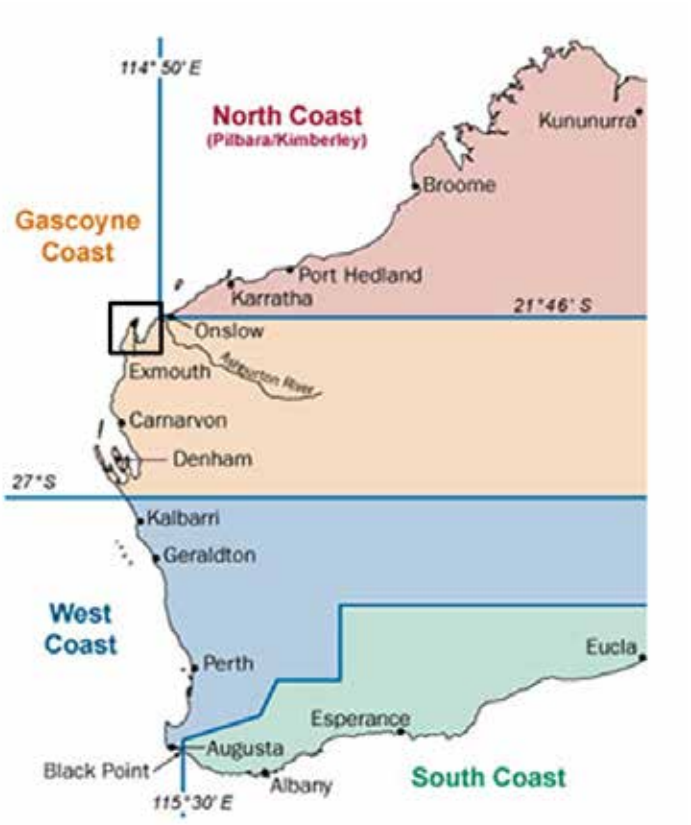


Figure 1.1. Locality of Exmouth Gulf (black box) within the Gascoyne Coast Bioregion of Western Australia

Key habitats within the Gulf include mangroves, intertidal mudflats, coral reef, seagrass and mud / sand bottom areas. The Gulf supports a number of tropical fish and invertebrate species, as well as protected species such as dolphins, marine turtles, elasmobranchs (e.g. sawfish), sea snakes and sea horses and pipefish.

2. Target Species / Stock Description

2.1 Brown Tiger Prawn

Figure 2.1. The brown tiger prawn. Illustration © R. Swainston (www.anima.net.au)

2.1.1 Taxonomy and Distribution

The brown tiger prawn (*Penaeus esculentus*) is a decapod crustacean of the family Penaeidae. The species is easily identified by its pattern of distinctive pale brown and darker bands (Figure 2.1).

Brown tiger prawns are generally regarded as endemic to Australian and are distributed around the northern coast, from central New South Wales in the east to Shark Bay, WA (Ward et al. 2006; Figure 2.2). Major fisheries for this species in WA operate in Shark Bay and Exmouth Gulf, with smaller catches landed in the coastal waters of the North Coast Bioregion, around Onslow and in the Kimberley.

Figure 2.2. Distribution of brown tiger prawns in Australia

2.1.2 Stock Structure

A number of genetic studies have explored the stock structure of brown tiger prawns in Australia. Mulley and Latter (1981) examined four polymorphic allozyme loci in populations of this species from Exmouth Gulf, the Gulf of Carpentaria, and northern and southern Queensland, finding no differences in gene frequency between these regions. In contrast to these findings, which have since been considered not to be statistically robust (Ward et al. 2006), Lavery and Keenan (1995) revealed significant spatial heterogeneity in a mitochondrial region of brown tiger prawns from Shark Bay and the east coast of Queensland.

More recently, Ward et al. (2006) analysed eight polymorphic microsatellite loci of brown tiger prawns and demonstrated a small differentiation between the functionally-independent populations of this species in Shark Bay and Exmouth Gulf, and a larger differentiation of these stocks from those in the Gulf of Carpentaria and Moreton Bay in Queensland.

In the North Coast Bioregion of WA, small quantities of brown tiger prawns are landed by the Onslow Prawn Managed Fishery (OPMF), which operates in the coastal waters north of Exmouth Gulf. There are brown tiger prawn stocks in the OPMF both adjacent to the northern boundary of the EGPMF and to the east of Onslow near the Fortescue River, which have separate nursery areas. The majority of brown tiger prawn catches in the OPMF are taken from the coastline adjacent to the EGPMF boundary.

It is likely that the environmental factors affecting recruitment of prawns into the EGPMF and the OPMF are the same, and there may also be some movement of prawns occurring between these two fisheries. Even though the two fisheries are managed separately (due to historical licensing allocations), similar harvest strategies are applied to both. Monitoring of the OPMF, however, is less intensive than in Exmouth Gulf, reflecting its lower overall production and value. The adjoining fishery to the north of the OPMF, the Nickol Bay Prawn Managed Fishery (NPMF), is primarily a banana prawn fishery and only lands minimal quantities of brown tiger prawns.

The independent management and monitoring of brown tiger prawn fisheries in WA is a conservative management approach that ensures that there is no serial depletion of prawns in different fishing areas. If there is a sustainability issue with brown tiger prawns in any area, management actions will be taken to maintain spawning stocks in each area.

2.1.3 Life History

Although tiger prawns can live for 2 – 3 years, individuals older than two years of age are rarely caught under current harvest practises. Brown tiger prawns mature at six to seven months of age, at which time they undertake a migration into more offshore waters to spawn (Penn & Stalker 1979; Penn & Caputi 1986). Approximately one month after mating (see below), female prawns will release the fertilised eggs, which float and typically hatch within 24 hours (Dall et al. 1990).

Penaeid prawns have a comparable larval development (Figure 2.3), hatching from the egg as freely-swimming nauplii. During the nauplii stages, the larvae do not feed but utilise stored food from the egg, completing a series of six moults before developing to the next larval stage (Penn & Stalker 1979). As the larval development continues through the protozoea, mysis and postlarvae stages, predators are responsible for high mortality rates of the larvae. If by this time the larvae have drifted to a suitable nursery area (e.g. beds of seagrass and algae), they will settle as postlarvae two to four weeks after eggs are released from the females (Dall et al. 1990; Haywood et al. 1995; Liu & Loneragan 1997). If settlement occurs in unsuitable habitats, they are likely to perish (Penn & Stalker 1979).

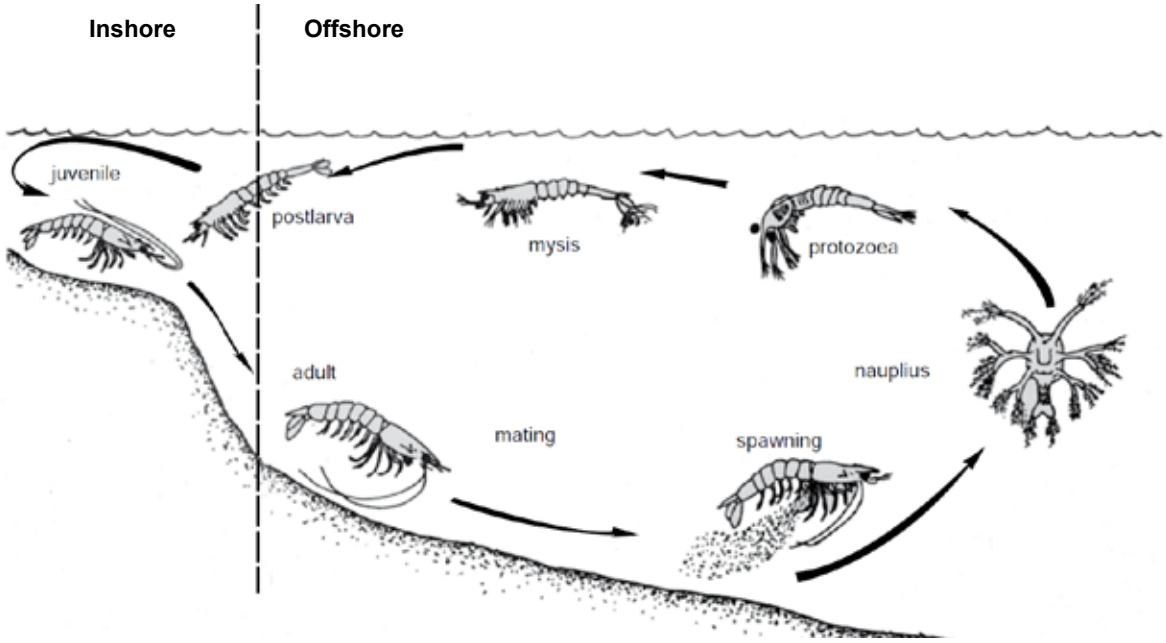


Figure 2.3. Life cycle of a penaeid prawn (modified from NSW Department of Industry and Investment 2010)

2.1.3.1 Movements and Important Habitats

Penaeid prawns need to move between different habitats to complete their lifecycle. Dall et al. (1990) describes these migrations as a larval and postlarval migration from the spawning ground to the nursery ground; a juvenile migration out of the nursery area; and an adult migration to deeper offshore water to spawn (see Figure 2.3).

Juvenile brown tiger prawns occupy shallow waters with seagrass and algal communities, which form the main juvenile habitat for this species (Kenyon et al. 1995, 1997). Despite a strong association of this species with structured habitats, however, tiger prawn larvae do not discriminate between different types of seagrass when they settle (Loneragan et al. 1998). In Exmouth Gulf, a main migration of juvenile prawns into deeper, more offshore waters occurs during late summer and autumn of each year, after spending approximately six months in the nursery areas (Penn 1980). Prawns move by either walking or swimming, however, the speeds recorded during migration are unlikely to be achieved by walking (Dall et al. 1990).

As pre-adults, brown tiger prawns migrate out of the nursery areas into deeper waters to spawn. Adult brown tiger prawns are generally found over mud or sandy mud substrates in

coastal waters less than 30 m depth, however, have been recorded as deep as 200 m (Grey et al. 1983). Most spawning females are found in water 13 – 20 m deep (Penn 1988; Penn et al. 1995).

Active vertical migration during the pelagic larval stage, in combination with water currents, is the most probable method transporting postlarvae to the inshore nursery areas (Penn 1975; Dall et al. 1990).

2.1.3.2 Reproduction

Brown tiger prawns first reach maturity at a size of 25 mm carapace length (CL), with 50 % of the population mature at 32 mm CL (Crocos 1987).

When prawns mate, the male needs to be hard-shelled and the female soft-shelled (i.e. newly moulted; Dall et al. 1990). The male inserts into the female reproductive organ (thelycum) a sperm capsule (spermatophore), which remains there until the female is ready to spawn her eggs. Eggs are released into the water before the female moults again, which is typically after approx. one month (Penn & Stalker 1979; Crocos & Kerr 1986). Spawning occurs at night with the eggs released from the female through small pores at the base of the third walking legs (Walker 1975).

Although spawning female brown tiger prawns are found in WA between July and the end of summer, the main spawning season of this species in Exmouth Gulf is between August and October (White 1975; Penn & Caputi 1986). Spawning occurs in the central marine waters of the embayment (White 1975; Penn & Caputi 1986).

2.1.3.3 Size-Fecundity Relationships

The relationship between the fecundity (F) and CL (mm) of brown tiger prawns can be described as:

$F = 22573 \times CL - 536291$ ($n = 131$) (Crocos 1987).

According to this relationship, mean fecundity in this species varies from around 96 000 to 615 000 for females between 32 mm and 51 mm CL (Crocos 1987). As retained ripe ova were rarely observed in spent ovaries, these values are considered to represent the numbers of eggs released at a single spawning. Females are capable to spawning more than once during a spawning season.

2.1.3.4 Factors Affecting Recruitment of Juveniles

Environmental factors such as rainfall, temperature and salinity have been identified as major causes of variation in penaeid recruitment (Garcia & Le Reste 1981; Jackson & Burford 2003). The recruitment of brown tiger prawns is negatively correlated with salinity and positively correlated with temperature (Penn & Caputi 1986; Courtney et al. 1995; Penn et al. 1995). Although juvenile brown tiger prawns can withstand a range of temperatures and salinities, exposure to extreme temperatures (15 and 35 ° C) and salinities (5 ‰ and 55 ‰) results in high mortality rates (O'Brien 1994). In Exmouth Gulf, cyclones can have both a

negative and positive effect on recruitment of prawns, depending on the timing, location and severity of the cyclone (Penn & Caputi 1986; see Section 5.3).

2.1.3.5 Weight-Length Relationships

The relationships between the wet weight (W, g) and CL (mm) of female and male brown tiger prawns in WA are described as:

Females: $W = 0.003739 \times CL^{2.5739}$

Males: $W = 0.002078 \times CL^{2.7645}$ (Penn & Hall 1974).

2.1.3.6 Age and Growth

Prawns have to moult (i.e. shed their external shell) in order to grow. Crustacean growth is a stepwise process, and moult frequency depends on the sex and size of the individual, as well as the environmental factors, such as food quality and quantity, population density, light, temperature and salinity (Dall et al. 1990). The size attained by crustaceans at any age is determined by the number of moults and the increase in size at each moult (Dall et al. 1990).

Small prawns moult frequently (daily to weekly), while adults moult around every month to two months (Kangas 1999). This often coincides with the lunar cycle, with a higher proportion of recently moulted prawns generally found during the full moon period. As newly moulted individuals are much more vulnerable to predation, they often remain buried in the sediment for a few days until the exoskeleton hardens, and they re-emerge at night to feed.

Due to the lack of hard parts, ageing of crustaceans cannot be undertaken by traditional age determination methods (Garcia & Le Reste 1981) and is instead typically done using modal analysis of size frequencies or tagging studies. The growth of female and male brown tiger prawns in Exmouth Gulf has been described by fitting a von Bertalanffy growth curve to a large sample of monthly length-frequency data for each sex collected from fishery-independent surveys between 1992 and 1996 (Harris 2000). A birth date of 15 September was assumed, based on this being the middle of the spawning period for this species (August to October). The resulting estimates of the von Bertalanffy growth parameters are: L_∞ = 40.4 mm CL for females and 32.7 mm CL for males, k = 2.5 year^{-1} for females and 2.9 year^{-1} for males, and t_0 = 0.06 years for females and -0.03 years for males (Harris 2000).

The longevity of brown tiger prawns is generally 2 – 3 years (Penn 1988). As indicated by the very high value of k, individuals of this species grow very rapidly early in life, which means that they attain an economically valuable size at about eight months of age. Fishing thus concentrates on the 0 + and, to a less extent, 1 + (residual) individuals.

2.1.3.7 Diet

Prawns feed primarily at night, and their diet includes small molluscs, crustaceans and polychaete worms (Dall et al. 1990). The diet of juveniles includes copepods, decapods, ostracods, gastropods, diatoms, filamentous algae and small protozoa diatoms, algae, and seagrass (O'Brien 1994).

2.1.3.8 Natural Mortality

Several values for natural mortality (*M*) of brown tiger prawns have been described in the published literature. In tiger prawn models for Australia's Northern Prawn Fishery, Wang and Die (1996) estimated *M* as 0.045 week^{-1}, while Somers and Wang (1997) assumed *M* to be 0.18 month^{-1} and considered values ranging from 0.12 to 0.26 month^{-1} when assessing the sensitivity of their model.

After reviewing estimates reported in the literature, Garcia (1985) recorded that the reported level of *M* for adults of *Penaeus* species was around 0.2 month^{-1}. This latter value was applied by Hall and Watson (1999) for brown tiger prawns in Shark Bay.

2.1.3.9 Parasites and Diseases

Bopyrid isopods and one species of copepod are the only crustaceans known to parasitise penaeids, including brown tiger prawns and western king prawns (Owens & Glazebrook 1985; Dall et al. 1990; Roberts et al. 2010). The parasites occupy the gill chamber of prawns and cause a conspicuous bulge of the branchiostegite (Dall et al. 1990). Female bopyrids have piercing mandibles which allow them to ingest the fluids of the host (Dall et al. 1990). Infection may cause the host to become sterile and take on the secondary characteristics of the opposite sex (Dall et al. 1990). It also affects the growth of infected prawns (Dall et al. 1990).

Several types of virus have been reported to infect penaeid prawns in aquaculture farms (e.g. DoF 2009; Department of Agriculture 2013); however, testing of wild prawns in WA has consistently provided negative results (Jones 2003; Jones and Crockford 2009)

2.2 Western King Prawn

Figure 2.4. The western king prawn. Illustration © R. Swainston (www.anima.net.au)

2.2.1 Taxonomy and Distribution

The western king prawn (*Penaeus latisulcatus*) is a decapod crustacean of the family Penaeidae. Following the elevation of the subgenera of *Penaeus* to genera by Pérez Farfante and Kensley (1997), many adopted the name *Melicertus latisulcatus* for this species. There is some controversy over the revised nomenclature, however, and thus the older names are used for the Australian species following Baldwin et al. (1998), Lavery et al. (2004) and Flegel (2007). The species is easily distinguished by its distinctive bright blue legs and tail (Figure 2.4).

The western king prawn is widely distributed throughout the Indo-West Pacific region (Grey et al. 1983). Within Australian waters, this species occurs in South Australia, WA, Northern Territory, Queensland and down the east coast to northern New South Wales (Grey et al. 1983; Figure 2.5). In WA, two major fisheries for western king prawns occur in Shark Bay and Exmouth Gulf, with smaller quantities landed in the North Coast Bioregion by prawn fisheries operating off Onslow and Broome.

Figure 2.5. Distribution of western king prawns in Australia

2.2.2 Stock Structure

Electrophoretic studies on western king prawns have demonstrated genetic differences among populations sampled in WA, the Gulf of Carpentaria and South Australia (Richardson 1982). This species generally only forms high level stocks in areas associated with the hypersaline waters of marine embayments (Kailola et al. 1993), which are likely to be largely independent of each other in terms of dynamics. The populations of western king prawns in Shark Bay and Exmouth Gulf thus function as independent, self-sustaining stocks, with distinct adult and juvenile habitats and independent variations in recruitment and abundance.

As the EGPMF shares a common boundary and possibly nursery areas with the OPMF, there may be some interchange of juvenile western king prawns, and almost certainly mixing of larvae, between the two fishery areas. The remaining western king prawn stocks distributed further northeast along the WA coastline are likely to be largely independent in a management context.

As with brown tiger prawns, the independent management and monitoring of western king prawns within each fishery is a conservative management approach that ensures that there is no serial depletion of prawns in different fishing areas. If there is any sustainability issue for this species in any area, management actions will be taken to maintain spawning stocks in each area.

2.2.3 Life History

The life cycle characteristics of western king prawns closely resemble those described above for brown tiger prawns (Penn & Stalker 1979; see Section 2.1.3). The larval development of this species has been described by Shokita (1984) and Dixon et al. (2010).

2.2.3.1 Movements and Important Habitats

As with other penaeid prawns, western king prawns undertake a migration from nursery areas to deeper, more offshore waters to spawn. This migration, which is likely to occur in response to either biological cues, such as size, and / or some change in their environment (such as rainfall, salinity, currents or temperature; Dall et al. 1990), is clearly demonstrated by changes in the abundance and size composition of prawns throughout the fishing season in Exmouth Gulf.

Post-larval and juvenile western king prawns can be found inshore on shallow tidal flats with sand or mud sediments, which are often backed by mangroves (Penn & Stalker 1979; Kangas & Jackson 1998). Because there is very little freshwater input, such inshore areas can have salinities higher than seawater (i.e. hypersaline waters). The juveniles of western king prawns prefer this habitat, unlike most other prawn species, which prefer estuarine conditions where seawater is diluted by freshwater.

Juvenile western king prawns spend about three to six months in the nursery grounds before they reach maturity and migrate offshore, entering the trawl fishing grounds (Penn & Stalker 1979). A smaller group of slow-growing juveniles that have spent the winter in nursery areas move offshore in early spring, appearing on the offshore trawl grounds in Exmouth Gulf in September / October. In contrast, the spring-spawned recruits grow faster over summer and arrive on the trawl grounds in February, March and April of each year. This cycle has been observed annually in Exmouth Gulf, where specific closures are used to protect the autumn-spawned recruits later in the fishing season (J. Penn, pers. comm.).

After moving out of the nursery areas, adult western king prawns inhabit coastal marine waters less than 80 m in depth, with bare sand substrate or with silt and shell grit, sponges and bryozoans (King 1977; Penn 1980). Western king prawns are nocturnal and highly sensitive to light, with their activity influenced by lunar cycles as well as temperature (Penn 1980). This species uses the sand as a defensive mechanism by burying itself to avoid predators (Tanner & Deakin 2001).

2.2.3.2 Reproduction

Western king prawns first mature at six to seven months of age, at a size of around 25 mm CL. As insemination rate is indicative of fertilisation success, Courtney and Dredge (1988) showed that ~ 50 % of females in Queensland populations of this species were inseminated at 34 mm CL, while ~ 95 % were inseminated at 42 mm CL. Females typically spawn their fertilised eggs in the water within a period of about one month of mating (Penn & Stalker 1979).

Spawning in western king prawns appears to be closely related to temperature, with increasing spawning periods observed with decreasing latitude along the WA coast (Penn 1980). Although spawning of this species occurs throughout the year in tropical areas, the peak spawning period in Exmouth Gulf extends from May to October (Penn 1980).

2.2.3.3 Size-Fecundity Relationships

Fecundity of western king prawns in WA is positively related to the size of the prawn (Penn 1980). The relationship between the ripe ovary weight (z, grams) and CL (mm) of western king prawns can be described as:

$z = 6.95 \times 10^{-5}\ CL^{2.916}$ ($n = 38$) (Penn 1980).

To relate the ovary weight data to fecundity, the relationship between size of the individual and number of ripe ova per gram of ovary was also investigated. As no significant difference in the number of ripe ova could be detected between prawns of different size, an overall mean value of 88 949 ova per gram was used. According to this estimate, female western king prawns can produce approximately 100 000 to 700 000 eggs per spawning (Penn 1980). Females of this species are capable of spawning multiple times within a season (Penn 1980; Courtney & Dredge 1988).

2.2.3.4 Factors Affecting Recruitment of Juveniles

Key factors that affect larval development and survival of penaeid prawns are generally considered to be temperature and salinity (e.g. Jackson & Burford 2003). Faster development and higher survival rates of western king prawns have been observed with increasing water temperatures (Rodgers et al. 2013). Under constant laboratory conditions, the total larval period of this species varies from 12.7 days (at 24.4 °C) to 31.3 days (at 17.1 °C), while larval survival is greatest at 25 °C (74 %) and lowest at 17 °C (36 %), demonstrating its strong tropical affinity (Rodgers et al. 2013).

Despite juvenile penaeids being very good osmoregulators (Dall 1981), prawn catch rates can be negatively correlated with salinity (Courtney et al. 1995). The optimum salinity range for rearing western king prawns is from 22 to 34 ‰, with the mean final weight, total length and specific growth being the highest at 34 ‰ (Sang & Fotedar 2004).

2.2.3.5 Weight-Length Relationships

The relationships between the wet weight (W, g) and CL (mm) of female and male western king prawns in WA are described as:

Females: $W = 0.001557 \times CL^{2.7010}$

Males: $W = 0.0008474 \times CL^{2.8899}$ (Penn & Hall 1974).

2.2.3.6 Age and Growth

The growth of western king prawns has been described by fitting a von Bertalanffy growth curve to monthly length-frequency data collected in Shark Bay. The values of the estimated parameters are: $L_\infty = 60.0$ mm CL for females and 45.0 mm CL for males and, $k = 3.24$ year^{-1}

for females and 2.04 year^{-1} for males, and t_0 = -0.03 years. The mean asymptotic length (L_∞) for western king prawns is substantially greater than brown tiger prawns but the former species is more slender and longer and thus lighter for a given carapace length.

The life cycle of western king prawns is generally 2 – 3 years (Penn 1980). As with brown tiger prawns, individuals of this species grow very rapidly early in life, which means that they attain an economically valuable size at about eight months of age. Fishing thus concentrates on the 0 + and, to a lesser extent, 1 + (residual) individuals.

2.2.3.7 Diet

Western king prawns are mainly detritus feeders, consuming benthic fauna and organic debris. They are nocturnal, burying themselves during the day and emerging at night to feed. Juvenile penaeid prawns feed on copepods, decapods, ostracods, gastropods, diatoms, filamentous algae and small protozoa diatoms, algae and seagrass (O'Brien 1994).

2.2.3.8 Natural Mortality

The daily instantaneous rate of *M* for western king prawns in WA has been calculated as 0.002 – 0.005 day^{-1} (Penn 1976). Similar values of *M* for this species for have also been determined in Spencer Gulf (0.003 – 0.005 day^{-1}; King 1977), Gulf St Vincent (0.003 day^{-1}; Kangas & Jackson 1997; Xiao & McShane 2000) and on the western coast of South Australia (0.001 – 0.014 day^{-1}; Wallner 1985).

2.2.3.9 Parasites and Diseases

For information about common parasites and diseases that affect penaeid prawns, see Section 2.1.3.9.

3. Fishery Information

3.1 Development of Fishery

Industrial fishing for penaeid prawns along the WA coastline started in the early 1960s, with two major fisheries developing at Shark Bay (26 º S) and Exmouth Gulf (22 º S; Penn et al. 1997). The Exmouth Gulf fishery began in 1963, initially with 12 boats targeting primarily banana prawns (*Penaeus merguiensis*) using single-rigged trawl nets. As the fishery expanded in the following years, the target species changed, with brown tiger prawns becoming increasingly more important. Currently, the two main target species of this fishery are brown tiger prawns (*P. esculentus*) and western king prawns (*P. latisulcatus*).

The key changes to the management of the prawn fishery in Exmouth Gulf throughout time are detailed in Kangas et al. (2008). Limited entry to the fishery was first introduced in 1965, with the trawl fleet developing incrementally to a maximum of 23 vessels in 1979 (Penn et al. 1997). Fishers could initially operate at anytime, anywhere within the Gulf, but they primarily stayed in the central areas. As the fishery developed and the understanding of spatial and temporal variation in prawn abundance increased, however, closed nursery areas and closed seasons over part of the fishing grounds were introduced to permit prawns to grow to an acceptable market size before being harvested (Meany 1979).

By 1975 all boats were towing twin-rigged nets, with the sizes of each net headrope being either 10.97 m (6 fathom [ftm]) or 12.8 m (7 ftm). As older fishing boats were replaced by larger boats, the engine power increased. This increased engine power resulted in an increase in the size of net headrope towed to a maximum of 14.6 m (8 ftm) nets in twin gear configuration.

A collapse of the Exmouth Gulf brown tiger prawn stock in the early 1980s (see below in Section 3.3) led to increased levels of monitoring and the implementation of additional fishery closures (Kangas et al. 2008). For example, a specified tiger prawn spawning area (TPSA) was to be closed when the commercial catch rate fell below a pre-determined level to maintain an adequate breeding stock of this species. Between 1984 and 1990, a Voluntary Fishery Adjustment Scheme (VFAS) reduced the number of licenses in the EGPMF from 23 to 16.

The prawn fishery in Exmouth Gulf came under formally legislated management in 1989, when the *Exmouth Gulf Prawn Limited Entry Fishery Notice 1989* was introduced. This notice, which is now referred to as the management plan for the fishery (see Section 4 below), included the formal legislation of a number of management measures, including seasonal opening and closing, gear standardisation and spatial closures. The boundaries of the EGPMF and the extent of the permanently closed areas as legislated under the management plan are outlined in Figure 3.1.

Restructures of the fishing fleet occurred in the 1990s, with further industry-funded licence buy-backs and the commencement of trialling more efficient, quad-rigged trawl gear. Since 2000, all licenced vessels in the EGPMF have been using quad-rigged gear, and the number of vessels has gradually reduced to six.

The estimated employment in the EGPMF in 2013 was 18 individuals, including skippers and crew, with 23 additional support staff based in Exmouth Township and Fremantle. Within the Exmouth area, the fishery is one of the major regional employers contributing to the economic viability of the Exmouth Township. There is a high degree of vertical integration within the EGPMF, with the fishing company that owns the boats undertaking direct marketing of the product into overseas markets. For this reason, prices quoted for prawns and other byproduct species are based on an overall average price, taking into account the abundance of each grade of product landed. The total estimated value of the fishery (including byproduct) in 2013 was AUD 6.8 million (Sporer et al. 2014).

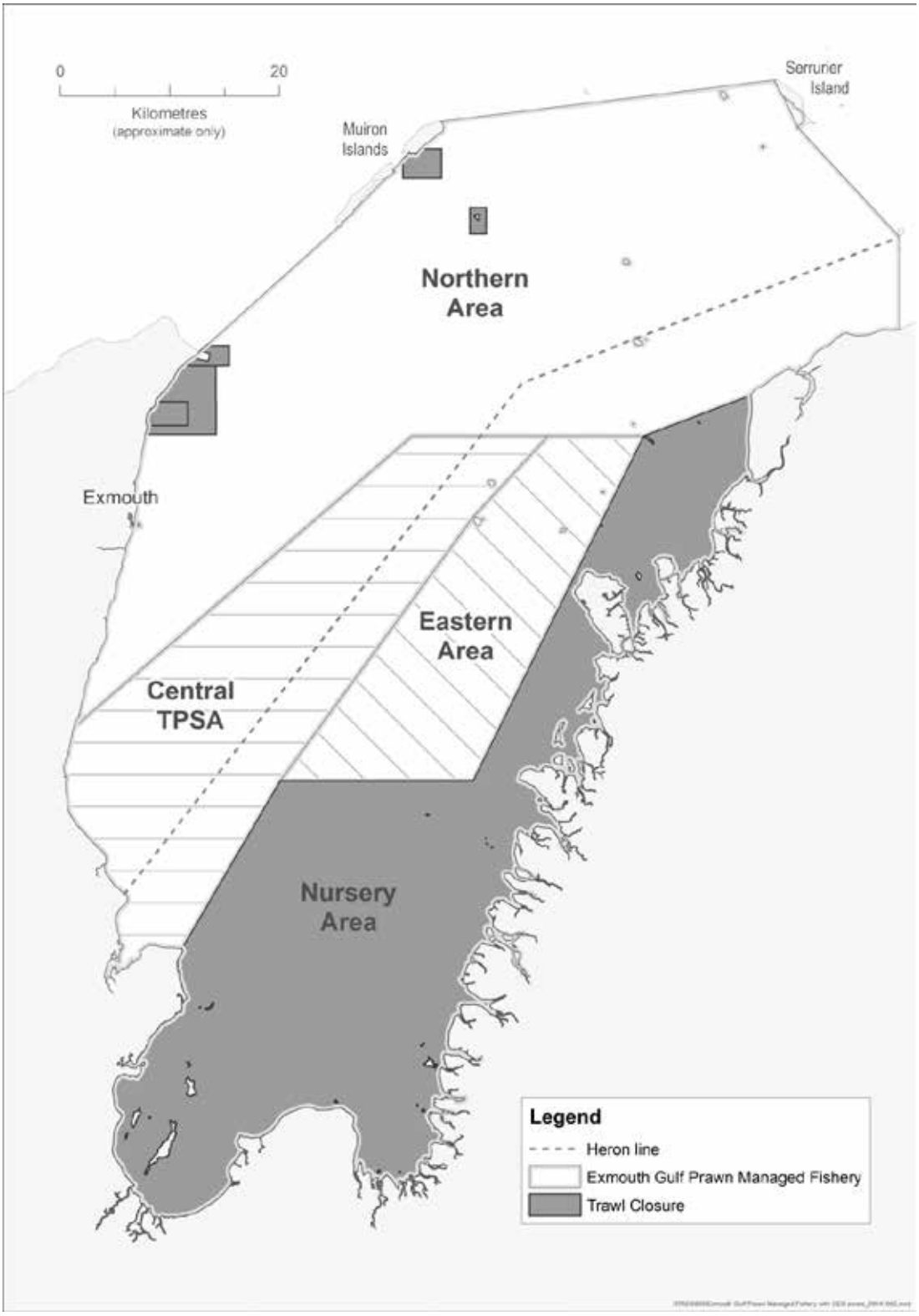


Figure 3.1. Main fishery boundaries and management areas of the EGPMF

3.2 Fishing Gear and Methods

Vessels in the EGPMF use low-opening demersal otter trawl nets in quad-rigged formation (Figure 3.2). Six boats operated in the fishery in 2013, towing a total of 292.6 m (160 ftm) of

net headrope. There were two different headrope sizes towed during the 2013 season: four boats towed 10.97 m (6 ftm) nets and two boats towed 14.63 m (8 ftm) nets.

Otter boards are attached to the extremities of each net (Figure 3.2), with the height of the fishing gear set by the height at the point where they are connected to the otter boards. Forces produced by water flowing over the otter boards open the trawl nets laterally. This lateral spread controls the catching efficiency of trawl gear and determines the area swept. Generally, the headrope and footrope are spread between 60 % and 85 % of their length.

Attached to the footrope is the ground chain. The ground chain is designed to skim over the sand instead of digging into the seafloor. As the ground chain travels over the sea floor, it disturbs the prawns so they rise into the oncoming net. The low-opening nets used have the headrope as a lead-ahead, which acts as a net veranda and is set in front of the footrope. This ensures that prawns disturbed by the ground chain do not pass over the headrope and thus, maintains the catch efficiency of the nets.

Each trawl shot ranges from 60 to 200 minutes in duration. Historically, all boats were "wet boats" and landed retained product ashore for processing at the Learmonth processing facility (Sporer et al. 2013); however, starting in the 2012 season, all six boats were fitted with freezer storage capacity for processing at sea.

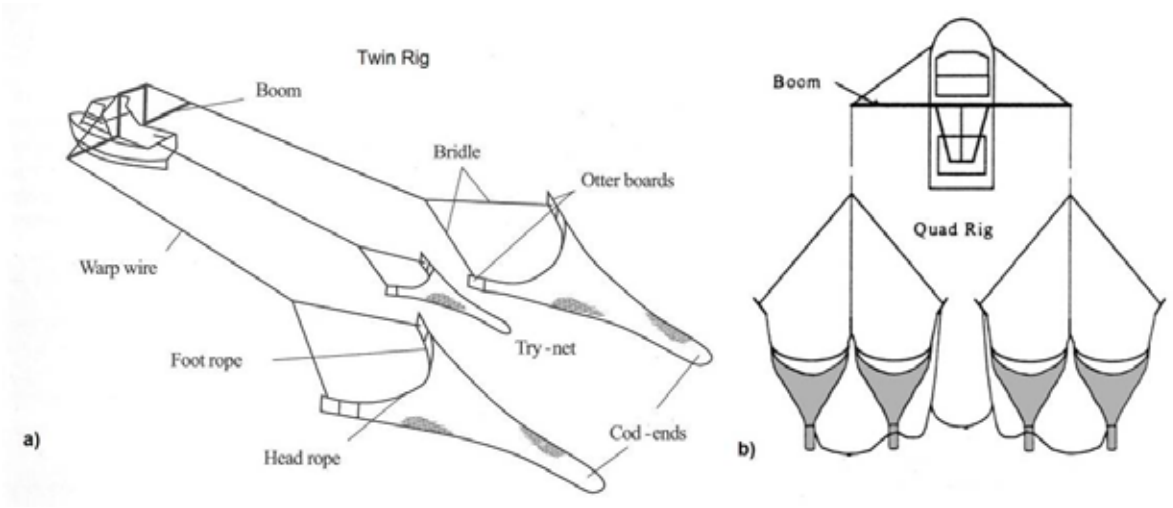


Figure 3.2. Standard historical twin-rig otter trawl (a) and current quad-rig otter trawl (b) configurations used in the EGPMF (Adapted from Stirling 1998)

All trawl nets in WA are required to be fitted with bycatch reduction devices (BRDs). In WA, BRDs are defined as "a device fitted within a net, and any modifications made to the net, which allows bycatch, or part thereof, to escape after being taken in the net and consists of a grid and a fish exclusion device either in combination or as separate devices". Grids are a rigid barrier fitted within a net, which allows large animals (including turtles and dolphins) and or objects to escape immediately after being taken into the net. In WA, grids must comply with the following specifications:

- Have a rigid inclined barrier (installed in the net at an angle no greater than 60 °), comprising bars that are attached to the circumference of the net, which guides animals and / or objects towards and escape opening forward of the grid;
- Have an escape opening with the following minimum measures when measured with a taut net:
    - 75 cm across the widest part of the nets; and
    - A perpendicular measure of 50 cm from the midpoint of the width measure.
- Have a maximum vertical bar clearance spacing of 20 cm.

Within these requirements, the EGPMF industry has continued to develop, trial and implement fishery-specific BRDs for efficiency purposes. In addition to grids, all nets must have square mesh panels (see details on BRD trials provided in Section 9.1). Since 2002, the industry has also used onboard 'hopper' or 'well' in-water sorting systems, which provide an improved quality of prawns and reduces mortality of some bycatch species (Ocean Watch Australia 2004). Hoppers allow for the catch to remain in recirculating seawater for an extended period, thereby maximising the survival of discarded species.

Trawling by vessels in the EGPMF generally occurs in approximately 30 % of Exmouth Gulf each season, and in 2013, ~ 22 % of the Gulf was trawled. The trawling effort is focused predominantly on mud and sand habitats in the deeper, central and north-western parts of Exmouth Gulf (see Figure 3.1).

The annual cycle of operation for the EGPMF is dynamic and depends on the strength and timing of prawn recruitment. The harvest strategy adopted for the EGPMF (see Section 8 for more detail) aims to allow prawns to reach optimal market sizes before fishing commences, as well as to provide protection to the spawning stocks through temporal closures of key spawning areas throughout the season.

Fishing during the first part of the season (between April and July) focuses primarily on brown tiger prawns, which arrive first on the trawl grounds. When the Central TPSA and the Eastern Area of the fishery (Figure 3.1) closes around August to protect spawning tiger prawns, fishing effort shifts to the Northern Area of the Gulf to target western king prawns, which peak in abundance during August and September. Fishing effort normally continues into November, and in 2013, fishing ceased on 10 November, with 144 days of the season actually fished (Sporer et al. 2014).

3.3 Overview of Catch and Effort

As the prawn fishery in Exmouth Gulf developed, fishing effort and catches of prawns steadily increased to a peak level in the late 1970s (Figure 3.3). Catches in this early period were largely dominated by brown tiger prawns and in 1981 and 1982 there was a decline in recruitment and subsequent catch of this species associated with overfishing (Figure 3.3). Due to the low abundance of brown tiger prawns in the early 1980s, effort in the fishery shifted onto western king prawns, which is a species considered to be less vulnerable to overfishing. Since the recovery of the brown tiger prawn stock after the collapse, overall

fishing effort in the EGPMF has gradually declined in response to licence buy-backs and subsequent reductions in the size of the fishing fleet (Figure 3.3).

Following the introduction of new management measures to help rebuild the brown tiger prawn stock, catches of the species returned to levels achieved in the 1970s (400 – 600 t; Figure 3.3). Landings of both target species in Exmouth Gulf then remained relatively stable until 2000, when a substantial decline in stock levels (particularly of brown tiger prawns) associated with impacts of the Category 5 Cyclone Vance was observed (Figure 3.3). The cyclone caused significant damage to the seagrass habitats in the gulf (see Section 5.3), which act as important nursery areas for juvenile brown tiger prawns. Once seagrass habitats recovered, brown tiger prawn catches increased to pre-cyclone levels (Figure 3.3).

Western king prawn landings in Exmouth Gulf after Cyclone Vance returned to normal levels for three years, however, in 2007, began to decline and reached a very low level in 2011 (Figure 3.3). This was also reflected in low recruitment of western king prawns in that year (see Section 6.1.2 for more information). Although the western king prawn stock has shown signs of recovery over the past few years in response to a reduction in fishing effort, including implementing delayed fishing and spatial closures, catches of brown tiger prawns in 2012 and 2013 have been as low as previously recorded throughout the history of the fishery (Figure 3.3). The low brown tiger prawn recruitment levels in recent years appear to once again be associated with a lack of structured vegetated habitats in nursery areas in Exmouth Gulf (see Section 6.1.1 for more information).

In response to the recent low recruitment levels of brown tiger and western king prawns in Exmouth Gulf, fishing effort in the EGPMF has remained low. Total nominal effort in the EGPMF for the 2013 season was 9503 hours, an increase compared to the extremely low nominal effort of 7042 hours recorded in 2012 (Sporer et al. 2014). The adjusted effort (to twin gear) in 2013 was 17 124 hours, which is the second lowest in 40 years, after the 2012 record low (Figure 3.3).

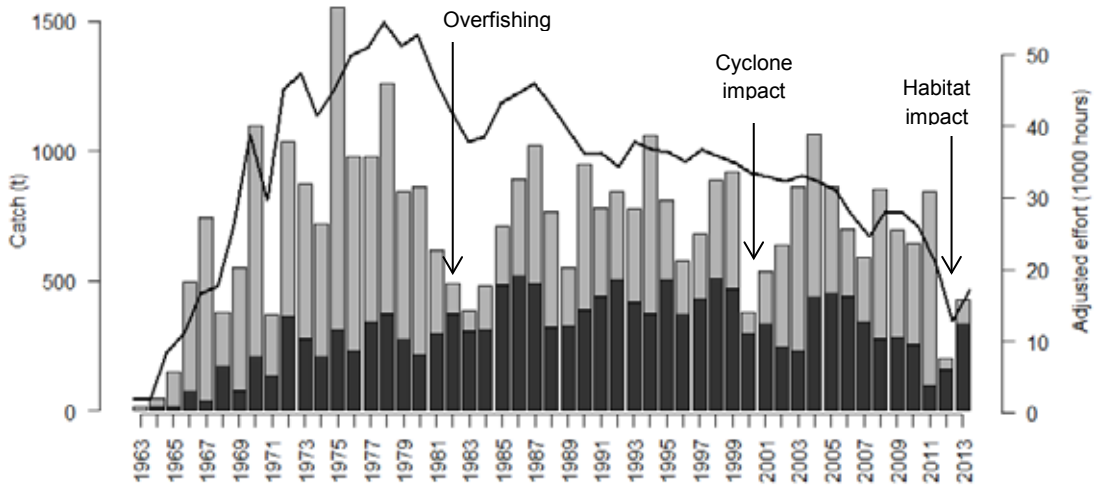


Figure 3.3. Annual adjusted (to twin gear) fishing effort (black line) and catches of brown tiger prawns (grey bars) and western king prawns (black bars) in the EGPMF between 1963 and 2013

It is worth noting that whilst trends in the total adjusted fishing effort shown (directed at all prawn species) in Figure 3.3 is useful for understanding broader changes in overall effort in the EGPMF, it is not used directly in assessment of the targeted species. Analysis of the spatial distribution of catches from logbook data (see Section 8.4.2.1.1 for more detail) shows that the majority of brown tiger prawn catch is taken from the central areas for the Gulf, whilst western king prawns are mainly targeted in the Northern Area (Figure 3.1). This has important implications for monitoring and assessment as it allows calculation of robust indices of recruitment and spawning stock abundance for the two target species (see Section 7.1) based on the effort directed on each species. Although the stocks of brown tiger and western king prawns in Exmouth Gulf are also retained by commercial fishers operating in waters north of the Gulf by the OPMF, catches, particularly in recent years, are very minor (see Section 5.1 for a catch summary).

4. Fishery Management

An overview of the fishery-specific governance and management relating to the EGPMF is presented below. More detailed information, including a description of the long- and short-term management objectives for these fisheries, is provided in the MSC Principle 3 Sections 14 and 15.

4.1 Management System

The fishery is managed by the Department under the following legislation, which can be accessed via the Department's website[1]:

- *Fish Resources Management Act 1994* (FRMA) [2];
- *Fish Resources Management Regulations 1995* (FRMR);
- *Exmouth Gulf Prawn Managed Fishery Management Plan 1989*;
- Managed Fishery Licence (MFL) conditions;
- Section 43 Orders - *Prohibition on Commercial Fishing (Muiron Islands Marine Management Area) Order 2008* and *Prohibition on Commercial Fishing (Ningaloo Marine Park) Order 2005*; and
- FRMA Section 7(2) instruments of exemption.

Fishers must also comply with the requirements of the:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Western Australian Marine Act 1982*; and
- Western Australian *Wildlife Conservation Act 1950*.

[1] http://www.fish.wa.gov.au/About-Us/Legislation/Western_Australian_Fisheries_Legislation/Pages/default.aspx
[2] Note the FRMA will be replaced by *Aquatic Resources Management Act* once enacted.

4.1.1 FRMA

The FRMA provides the overarching legislative framework to implement the statutory management arrangements for EGPMF and contains the head powers to determine a management plan (section 54). WA management plans are subsidiary legislation which set out the operational rules that control managed commercial fishing activities and should be viewed in conjunction with other specific relevant subsidiary legislation and strategies in place for the fishery. The management plan provides the power (pursuant to section 58) to issue and restrict the number of authorisations and regulate other conditions and grounds relating to fishing. There is also power to set the capacity of the fishery under a management plan (section 59). The FRMA also sets out the procedure for determining and amending a management plan (sections 64 and 65).

4.1.2 FRMR

The FRMR contain a number of requirements pertaining to all commercial fisheries in WA. For example, regulation 64 requires commercial fishers to submit mandatory catch returns in the form approved for that fishery. Licensees in the EGPMF are required to report retained species catches, effort, any endangered, threatened and protected (ETP) species interactions and fishing location in statutory daily logbooks.

4.1.3 Management Plan

The *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* (the Management Plan) is the primary statutory management instrument for the EGPMF. The Management Plan was established as a *Limited Entry Fishery Notice* under the previous State *Fisheries Act 1905*; however, all existing management plans established under section 32 of the *Fisheries Act 1905* were transitioned under section 266 of the FRMA when it was established in 1994. The Management Plan implements the following set of statutory measures to meet the fishery-specific management objectives for the EGPMF:

- **Limited entry:**

  The number of managed fishery licences (MFLs) in the EGPMF is limited to 15. Each licenced fishing boat operating in the EGPMF must be documented on a MFL and all persons commercially fishing in the EGPMF must hold a commercial fishing licence.

  All 15 MFLs in the EGPMF are held in the name of a single fishing company — MG Kailis Pty Ltd.

- **Areas of the fishery:**

  The Management Plan prescribes the following boundary and areas of the EGPMF —

  - The overall waters of the fishery (see Figure 3.1);
  - The boundaries of a permanently closed prawn nursery area in the eastern and southern section of Exmouth Gulf (see Figure 3.1);

- An area in which gear may be trialled no more than 14 days before the opening of the fishery with codends open and during daylight hours; and
- A port area closure within three nautical miles of Exmouth Marina.

- **Annual closed season:**

  The EGPMF is closed to fishing each year between November and March / April pursuant to clause 10 of the Management Plan (see Section 4.1.4 below). Seasonal closure and opening is based on prawn biology and historical fishery information, and season-specific dates vary each year, depending on lunar phase (i.e. after the full moon).

  For the 2013 season, official opening and closing dates were set at 8 April and 14 November. The timing and extent of fishing within this set period are flexible and based on both fishery independent and fishery dependent information. In 2013, fishing actually commenced on 15 May and ceased on 10 November.

- **Permanent temporal closure:**

  Fishing is only allowed at night when the fishery is open (daytime closures apply from 0800 hrs to 1800 hrs). This measure greatly reduces trawler visibility and conflict with other marine users.

- **Gear specifications:**

  Clause 11 of the Management Plan sets out the statutory 'default' net, otter board and ground chain specifications that the fishery must adhere to. In order to increase the overall operational efficiency of the fleet through the development of fishing technology within a sustainable management framework, the fishery has, in recent years, implemented the use of quad-net gear and otter boards with dimensions other than what is provided in clause 11. However, the fishery must operate to an overall headrope limit (gear capacity). Licenced fishing boats are permitted to use the alternative gear (and restricted to the headrope limit) by way of an exemption to clause 11 (see Section 4.1.5 below).

  Clause 15 of the Management Plan limits the size of a licenced fishing boat that may be used to operate in the fishery (i.e. the 375 boat unit rule). To provide the licensee with the opportunity to optimise the economic returns generated by the fishery within a sustainable management framework, the fleet no longer has to comply with the 375 boat unit rule (as calculated in accordance with clause 15), however; there is an overall limit on the size of the boat used to fish in the fishery. This allowance is provided by way of an exemption to clause 15 (see Section 4.1.5 below).

- **Vessel Monitoring System:**

  Fishing activities (location and intensity) are monitored by the Department via a Vessel Monitoring System (VMS), with all licenced fishing boats operating in the EGPMF required to install an operational Automatic Location Communicator (clause 16A of the Management Plan).

4.1.4 Determinations by the Director General (Chief Executive Officer)

The annual closed season in the EGPMF is implemented by virtue of an annual statutory notice made by the Director General (as the Chief Executive Officer) pursuant to clause 10 of the Management Plan. This framework provides the power for the Director General to statutorily open and close the EGPMF annually without the need for an amendment to the Management Plan. The annual notice is the statutory instrument that caps the maximum number of days that fishing is permitted each season, and also prescribes spatial management areas within the fishery that are used to manage the distribution of fishing effort during the season (see Section 4.2 below).

4.1.5 Exemptions

The FRMA provides the head power (section 7) to implement statutory management measures alternative to existing arrangements. Exemptions are often used when measures are being trialed, prior to them being implemented permanently (e.g. in the Management Plan). Two such Exemptions are currently in place for the EGPMF:

- **Gear specifications:** Exemption 2056 permits a licenced fishing boat operating the EGPMF to fish using quad-rigged trawl nets and otter boards being no greater than 290 cm (114 inches) in length and 107 cm (42 inches) in breadth. The Exemption also restricts the total allowable headrope length (excluding try nets) to be used at any one time to 395.02 m (216 ftm). In 2013, six licenced fishing boats towed 74 % (292.6 m [160 ftm]) of the total allowable headrope length.

- **Maximum size of licenced fishing boat:** Exemption 2202 permits a licenced fishing boat operating the EGPMF to be larger than the prescribed 375 boat units; however, the Exemption limits the size of the boat used to fish in the fishery when operating under the authority of the Exemption to a maximum of 24.99 m.

4.1.6 Managed Fishery Licence Conditions

The EGPMF fleet is required to have BRDs in the forms of grids and fish exclusion devices (FEDs), such as square mesh panels, in each net. This requirement is currently implemented via a MFL condition.

4.1.7 Section 43 Orders

Following the establishment of the Ningaloo Marine Park and Muiron Islands Marine Management Area, trawling closures were implemented in the north-eastern area of Exmouth Gulf pursuant to section 43 of the FRMA (see Section 4.6.1 below).

4.2 Harvest Strategy

The *EGPMF Harvest Strategy 2014 - 2019* (DoF 2014a) outlines the long- and short-term fishery-specific management objectives; a description of the performance indicators used to measure performance against these objectives; reference levels for each performance indicator; and associated harvest control rules, which articulate pre-defined, specific management actions designed to maintain each resource at target levels and achieve the management objectives for the fishery.

Once the EGPMF is opened to trawling (via a notice made by the Director General pursuant to clause 10 of the Management Plan), fishery-independent and fishery-dependent (monitoring daily catch rates) information informs the timing and extent of fishing for prawns in each management area during the season, in line with the harvest strategy. While the in-season openings and closing of areas are non-statutory, they are monitored by VMS.

4.3 Bycatch Action Plan

A program of bycatch reduction and assessment of biodiversity impacts have been in place for the EGPMF for more than a decade. The *EGPMF Bycatch Action Plan 2014 – 2019* (DoF 2014b) sets out the current and proposed activities aimed at achieving long- and short-term fishery-specific management objectives as they relate to bycatch, ETP species and ecosystem processes.

4.4 Cooperative Management Framework

In addition to the sustainable fishing framework as set out in the *EGPMF Harvest Strategy*, a cooperative framework is applied for decisions predominantly aimed at meeting economic objectives. This consists of non-statutory "openings" and "closings" of the management areas where the determination of actual areas to be fished within the fishery is done through agreement with the licensee. The Department and the licensee collaborate to make decisions regarding the timing and extent of the areas to be fished, including the extent of moon closures. This approach provides the licensee with the opportunity to maximise returns by managing fishing effort on small and soft prawns, which have a lower market value. For further information on the cooperative management framework please refer to Section 15.2.

4.5 Customary and Recreational Fishing

There is no evidence of significant fishing activity for prawns by Indigenous or recreational fishers in Exmouth Gulf.

People of Aboriginal descent do not need a recreational fishing licence if fishing for prawns using traditional methods; otherwise, they are required to adhere to recreational fishing rules. There is a state-wide recreational daily bag limit of nine litres of prawns. Prawns can be legally caught using a single hand-dip net, hand scoop net, hand throw net, or prawn hand trawl (drag) net that is not more than four metres across with a mesh of not less than 16 mm, and must not be attached to a boat or set. A fishing licence is required for a person using set, haul or throw nets recreationally in WA. A recreational boat fishing licence is required if dip netting for prawns using a powered boat.

For further information the customary fishing framework in WA, please refer to Section 14.1.

4.6 Marine Protected Areas

4.6.1 State Marine Protected Areas

The Ningaloo Marine Park (State Waters) and Muiron Islands Marine Management Area are two State-managed marine protected areas that occur within the boundaries of the EGPMF (Figure 4.1).

Ningaloo Marine Park[3]

Ningaloo Marine Park was gazetted in 1987 and is located in the north-western part of Exmouth Gulf. Operators in the EGPMF are permitted to trawl in the general use / unzoned areas within the waters of the fishery but not in recreational areas and sanctuary zones.

Muiron Islands Marine Management Area[3]

The Muiron Islands Marine Management Area, WA's first marine management area, was gazetted on 30 November 2004 and covers the North and South Muiron Islands and Sunday Island north of Exmouth Gulf. Trawling is permitted in the general use / unzoned areas within the waters of the fishery but is prohibited in sanctuary zones.

The *Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015*[4] was formally approved by the Minister for the Environment on 7 January 2005.

The Department gazetted two orders under section 43 of the FRMA to manage fishing in the Ningaloo Marine Park and Muiron Islands Marine Management Area:

- *Prohibition on Commercial Fishing (Ningaloo Marine Park) Order 2005*; and
- *Prohibition on Commercial Fishing (Muiron Islands Marine Management Area) Order 2008*.

[3] http://parks.dpaw.wa.gov.au/sites/default/files/downloads/parks/Ningaloo%20Marine%20Park%20Zones%20January%202014.pdf

[4] http://www.dec.wa.gov.au/management-and-protection/marine-environment/marine-parks-and-reserves/marine-parks-and-reserves-authority/5214-management-plans55.html

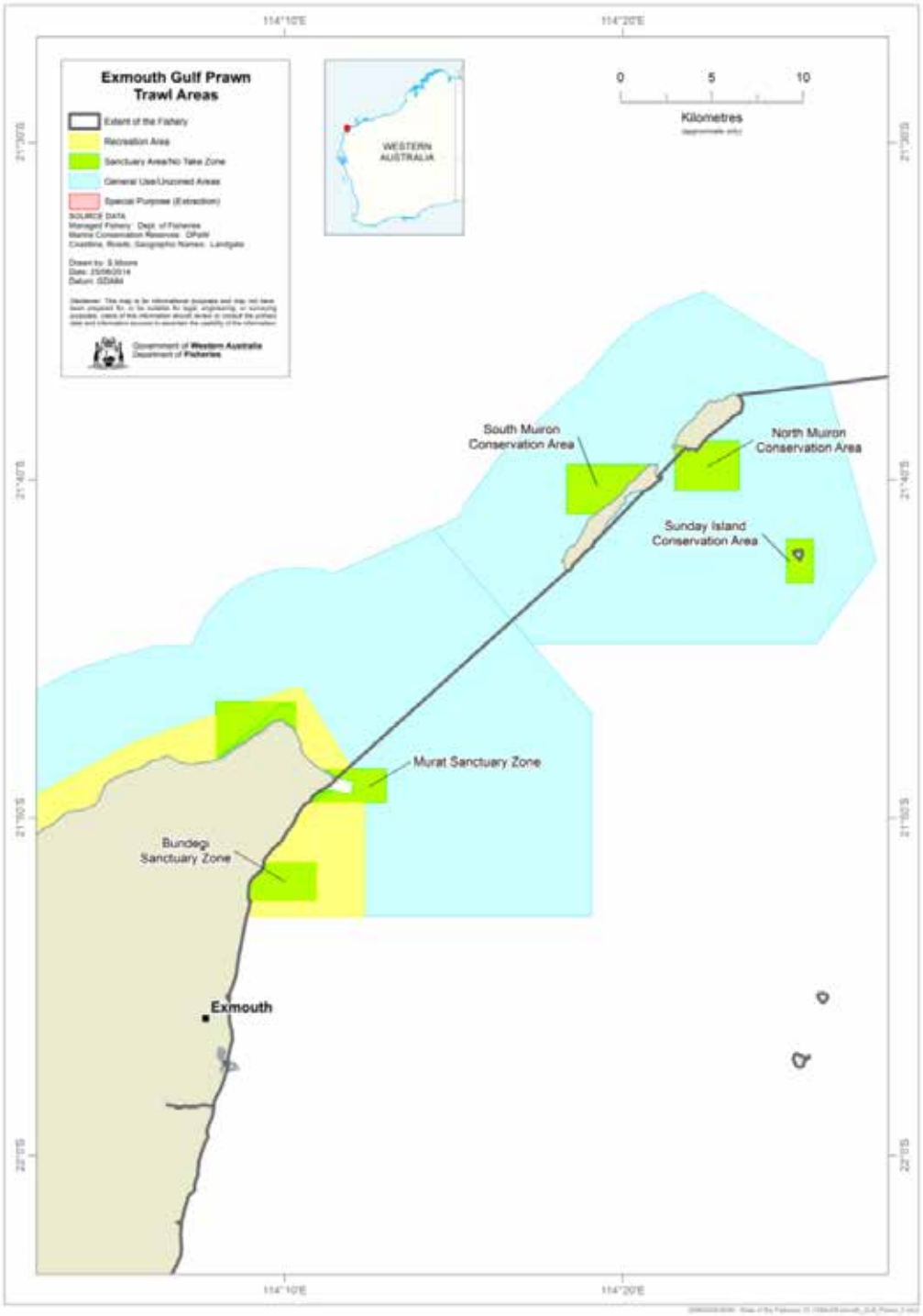


Figure 4.1. Ningaloo Marine Park and Muiron Islands Marine Management Area and areas of overlap with the north-western waters of the EGPMF

4.6.2 Commonwealth Marine Parks and Reserves

The Ningaloo Marine Park (Commonwealth Waters)[5] sits to the west of the EGPMF in Commonwealth waters outside three nautical miles and was declared by proclamation under the *National Parks and Wildlife Conservation Act 1975* (NPWC Act) on 7 May 1987. The

[5] http://laptop.deh.gov.au/coasts/mpa/publications/pubs/ningaloo-plan.pdf

Commonwealth Department of the Environment (DotE) is lead agency for marine parks and reserves management in Commonwealth waters.

On 17 November 2012, the (then) Minister for Environment declared 40 new Commonwealth marine reserves across Australia, including the North-west Marine Region (known as the "North-west Marine Reserves Network"). The North-west Commonwealth Marine Reserves Network[6] covers 335 437 km^2 and includes 13 Commonwealth Marine Reserves in waters outside State waters (beyond three nautical miles).

Transitional arrangements are currently in place (meaning no "on-water" changes to existing fishing activities) until such time as a management plan is given effect. The North-west Marine Reserves Network is currently under review by the Commonwealth DotE.

There are no further Commonwealth marine parks proposed for the area of Exmouth Gulf in addition to the existing Ningaloo Marine Park (Commonwealth Waters).

4.7 ESD Reporting and Risk Assessments

Ecologically Sustainable Development (ESD) is the concept that seeks to integrate short and long-term economic, social and environmental effects in all decision-making. The WA Government is committed to the concepts of ESD, and these principles are implicitly contained in the objectives of the FRMA. Under the WA *Policy for the Implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia* (Fletcher 2002), the Department is required to report on the progress of each commercial fishery against the major ESD objectives using the National ESD Framework for Fisheries (see Fletcher et al. 2002). This framework operates by identifying the relevant issues for a fishery, completing a risk assessment on each of the identified issues and providing suitably detailed reports on their status (Kangas et al. 2006).

The ESD report for the EGPMF (i.e. Kangas et al. 2006) provides a comprehensive overview of fishery information, a major component of which is the explicit determination of the operational objectives, performance measures and indicators used to assess the performance of the fishery. The annual *Status Reports of the Fisheries and Aquatic Resources of Western Australia: state of the fisheries* (e.g. Fletcher & Santoro 2013) reports on the evaluation of performance of the fishery against the sets of 'agreed' objectives and performance measures identified during these risk assessments.

EGPMF-specific component trees were developed during an open consultative process involving all stakeholder groups in June 2001 (Kangas et al. 2006). After the components / issues were identified, a process to prioritise each of these needs was completed using a formal risk assessment process. The risk assessment framework that was applied during the workshop was consistent with the Australian Standard AS/NZS 4360:1999, using a combination of the level of consequence and the likelihood of occurrence of that event to produce an estimated level of risk associated with the issue(s) in question. Issues of sufficient

[6] http://www.environment.gov.au/topics/marine/marine-reserves

risk (i.e. Moderate, High or Extreme) require specific management actions, with a full performance report completed for each issue at these levels (Kangas et al. 2006).

As an update on this initial risk assessment for the fishery, an internal risk assessment for the EGPMF was completed in 2008. As a number of key changes had taken place in the fishery since 2001, the aims of the internal risk assessment workshop were to revisit the risk ratings identified in 2001 and determine whether they were still relevant or whether they required amendment. In addition, any possible new risks were identified[7].

Additionally, in 2014, an internal risk assessment was conducted on target, byproduct, bycatch and ETP species for the EGPMF using Productivity Susceptibility Analysis (PSA) methodology. Twenty-seven species were assessed, with eight ETP species / groups assessed to be at medium risk and one ETP species group (sawfish) assessed to be at high risk. The ETP species assessed to be at medium and high risk have mostly been assessed at this level due to low productivity attributes, with the majority of species recognised as an ecological issue for this fishery for many years. PSA tables generated as part of this risk assessment process are provided in Appendix A. The identified issues and their associated risk ratings are provided throughout this document where relevant.

4.8 Assessments and Certifications

The EGPMF has been assessed under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act; Part 13A) and has been found to meet the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries* (Commonwealth of Australia [CoA] 2007). Initial assessment of the fishery took place in 2002, with the most recent reassessment and approval completed in February 2013[8]. As such, the EGPMF is an approved Wildlife Trade Operation (WTO) until February 2018. Some recommendations were provided by the Commonwealth's Department of the Environment as part of the most recent assessment, focusing on ensuring the continuation of good management practices in the fishery.

Additionally, in 2005, the EGPMF successfully gained certification from the United States Department of State for its BRD compliancy and the use of turtle exclusion devices (TEDs), allowing licensees to export prawns to the US market. In order to meet this exemption, the fishery was required to demonstrate that local legislation requiring fishers to use standard TEDs that meet US standards is in force and that the WA Government effectively monitors compliance and enforces penalties for violations[9].

[7] A copy of the final document is available at: http://www.environment.gov.au/system/files/pages/6c513801-5924-4b57-8224-b5b9aaeac02d/files/appendix-6-application-nov12.pdf
[8] Full details of the current and previous assessments are available at: http://www.environment.gov.au/topics/marine/fisheries/wa-exmouth-gulf-prawn.
[9] More information on US certification of TEDs is available at: http://www.state.gov/e/oes/ocns/fish/bycatch/turtles/index.htm.

5. External Influences

External influences include other activities and factors that occur within the Exmouth Gulf region that may or may not impact on the productivity and sustainability of fisheries resources and their ecosystems. The main external influences outlined here for the EGPMF are (1) catches of the targeted stocks by other fisheries, (2) market influences, (3) environmental factors and (4) other activities, such as oil and gas exploration.

5.1 Catch from Other Fisheries

In addition to the EGPMF, the stocks of brown tiger prawns and western king prawns in Exmouth Gulf are also commercially targeted in waters north of the gulf by the Onslow Prawn Managed Fishery (OPMF). The annual catches of brown tiger prawns and king prawns in the OPMF have fluctuated widely from 2004 to 2013 (see Table 5.1), typically following the same catch trends as observed in the Exmouth Gulf fishery for brown tiger prawns. Due to oil and gas exploration activities undertaken in the waters off Onslow restricting fishing activities there has been very low fishing effort since 2010 which has resulted in only minor catches of the two species.

Table 5.1. Retained catches (in tonnes, t) of brown tiger prawns and western king prawns by the Onslow Prawn Managed Fishery between 2004 and 2013. Note that no boats fished in 2012 and only one boat fished for four nights in 2013

Species	Catch (t)									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brown tiger prawns	150	55	39	<2	25	42	27	14	0	<1 (total)
Western king prawns	27	20	5	<1	4	9	1	1	0	

There is no recreational or traditional fishery for brown tiger prawns or western king prawns in Exmouth Gulf, or in the waters off Onslow. Thus all removals from the stocks of these two species are those reported by commercial fishers in the EGPMF and the OPMF.

5.2 Market Influences

Increasing cost of fishing and lower returns due to the global economic climate, high value of the Australian dollar, escalating fuel costs and competition from imported and Australian prawns has impacted harvesting activities in the EGPMF. Fishers have shifted to targeting larger prawns during efficient catch rate periods and focus on the domestic market rather than export markets (Sporer et al. 2013).

5.3 Environmental Factors

There are a number of environmental factors influencing prawn fisheries in Australia, including temperature, rainfall, ocean currents and extreme weather conditions. Extended periods of elevated temperatures in shallow nearshore waters may affect the distribution and viability of prawn nursery habitats, such as seagrasses, as well as the growth and survival of various life stages of penaeid species (Hobday et al. 2008). Catches of prawns may also be

impacted through changes in rainfall, which is predicted to slightly decrease in northern Australia (Hobday et al. 2008).

A key factor influencing prawn stocks in WA is the flow of the Leeuwin Current along the coastline. A relationship exists between strength of this current (measured as the sea level height in Fremantle, WA) and the catches of western king prawn in Shark Bay (Lenanton et al. 1991; Caputi et al. 1996; Lenanton et al. 2009). It is suggested that higher catches are related to stronger flows during the March to June period due to a positive effect on the catchability, growth and survival of prawns (Caputi et al. 1996).

Cyclones can also have significant impacts on the catches of prawns in Exmouth Gulf. Early (December to January) cyclones can have a negative impact on small size prawns due to high mortality in shallow nursery areas. Cyclones may also cause destruction of shallow seagrass areas, reducing available nursery habitat within the Gulf. Alternatively, cyclones can positively influence prawn landings by increasing water turbidity and triggering prawns to move onto the trawl grounds. In 1999, when the Category 5 Cyclone Vance reduced the cover of seagrass in Exmouth Gulf to less than 2 %, brown tiger prawn landings declined from about 400 t to less than 100 t, despite the presence of a good spawning stock. When the seagrass recovered after 2 – 3 years, brown tiger prawn landings increased to their pre-cyclone levels (Loneragan et al. 2004).

The 2010/11 marine heatwave event in WA (Pearce et al. 2011), and continued higher than average temperatures in the summers of 2012 and 2013, may have contributed to recent extremes in the 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 a very low catch. This in turn resulted in a low spawning stock in 2012, although it was still at levels that have historically resulted in moderate recruitment (Sporer et al. 2013). Since 2012, the level of recruitment of brown tiger prawns has been slowly increasing and is currently at the target level (see Section 6.1.1).

The paucity of spatially and temporally relevant pre- and post-impact data for indicator habitats and environmental drivers has limited the Department's ability to accurately quantify the impact of environmental changes in this fishery. In light of this, a project to develop methodologies to monitor and understand the associations between critical habitats, environmental drivers, ecosystem productivity and fishery recruitment in Exmouth Gulf (and Shark Bay) is currently being developed by the Department in conjunction with the University of Western Australia. The objectives of the project are to:

- Collate and review historical, satellite, habitat and 'environmental productivity' data for Exmouth Gulf and Shark Bay ecosystems to identify factors that may influence recruitment;
- Assess the ability of different techniques at various spatial scales to identify and assess critical habitat in a range of environmental conditions, comparing Exmouth

Gulf and Shark Bay habitat and recruitment patterns in relation to environmental factors;

- Collect in-situ environmental and productivity data to assess the feasibility of collecting broad-scale data remotely;
- Develop a cost effective monitoring program for critical habitat and environmental drivers, which allows the development of mitigation measures to assist in alleviating poor recruitment events.

This project is considered to be high-priority for the Department, with funding recently secured.

5.4 Other Activities

Other activities within the Gascoyne Coast Bioregion and Exmouth Gulf include aquaculture, tourism and oil and gas exploration.

Aquaculture development in the area is largely restricted to the production of pearl oysters. Hatchery production of pearl oysters is of critical importance to the region, driven by the irregular recruitment of large pearl oyster species in the wild. Hatcheries at Exmouth supply significant quantities of *Pinctada maxima* spat to pearl farms in Exmouth Gulf and the Montebello Islands, while several hatcheries supply juvenile blacklip pearl oysters (*P. margaritifera*) to the bioregion's developing black pearl farms (Fletcher & Santoro 2013).

The Gascoyne Coast is also a focal point for winter recreation by the WA community. Apart from the scenic beauty, the main attraction of the coastline is the high quality of marine life. The region supports extensive scuba diving and snorkelling activities, particularly around Ningaloo Reef (Smallwood et al. 2011). Fishing is also a key component of many tourist visits, with a range of angling activities available.

Exploration and appraisal-drilling for oil and gas has mainly occurred in the northern part of the Bioregion, near Exmouth Gulf, with significant oil and gas activity offshore of the North West Cape in the Exmouth Sub-basin (Fletcher & Santoro 2013).

MSC Principle 1

MSC Principle 1 (P1) focuses on maintaining, indefinitely, fishing activity at a level that is sustainable for the targeted populations (MSC 2013).

6. Stock Status

The status of the stocks of brown tiger prawns and western king prawns in Exmouth Gulf is assessed annually using a weight-of-evidence approach that considers all available information about the stocks (see Wise et al. 2007 for explanation of weight-of-evidence approach). The assessment approach, which is described in more detail in Section 7, is primarily based on 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. Although these abundance indices represent key indicators for the stocks, other information collected throughout the season (e.g. commercial catches, effort and environmental data, see Monitoring Section 8.4) is also evaluated to provide insight on, for example, any environmental factors affecting prawn recruitment.

6.1 Current Stock Status

At the time of writing this report, full assessments of the stocks of brown tiger prawns and western king prawns in Exmouth Gulf were available for 2013, with some 2014 data also available for the two species. Please refer to Figure 8.5 for a description of the different fishing grounds in Exmouth Gulf which are referred to in the following sections.

6.1.1 Brown Tiger Prawns

Following the collapse of the brown tiger prawn stock in Exmouth Gulf in the early 1980s, monitoring and assessment has been largely focused on this species. Brown tiger prawns are typically considered more vulnerable to overfishing than western king prawns because of their shorter breeding period and higher catchability (Penn 1984; Penn & Caputi 1986).

In 2014, the brown tiger prawn spawning stock index (i.e. the mean catch rate from the fishery-independent spawning stock surveys conducted in fishing grounds Q1 and Q2, which are key brown tiger prawn spawning areas) of 27.7 kg / hr was slightly (11%) above the target level (25 kg / hr) and well above the limit level (10 kg / hr; Figure 6.1). The brown tiger prawn spawning stock index in 2014 was slightly greater than in 2013 (22.6 kg / hr) and 2012 (17.3 kg / hr) but far less than in 2011, when the highest ever abundance of brown tiger prawns was recorded in Exmouth Gulf (80.8 kg / hr) (Figure 6.1). As has often been the case over the history of the fishery, in 2014 the mean catch rate recorded in Q2 was greater than in Q1 (Figure 6.1).

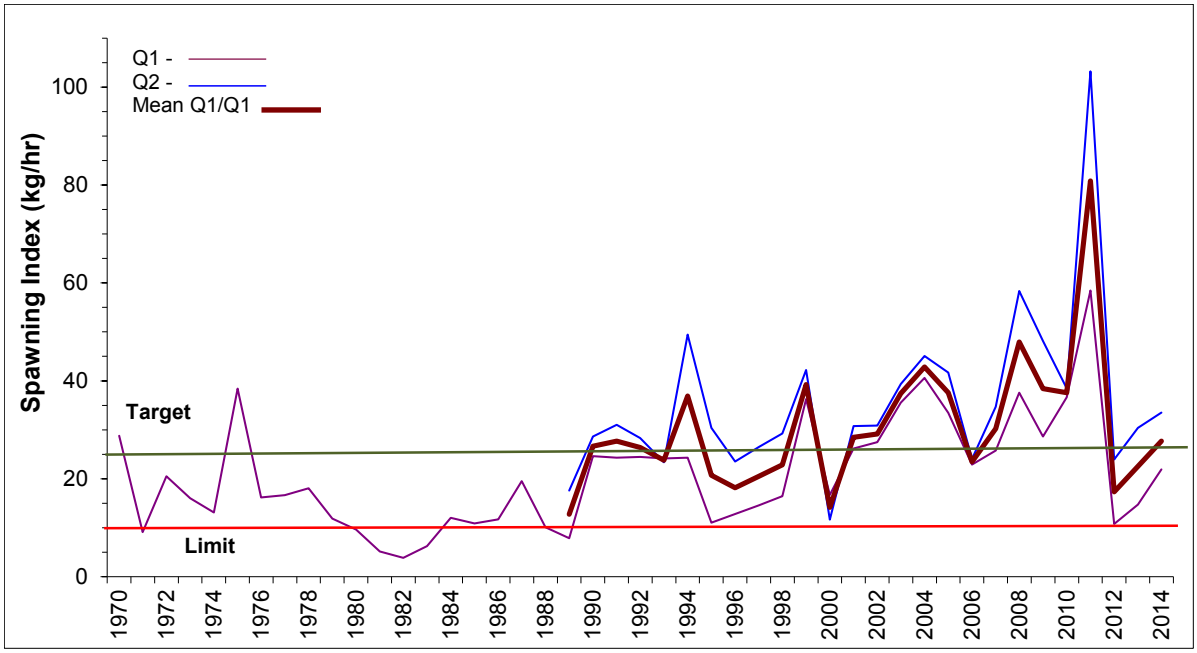


Figure 6.1. Mean spawning stock index (kg / hr) for brown tiger prawns in Exmouth Gulf between 1970 and 2014, relative to the target and limit reference points (25 and 10 kg / hr, respectively). Note that prior to 1989, the mean value reflects catch rates in area Q1 only

The fishery-independent recruitment survey catch rates for brown tiger prawns in Q3 and P2 have fluctuated around the target level since the mid-1980s, with no increasing or decreasing trend (Table 6.1, Figure 6.2). When the catch rates were regressed against year, the slope was not significant ($p > 0.05$, $r = 0.04$, $r^2 = 0.02$). In 2014, the brown tiger prawn recruitment index (i.e. the mean catch rate from the recruitment surveys conducted in fishing grounds Q3 and P2) of 42.0 kg / hr was just above the target level (40 kg / hr), and thus well above the limit (10 kg / hr; Table 6.1, Figure 6.2). Following the exceptional recruitment recorded in 2011 (82.0 kg / hr), the index fell to below the target in 2012 (21.5 kg / hr) but has since progressively increased to the current level (Table 6.1, Figure 6.2).

As a consequence of the brown tiger prawn recruitment index in 2012 and 2013 being below the target level, commencement of fishing in both of these years was delayed until subsequent sampling in the brown tiger prawn areas indicated that the catch rates had risen to above the target level. Due to the reduced fishing effort in these years, brown tiger prawn landings have been as low as previously recorded throughout the history of the fishery (46 t in 2012 and 95 t in 2013)[10]. In 2014, despite the brown tiger prawn recruitment index being just above the target for commencing fishing, the opening of the season was again delayed to prevent early fishing on western king prawns (see below).

The reasons for the low levels of recruitment of brown tiger prawns in 2012 and 2013 compared with 2011 are not well understood (see comments on proposed research into environmental impacts in Section 5.3). However, given that the level of spawning stock in 2011 was at a record high, it is believed that the environmental conditions in 2011/12 must

[10] Note that 2014 landings of brown tiger prawns in the EGPMF were 162 t (Sporer et al. in prep.)

not have been favourable for successful recruitment. There is some evidence that recent recruitment has been impacted by a current lack of seagrass coverage in key brown tiger prawn nursery habitats in Exmouth Gulf (see Section 8.1.2).

Although the brown tiger prawn stock abundance in Exmouth Gulf has been low in recent years, it is not unprecedented in the history of this fishery, with a collapse in the early 1980s associated with overfishing, and in 2000 associated with cyclone impacts on nursery habitats (see Section 3.3). As levels of brown tiger prawn spawning stock similar to those recorded in 2012 and 2013 have previously resulted in moderate recruitment, under normal environmental conditions (i.e. no elevated temperatures, no negative cyclone impacts, vegetated nursery areas), recruitment should not be impaired.

Table 6.1. Catch rates (kg / hr) of brown tiger prawns in areas Q3 and P2 in Exmouth Gulf during recruitment surveys in early March (1st), late March (2nd) and early April (3rd) between 1985 and 2014. Note that values shown in red for 1999 and 2006 have been estimated from the mean relationship between surveys based on historical data (1985-2011) because surveys were not undertaken in these periods due to Cyclone Vance in 1999 and a boat breakdown in 2006

	Q3				P2				Mean
	1st	2nd	3rd	Mean	1st	2nd	3rd	Mean	P2 and Q3
1985	23.29	33.48	41.09	32.62	17.63	25.72	26.21	23.19	27.90
1986	39.95	54.67	51.28	48.64	21.35	46.91	66.65	44.97	46.80
1987	92.20	84.44	82.50	86.38	79.10	65.19	48.53	64.27	75.33
1988	43.35	56.94	68.75	56.35	33.65	37.53	49.66	40.28	48.31
1989	47.88	56.45	66.32	56.89	24.26	29.60	31.54	28.47	42.68
1990	66.81	69.88	75.06	70.58	61.31	90.42	39.79	63.84	67.21
1991	28.15	55.16	73.28	52.19	35.59	51.44	46.43	44.48	48.34
1992	33.97	37.20	50.95	40.71	19.09	30.25	40.44	29.93	35.32
1993	38.98	33.16	40.28	37.47	29.12	36.40	40.76	35.43	36.45
1994	70.20	93.50	98.19	87.30	100.13	89.78	73.76	87.89	87.59
1995	54.03	54.03	51.44	53.17	35.43	20.87	37.53	31.27	42.22
1996	50.79	55.48	51.12	52.46	27.34	22.32	36.72	28.79	40.63
1997	54.03	72.63	58.23	61.63	22.00	28.31	27.18	25.83	43.73
1998	45.78	75.70	100.29	73.92	36.07	27.98	54.03	39.36	56.64
1999	40.76	**48.10**	77.00	**55.29**	20.71	**27.00**	45.78	**31.16**	**43.22**
2000	17.96	31.06	21.35	23.46	29.60	54.19	48.69	44.16	33.81
2001	14.07	23.46	26.69	21.41	13.91	17.79	38.50	23.40	22.40
2002	47.23	44.81	79.10	57.05	27.50	53.70	58.23	46.48	51.76
2003	63.25	74.41	109.67	82.44	82.50	90.75	117.76	97.00	89.72
2004	70.20	41.25	62.76	58.07	66.97	98.19	102.23	89.13	73.60
2005	37.85	41.41	57.26	45.51	80.72	80.72	82.17	81.20	63.36
2006	35.43	39.63	31.70	35.59	38.82	41.57	**46.23**	**42.21**	**38.90**
2007	34.45	48.20	53.54	45.40	24.10	37.53	47.40	36.34	40.87
2008	87.70	60.40	101.50	83.20	61.50	40.40	101.70	67.87	75.53
2009	46.70	68.40	116.70	77.27	49.00	72.60	74.00	65.20	71.23
2010	42.24	47.78	58.74	49.59	36.43	44.61	39.95	40.33	44.96
2011	83.80	93.80	115.40	97.67	60.60	70.40	67.70	66.23	81.95
2012	26.90	30.60	27.90	28.47	12.00	15.00	16.40	14.47	21.50
2013	27.67	44.87	89.20	53.92	6.35	9.39	13.93	9.89	31.90
2014	49.50	54.90	72.10	58.83	16.70	24.80	33.90	25.13	41.98

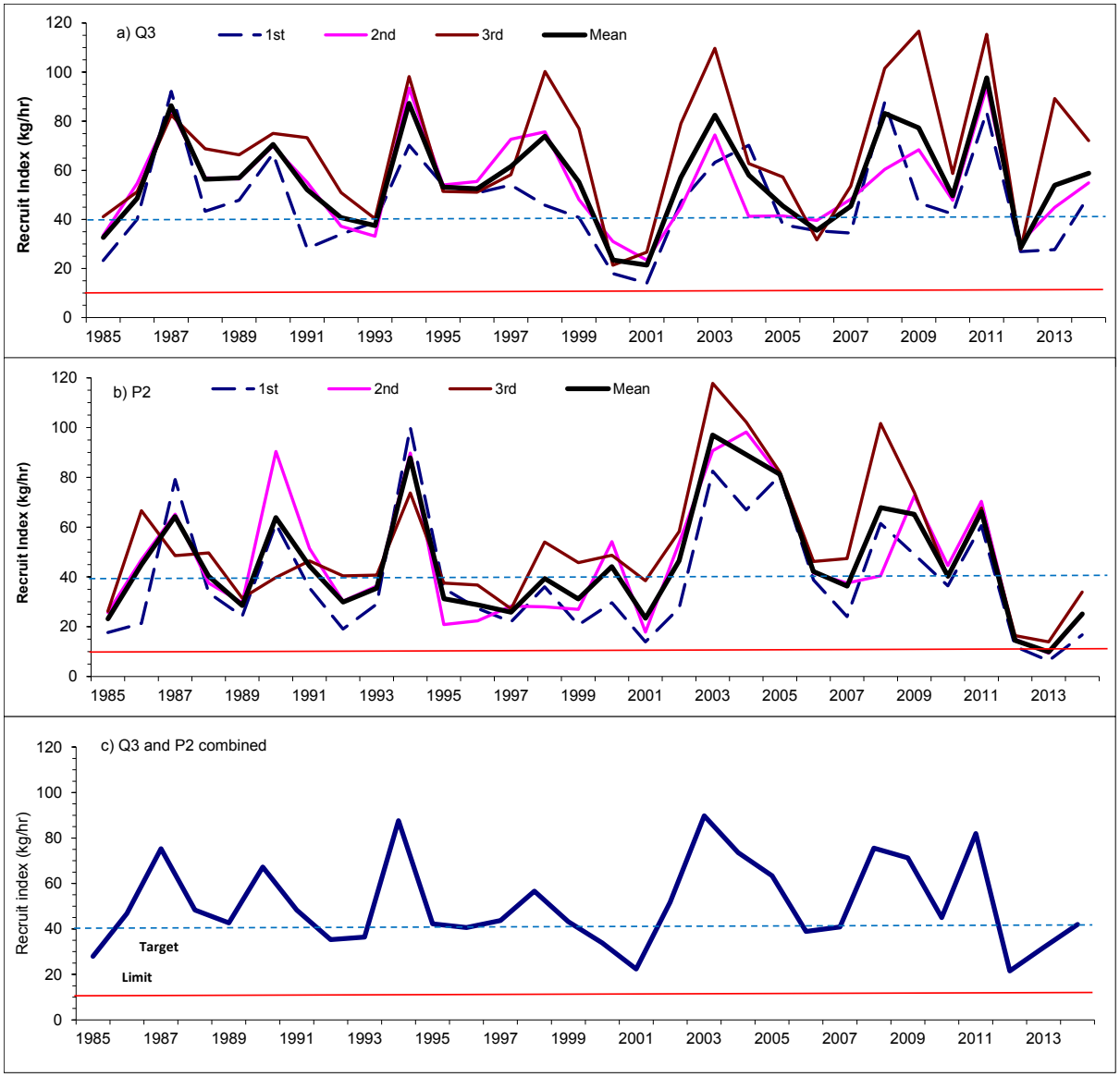


Figure 6.2. Mean recruitment index (kg / hr) and individual survey indices for each of the three recruitment surveys for brown tiger prawns in Exmouth Gulf between 1985 and 2014, relative to the target and limit reference points (40 and 10 kg / hr, respectively)

6.1.2 Western King Prawns

As western king prawns have a longer breeding period than brown tiger prawns and lower catchability (Penn 1984; Penn & Caputi 1986), they have long been considered to be less vulnerable to overfishing. However, due to the observed low recruitment of western king prawns in recent years (see below), there has been an increased focus on assessment and monitoring of this species, as well as management actions to control effort and the timing of effort directed towards this species.

The fishery-dependent spawning stock index for western king prawns (i.e. mean commercial catch rate in R1 and S2 fishing grounds during August and September) has fluctuated around and above the target level since 1998 (Figure 6.3). At the time this report was written, the preliminary commercial catch rate for August / September 2014 (primarily in the R1 and S2

grounds) was 30.5 kg / hr, which is above the target level and well above the limit reference level.

In 2014, the western king prawn recruitment index (i.e. mean catch rate from the April fishery-independent recruitment survey conducted in fishing grounds R1, S2 and S1, which are key western king prawn recruitment areas) of 23.0 kg / hr was between the target (30 kg / hr) and limit (15 kg / hr). This level of recruitment of western king prawns was the lowest recorded since the recruitment surveys for this species commenced in 2002. As a result of the low recruitment index in 2014, fishing on western king prawn grounds was delayed until mid-July (with additional surveys undertaken in May and June), thus reducing overall effort on this species.

In the last four years, the annual western king prawn landings have been lower than in all but the very early years of the fishery (see Section 3.3). The low king prawn catch in 2011 (97 t) could be partially attributed to more targeted fishing effort on brown tiger prawns due to this latter species' very high abundance that year. A slight recovery in catches of western king prawns has since been observed, with landings back to normal levels (331 t) in 2013. Effort on western king prawns in 2014 was restricted due to the low level of recruitment and the small size of prawns at the time the fishery commenced[11].

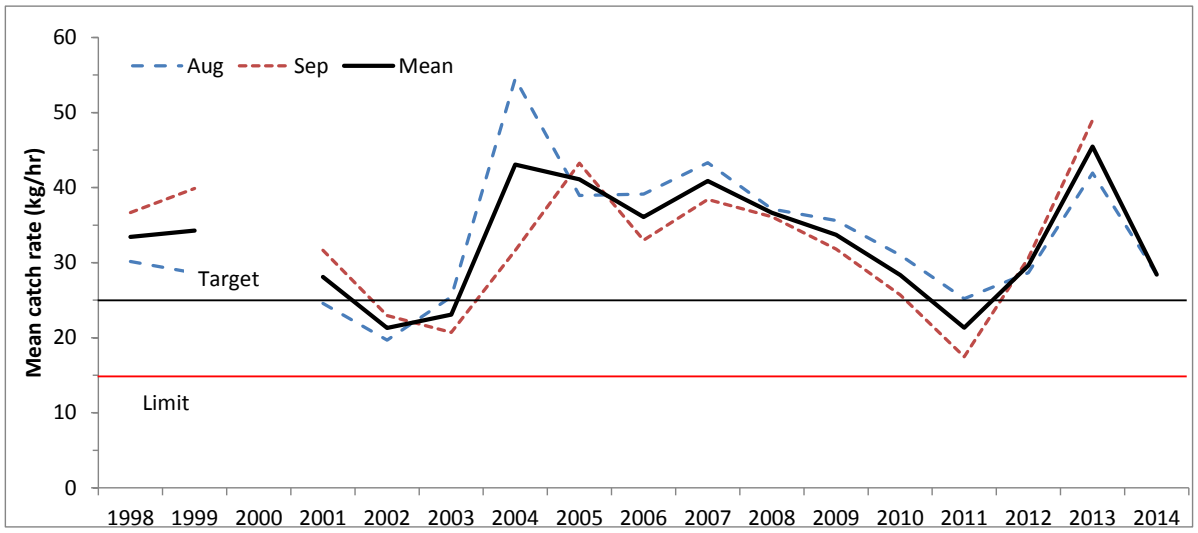


Figure 6.3. Mean western king prawn spawning stock index (commercial catch rates (kg / hr) of in areas R1 and S2 during August and September) in Exmouth Gulf between 1998 and 2014, relative to the target (25 kg / hr) and limit (15 kg / hr) reference points. Note that 2000 data are not included due to incomplete logbook records and the 2014 data point includes only August

[11] Note that final 2014 landings of western king prawns in the EGPMF were 171 t (Sporer et al. in prep.)

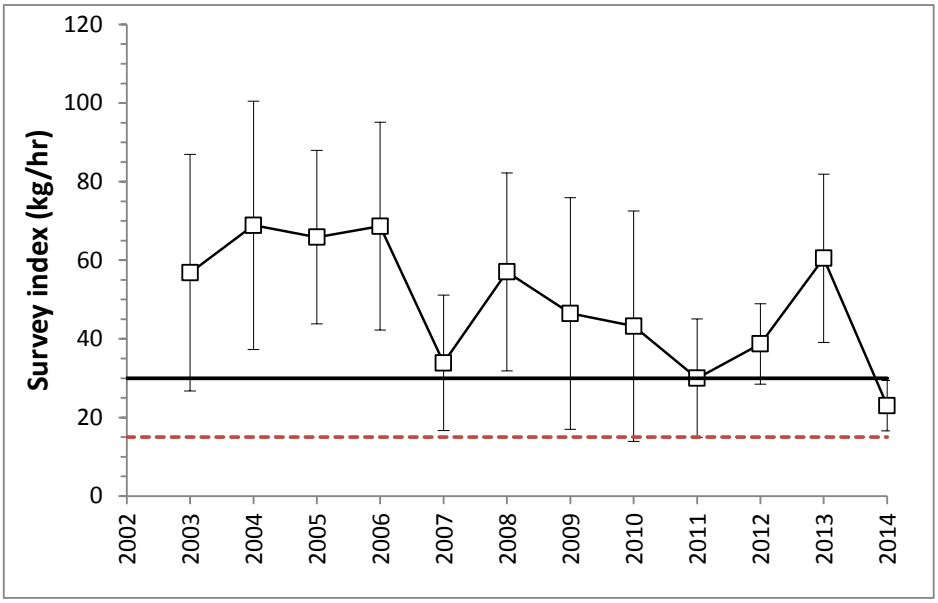


Figure 6.4. Mean recruitment index (kg / hr, ± 95% CI) for western king prawns in Exmouth Gulf between 2003 and 2014, relative to the target (30 kg / hr, solid black line) and limit (15 kg / hr, dashed red line) reference points. Survey sites, which are sampled in April, are located in fishing grounds R1 and S2 (with an additional site in S1)

7. Stock Assessment

7.1 Assessment Description

The stocks of brown tiger prawns and western king prawns in Exmouth Gulf are assessed throughout each fishing season and at the end of each fishing season, based primarily on inter- and intra-annual trends in recruitment and spawning stock abundance relative to specified reference points (Section 8.2). Note, however, that the annual weight-of-evidence assessment of each species is based on all of the stock status information collected throughout the year (see Monitoring Section 8.4 for more detail).

7.1.1 Recruitment Indices

Fishery-independent recruitment surveys are undertaken in March and April each year (prior to the fishing season commencing) to provide abundance (and size / grade) information from the key recruitment areas for both brown tiger prawns and western king prawns within Exmouth Gulf (see Section 8.4.2.2.1 for more information about the recruitment surveys). The mean catch rate data for each of the two target species from these surveys are used as indices of recruitment strength (derived from the previous year's spawning; Table 7.1). These are compared against species-specific reference points and used to inform the timing of the openings of different management areas within the fishery for the fishing season. For each species, the relationship between the recruitment index and annual landings (between April and November) is also used to provide a catch prediction for the season.

7.1.2 Spawning Stock Indices

Dedicated fishery-independent surveys are undertaken to measure the spawning stock abundance of brown tiger prawns in Exmouth Gulf during the key spawning period (August-October), when the tiger prawn spawning areas are closed to fishing (see Section 8.4.2.2.2 for more information about the spawning stock surveys). The mean brown tiger prawn catch rate, calculated based on all three spawning stock surveys undertaken, provides an index of spawning stock abundance for this species (Table 7.1) and is compared annually against species-specific reference points (see Section 8.2).

Although fishery-independent spawning stock surveys are not currently undertaken specifically for western king prawns in Exmouth Gulf, the mean commercial (fishery-dependent) catch rate of this species in fishing grounds R1 and S2 during August and September is considered to represent an appropriate index of spawning stock abundance (Table 7.1). The catch rates are derived from key western king prawn fishing grounds during the spring spawning period for this species, at a time when the fleet is focusing their fishing effort on western king prawns (the brown tiger prawn fishing grounds are closed). As with brown tiger prawns, the index is assessed annually against specified reference points (see Section 8.2).

Table 7.1. Key indices of abundance used for assessing the brown tiger and western king prawn stocks in Exmouth Gulf. See Figure 8.5 for a description of fishing grounds in Exmouth Gulf

Key performance indicator	Brown tiger prawns	Western king prawns
Recruitment index	Mean fishery-independent catch rates (kg / hr) of brown tiger prawns from the recruitment surveys in March / April within fishing grounds P2 and Q3.	Mean fishery-independent catch rates (kg / hr) of western king prawns from recruitment surveys undertaken in April in the northern fishery area (i.e. mainly in R1 and S2, and one site in S1).
Spawning stock index	Mean fishery-independent catch rates (kg / hr) of brown tiger prawns from the surveys between August and October within fishing grounds Q1 and Q2.	Mean commercial catch rates (kg / hr) of western king prawns within fishing grounds R1 and S2 during August and September.

7.1.3 Commercial Catch Rate Monitoring

At critical times during the season, monitoring of commercial catch rates in the EGPMF becomes daily to inform the timing of particular management area closures (e.g. brown tiger prawn spawning closure in the Central TPSA and Eastern Area during the key spawning period for this species in Exmouth Gulf). It is possible in this fishery to obtain real-time information on boat catch and prawn size (grade) through daily emails from the licensee. The nightly effort is estimated or skippers are called to provide the actual hours trawled to calculate average daily catch rates for the fleet. This detailed catch rate and size structure

information is important for managing the fishing effort on brown tiger and western king prawns throughout the fishing season.

7.2 Appropriateness of Assessment

The direct, empirically-based stock assessment methodology that has been adopted for brown tiger and western king prawns in Exmouth Gulf is reflective of their biology, life history, habitats and inherent population variability. Short lifespans, inter-annual and intra-annual recruitment variability and spatial and temporal variations in the size distributions and abundances of juvenile and adult prawns are key factors in the biology of each species that are explicitly accounted for within assessments to support the constant escapement-based harvest strategy (as described in Section 8). The biological characteristics of these species, combined with the ability of the fishing fleet to rapidly deplete their abundance, requires the assessments to provide information at an appropriate timescale to enable rapid, real-time management responses within each season to protect the breeding stocks.

The assessments of brown tiger and western king prawns are designed to not only maintain the sustainability of these stocks but also that of other retained species, provide the opportunity for industry to optimise the economic return to the fleet, and ensure cost-effective management for the Department and therefore the benefits to the community. The assessments work together within a constant escapement harvest strategy framework to ensure that, irrespective of the level of recruitment, the appropriate amount of catch, and also size composition, is taken using the minimum amount of fishing effort annually.

The empirically-based assessments are the most appropriate for informing in-season control rules; anything more complex and time-consuming to calculate would not be practicable for in-season assessment, which would prohibit the rapid response required for this fishery to ensure adequate stock is left in the water at the end of each season.

7.3 Assessment Approach

As described in the above section, the approach used to assess brown tiger and western king prawns in Exmouth Gulf provides adequate information for evaluating the status of these stocks in relation to specified, precautionary reference points (see Section 8.2).

7.4 Uncertainty in the Assessment

The stock assessments for brown tiger and western king prawns in Exmouth Gulf are based on comprehensive and robust indices of abundance for the two species. Uncertainty in these performance measures is reduced by employing, where possible, data from fishery-independent recruitment and spawning stock surveys that have been collected using standardised sampling methods. The approaches employed to address the uncertainty in the measures that form the basis of the assessment include:

- Multiple fishery-independent surveys are undertaken to provide indices of recruitment for brown tiger prawns and western king prawns, and of spawning stock abundance for brown tiger prawns. For example, the indices from the annual spawning stock

surveys used in the brown tiger prawn assessment are presented both as a combined overall annual catch rates and also for individual areas (Q1 and Q2).

- Spawning stock surveys are designed to ensure that each site within each area (see Section 8.4.2.2) is sampled on multiple days and thus the mean index values account for any daily variation in catch rates (e.g. due to weather).
- Uncertainty in the spawning stock index for western king prawns, which is based on fishery-dependent catch rates, is dealt with by only considering catch and effort in those fishing grounds that have been clearly identified as being dominated by western king prawns and represent the key spawning areas for this species.
- Uncertainty in the overall landings is accounted for by validating commercial catch data against processor unloads. Each carton is weighed accurately on-board the boat and when unloaded, each carton (of the different species and prawn size grades) is counted by the trucking company and the total weight by grade are provided to the Department. Therefore daily estimates of catch have a high degree of accuracy. There are multiple checks of the landed catch i.e. trucking company and fishing company prior to data being received by the Department.
- Uncertainty in fishing fleet behaviour is minimised through regular communication with fishers covering the full fleet (at times daily). If fishing has not occurred in some areas, a survey may be undertaken to determine the abundance of stock in unfished areas.

7.5 Evaluation of Assessment

The current assessment approach for brown tiger prawns in Exmouth Gulf, focused on the monitoring of catch rates as performance measures, has been in use for several decades and has been shown to maintain stocks at appropriate levels. On those occasions when the brown tiger prawn stock underwent marked declines (see Section 3.3), noting the two most recent declines in 2000 and 2012 were associated with environmental factors, the stock recovered within 3-4 years. This demonstrates that the constant escapement harvest strategy implemented for the EGPMF, and the associated stock assessments based on direct measurement of relative spawning stock levels that are used to inform management decisions, are robust.

The basis for the current assessment of brown tiger prawns is the stock-recruitment relationship (SRR) for this species originally developed by Penn and Caputi (1985, 1986) (see Section 8.2.1). An alternative hypothesis, that recruitment of prawns is only environmentally driven, has been tested in Shark Bay by not intervening or providing additional protection of the brown tiger prawn breeding stock when it had declined to low levels in the early 1980s. This hypothesis was proven to be incorrect because the recovery of the Shark Bay stock took much longer than in Exmouth Gulf, where management actions were implemented immediately. The recovery in Shark Bay only occurred when the spawning stock was eventually protected.

7.6 Peer Review of Assessment

The SRR that has underpinned the assessment of brown tiger prawns in Exmouth Gulf has been reviewed and published in the scientific literature (Penn & Caputi 1986). Significant independent peer-review of all aspects of the EGPMF, including the stock assessment components, has also been conducted through the assessments of the fishery to meet the Commonwealth's requirements for export accreditation under the EPBC Act (see Section 4.8).

Up until the third party certification initiative began in WA, whereby all the state's fisheries would undergo a pre-assessment review against the MSC standard for sustainability, the Department adopted a schedule for the periodic peer-review of assessments for all fisheries in WA. This "rolling" schedule aimed to generate major reviews of 5 – 8 fisheries per year, employing a mix of internal and external fisheries experts (e.g. from universities, CSIRO and inter-state fishery departments). The prawn fisheries in Exmouth Gulf and Shark Bay were both reviewed by Dr Malcolm Haddon (Marine Research Laboratory Tasmanian Aquaculture and Fisheries Institute, University of Tasmania) during a two-day workshop undertaken in November 2012.

8. Harvest Strategy

A harvest strategy (decision rule framework) for the EGPMF (DoF 2014a) makes explicit the management objectives, performance indicators, reference levels and harvest control rules for the brown tiger prawn and western king prawn resources, which are taken into consideration by the Department when preparing advice for the Minister for Fisheries. The harvest strategies have been developed in line with the Department's over-arching *Harvest Strategy Policy for the Aquatic Resources of Western Australia* (DoF in press) and relevant national policies / strategies (ESD Steering Committee 1992) and guidelines (e.g. Sloan et al. 2014). In addition to target species (i.e. brown tiger prawns and western king prawns) they also incorporate retained non-target species, bycatch, ETPs, habitats and ecosystem components to ensure the risks to these elements are effectively managed.

8.1 Framework

A summary of the harvest strategy in place for managing the brown tiger prawn and western king prawn resources in Exmouth Gulf is presented in Table 8.1 (see also DoF 2014a). Additional information about the reference points and associated harvest control rules specified for these species is provided in Section 8.2 and 8.3. Information and monitoring undertaken to inform the harvest strategies and the overall weight-of-evidence approach used for assessing the status of these resources are outlined in Section 8.4.

Table 8.1. Summary of current performance indicators, reference points, control rules and justification for brown tiger and western king prawns in the Exmouth Gulf Prawn Managed Fishery. *indicates decisions made prior to season opening and provided to fishers as part of annual season arrangements

Component	Management Objectives	Species	Performance Indicators		Reference Levels	Control Rules
In-season Operations						
Target Species	**Ecological:** To maintain spawning stock biomass of each target species at a level where the main factor affecting recruitment is the environment.	Brown tiger & western king prawns	**Season Opening***	April lunar phase	After April full moon phase	Fishing season opens; however, fishing may only occur in areas where March and / or April recruitment surveys are not undertaken until all recruitment surveys are completed (see 'Commencement of Fishing in Management Areas' below).
		Brown tiger prawns	**Commencement of Fishing in Central TPSA and Eastern Area**	Catch rate of brown tiger prawns from combined recruitment surveys	**Target:** Mean catch rate is 40 kg / hr.	If the target level is met, fishing may commence in the Central TPSA and Eastern Area.
					Threshold: Mean catch rate is < 40 and > 10 kg / hr.	Review options for fishing and consult with industry regarding the timing and spatial extent of fishing operations (also influenced by prawn size).
					Limit: Mean catch rate is 10 kg / hr.	If the catch rate is at or below the limit, no fishing occurs in the Central TPSA and Eastern Area.

Component	Management Objectives	Species	Performance Indicators		Reference Levels	Control Rules
		Western king prawns	**Commencement of Fishing in Northern Area**	1. Size of western king prawns in April recruitment survey 2. Catch rate of western king prawns from April recruitment survey	**Target:** 50% of western king prawns are larger than 21/30 grade[1] AND mean catch rate is ≥ 30 kg / hr.	If the target level is met, fishing can commence in the Northern Area.
					Threshold: Mean catch rate is < 30 and > 15 kg / hr.	Review options for delaying fishing or modifying the spatial extent of fishing operations within the northern area.
					Limit: Mean catch rate of western king prawns is 15 kg / hr.	If the catch rate is at or below the limit, no fishing occurs in the Northern Area unless additional surveys indicate that catch rates have improved.
		Brown tiger & western king prawns	**Closure of Central TPSA and Eastern Area prior to August**	Commercial catch rate of brown tiger prawns in Central TPSA	Mean commercial catch rate is ≤ 25 kg / hr for two consecutive nights.	Central TPSA and Eastern Area are closed to fishing prior to the August spawning closure.
			Central TPSA and Eastern Area closure*	August lunar phase	Start of August moon closure.	Central TPSA and Eastern Area are closed to fishing.

[1] Count per pound – historical standard for size grading.

Component	Management Objectives	Species	Performance Indicators		Reference Levels	Control Rules
			Re-opening of Central TPSA and Eastern Area (following spawning closure)	Catch rate of brown tiger prawns in the Central TPSA during first two spawning stock surveys in August and September	Mean catch rate is > 25 kg / hr.	The Central TPSA and Eastern Area may re-open to fishing.
					Mean catch rate is ≤ 25 kg / hr.	The Central TPSA and Eastern Area do not re-open at this time (re-assess opening after October survey).
				Catch rate of brown tiger prawns in the Central TPSA during October spawning stock survey	Mean catch rate is > 19 kg / hr.	Re-open the Central TPSA and Eastern Area on 1 November if catch rate is >19 kg / hr subject to consultation. If catch rate >25 kg / hr then Central TPSA and Eastern Area may re-open to fishing at an earlier date.
			Final closure of Central TPSA and Eastern Area	Daily commercial catch rate of brown tiger prawns in the Central TPSA and Eastern Area in September and October, or in November	(Prior to 1 November) Mean daily commercial catch rate of brown tiger prawns (in September / October) is < 25 kg / hr.	The Central TPSA and Eastern Area are closed to fishing.
					(1 November onwards) Mean daily commercial catch rate of brown tiger prawns (in November) is < 19 kg / hr.	The Central TPSA and Eastern Area are closed to fishing.
		Western king prawns	**Closure of Northern Area**	Size of western king prawns in commercial catches from Northern Area from October onwards	50 % or more of western king prawns are 21/30 size grade or smaller.	The Northern Area is closed to fishing.
		Brown tiger & western king prawns	**Season Closure***	Number of total available fishing nights since the season opening date	Season has been open for a maximum of ~ 200 fishing nights depending on seasonal arrangements and survey results for any one year.	Fishing season closes.

Component	Management Objectives	Species	Performance Indicators	Reference Levels	Control Rules
Annual Operations					
Target Species	**Ecological:** To maintain spawning stock biomass of each target species at a level where the main factor affecting recruitment is the environment.	Brown tiger prawns	Catch rate of brown tiger prawns from spawning stock surveys	**Target:** Mean catch rate of brown tiger prawns ≥ 25 kg / hr.	If the target level is met, no change to season management arrangements required for the following season.
				Threshold: Mean catch rate of brown tiger prawns is < 25 and > 10 kg / hr.	A review of season management arrangements and monitoring system is triggered to investigate the reasons for the variation, which may trigger changes to the arrangements for the following season if sustainability is considered to be at risk.
				Limit: Mean catch rate of brown tiger prawns is 10 kg / hr.	If the catch rate is at or below the limit, a comprehensive review of the fleet's spatial fishing pattern and catch rates is undertaken to investigate the reasons for the low catch rate in the monitored spawning areas. This will either trigger management actions to limit fishing on that species for the following season if sustainability is considered to be at risk or a change to the monitoring system if it is considered to be inaccurate.
		Western king prawns	Commercial catch rate of western king prawns in fishing grounds R1 and S2 during August and September.	**Target:** Mean commercial catch rate of western king prawns is ≥ 25 kg / hr.	If the target level is met, no change to season management arrangements required for the following season.
				Threshold: Mean commercial catch rate of western king prawns is < 25 and > 15 kg / hr.	A review of season management arrangements and monitoring system is triggered to investigate the reasons for the variation, which may trigger changes to management for the following season if sustainability is considered to be at risk.

Component	Management Objectives	Species	Performance Indicators	Reference Levels	Control Rules
				Limit: Mean commercial catch rate of western king prawns is 15 kg / hr.	If the catch rate is at or below the limit, a comprehensive review of the fleet's spatial fishing pattern and catch rates are undertaken to investigate the reasons for the low catch rates. This will either trigger management actions to limit fishing on that species for the following season if sustainability is considered to be at risk or a change to the monitoring system if it is considered to be inaccurate.

8.1.1 Design

The harvest strategy for brown tiger and western king prawns in the EGPMF is based on a constant escapement harvesting approach. The use of a this type of approach recognises that short-lived prawn species exhibit naturally variable annual recruitment and that, regardless of the level of recruitment in any year, it is necessary to ensure that sufficient spawning stock is maintained. A detailed biological understanding of the two target species in the fishery (Section 2) has underpinned the development and application of in-season temporal and spatial closures in the fishery that contribute to the constant escapement harvest strategy and also generate economic benefits for the fleet (i.e. by minimising harvest of small-sized prawns which are less valuable than larger prawns). This harvesting approach has contributed to a high level of cooperation from industry regarding adherence to regulations.

The EGPMF harvest strategy involves constant monitoring of stock status of brown tiger and western king prawns from just prior to the commencement of fishing in each year to the end of each fishing season, based on a combination of fishery-dependent and fishery-independent data (see Table 8.1). In-season monitoring of catch rates and size-based performance measures for the two target species is used to determine (based on defined control rules) when to open and close certain areas of the fishery, to provide protection to spawning stocks, prevent growth overfishing and help facilitate optimal economic harvesting of the stock by industry. At the end of the season, the stocks of brown tiger and western king prawns in Exmouth Gulf are assessed based on inter-annual trends in recruitment and spawning stock indices (against specified reference points), together with additional information on annual landings, fine-scale spatial data on patterns of fishing effort and catch, and size composition data. The end-of-season assessments are linked to control rules which ensure that, if stocks are considered to be at risk of other factors adversely impacting recruitment (i.e. environment), measures are in place to provide protection for the stocks during the next fishing season.

The reference points developed for brown tiger and western king prawns in Exmouth Gulf (see Section 8.2) are based on a detailed understanding of the biology of these species, considering key aspects such as their longevity, growth, movements and reproductive biology, including SRRs (Penn & Caputi 1985, 1986). This, combined with the long history of detailed monitoring of the key target species (i.e. since the inception of the fishery), has led to a good understanding of the level of spawning stock abundance of each species above which recruitment is not impaired under normal environmental conditions (see also Section 8.2.4).

Throughout much of the history of the EGPMF, brown tiger prawns were the primary focus of management with respect to sustainability, as this species has been found to be the most vulnerable to overfishing (Penn & Caputi 1986). This reflects the different reproductive and behavioural characteristics of brown tiger prawns compared with western king prawns. For example, tiger prawns spawn over a more restricted period of the year in Exmouth Gulf and have a greater catchability due to their reduced tendency to burrow.

The suite of management measures implemented to maintain the brown tiger prawn stock in Exmouth Gulf (e.g. the spawning closure) also provide a level of protection to the stocks of retained non-target species such as blue endeavour prawns. The added measure of ceasing fishing in the Northern Area of the fishery (i.e. the western king prawn fishing grounds) at the end of the fishing season, when small western king prawns begin to appear in the catches, provides protection to these new recruits which will contribute to the spawning stock of this species the following year. Economic drivers that often result in an end to fishing for western king prawns (when the combined catch rate for all species falls to 150 kg / night) provides further protection to the spawning stock of this species.

8.1.2 Evaluation

8.1.2.1 Brown Tiger Prawns

The success of the harvest strategy for brown tiger prawns in the EGPMF is evaluated every year based on the performance of the fishery and the outcomes of the annual assessment of the species. For the past 30 years (i.e. since the overfishing of the brown tiger prawn stock in the early 1980s), the harvest strategy has been demonstrated to be effective in ensuring that recruitment is not adversely impacted by fishing. The brown tiger prawn spawning stock has generally been at or above the specified target reference point since 2001 (see Section 6.1.1).

Despite a record high level brown tiger prawn spawning stock abundance in 2011, the spawning stock index in the following year was below the target reference point, following poor recruitment in 2012. The exceptionally high abundance of brown tiger prawns in 2011 was protected throughout August and September by the spawning closure. A week of fishing took place in the TPSA in early October, reducing the mean catch rate to 60 kg / hr, which is still more than double the target level of 25 kg / hr. The area was then re-opened in late October and the fishery closed in early November at a brown tiger prawn catch rate of 33 kg / hr, which is well above the end-of-season reference level of 19 kg / hr. Therefore, in 2011, there would have been a very high level of spawning activity and substantial escapement of large prawns at the end of the fishing season.

There is evidence to indicate that recruitment of brown tiger prawns in Exmouth Gulf since 2012 has been impacted by environmental factors. The strongest evidence is from observations during 2012, by researchers at Edith Cowan University, of negligible seagrass cover in known brown tiger prawn nursery sites that typically have seagrass coverage. Past studies on brown tiger prawn recruitment in Exmouth Gulf have established a strong correlation between presence of structured habitats (seagrass and algae) and recruitment success (Loneragan et al. 2013). The management response has been to reduce effort on brown tiger prawns by delaying the start of the season and to undertake additional surveys to closely monitor the prawns stocks throughout the season. This has resulted in progressive increases of the brown tiger prawn recruitment levels (see Figure 6.2), providing evidence of the harvest strategy working.

In the early 1980s, when the brown tiger prawn spawning stock fell below the limit reference point, the stocks were rebuilt within 3 – 4 years through implementing major changes to the

management of the fishery. By the late 1980s, catches had increased to 400 – 600 t, and the spawning stock was at or above the target reference point during the key spawning season. In 2000, due to impacts of a severe cyclone and loss of seagrass habitats important to juvenile brown tiger prawns, the spawning stock level dipped slightly below the limit reference point, resulting in management measures being implemented the following season to limit fishing effort to a very low level. By the following year the spawning stock was back at the target level, demonstrating the effectiveness of the harvest strategy.

8.1.2.2 Western King Prawns

The harvest strategy for western king prawns is assessed annually by comparing, against specified reference points, inter-annual trends in recruitment (from fishery-independent surveys) and spawning stock levels (from fishery dependent catch rates in key western king prawn spawning grounds during the spring spawning period), and additional data on annual catch trends and size compositions. Generally the annual catches correspond to the level of fishing effort on western king prawns but in recent years catches have also been affected by low abundance of the species (see Section 6.1.2). Given the reduced abundance of western king prawns in recent years, management action have been taken specifically to provide increased protection to western king prawns in Exmouth Gulf, including substantially-delayed season opening dates. This reduces the length of the fishing season and enables increased time for growth and spawning of this species prior to opening of the fishery.

8.1.3 Monitoring

As outlined in Section 8.4, the EGPMF has a comprehensive monitoring program, including collection of both fishery-dependent and fishery-independent data for both brown tiger and western king prawns. The provision of data throughout the fishing season permits rapid detection of changes in catch rate and prawn size, which in combination with the highly responsive management system can quickly enact control rules (see Section 8.3) to ensure that the spawning stocks of the target species are sufficiently protected.

The performance of the harvest strategy in maintaining spawning stock abundance at appropriate levels for both species is monitored annually and reported within the annual *Status Reports of the Fisheries and Aquatic Resources of WA: the State of the Fisheries* (e.g. Fletcher & Santoro 2013), as well as in industry reports and at Annual Management Meetings.

8.1.4 Review

Elements of the EGPMF harvest strategy have been reviewed many times over the past 30 years. These reviews have mostly been in response to changes in fleet dynamics (boat numbers and size of boats), net configurations and headrope lengths to improve fishing efficiency. The spatial extent of the closed nursery areas in the south-eastern parts of Exmouth Gulf have been increased three times and the shape of the TPSA has been adjusted once in the 1980s to better reflect the main areas of abundance of brown tiger prawns. The implementation of harvest strategy is continuously reviewed, incorporating all the

information available at the commencement of the season and marked changes to fishing operations (i.e. fleet size, changes in gear and technology) and economics of fishing.

The EGPMF harvest strategy for brown tiger and western king prawns, including the performance measures and control rules, was externally reviewed in 2012 by Dr Malcolm Haddon (CSIRO). Review of the harvest strategy has also been undertaken through the process of the fishery being assessed multiple times against the Commonwealth's requirements for export accreditation under the EPBC Act (see Section 4.8).

8.2 Reference Points

A range of annual and in-season references points are used for managing the harvest of brown tiger and western king prawns in Exmouth Gulf (Table 8.1). The references points are predominately based on a combination of fishery-independent and fishery-dependent catch rates, which represent the primary performance measures for the fishery and are designed to preserve sufficient spawning stock whilst also providing industry the opportunity to optimise economic efficiencies. Some additional reference points (e.g. related to the size of prawns) also exist and trigger openings / closures of different areas in the fishery throughout the season (Table 8.1).

For reference points associated with stock performance, three levels are in place; target, threshold and limit. Target levels correspond to stock levels at or above B_{MSY} and limit levels correspond to stock levels below which future recruitment levels will be directly affected. Consistent with the Harvest Strategy Policy (DoF in press), threshold levels are intermediate levels between the target and the limit and designed to ensure that management actions are taken before a stock triggers the limit level.

8.2.1 Appropriateness of Reference Points

The empirically-based reference points for brown tiger and western king prawns in the EGPMF are compared against direct catch rate-based measures of recruitment and spawning stock abundance in the key areas to which these species recruit and spawn. As the areas in which brown tiger and western king prawns are dominant are spatially separated, the catch rates for each species represent good indices of recruitment (at the beginning of the fishing season) and spawning stock abundance (towards the end of the season, noting that both species spawn in their first year of life). The catch rate-based performance measures and reference points for this fishery have been developed over the past 40 years, based on historical data and a detailed knowledge of the biology of the target species.

Reference points for recruitment indices

The fishery-independent, catch rate-based target reference points associated with the recruitment indices for both brown tiger and western king prawns, used in determining when to start fishing each year, are set well above the respective target reference levels for the spawning stock indices. This reflects recognition that, in short-lived prawn species, stock abundance declines over the duration of the fishing season, due to fishing and natural mortality. Therefore, for fishing to be sustainable there needs to be a substantially greater abundance of prawns at the start of the season to ensure that spawning stock abundance later in the season remains above the spawning stock target reference point. The reference points and control rules associated with the recruitment indices are an integral component of the harvest strategy as these ensure that, in years of lower recruitment, pre-emptive management action is taken to provide increased stock protection (e.g. delayed fishing or area closures), combined with additional monitoring of stock abundance.

Reference points for spawning stock indices

For brown tiger prawns, catch and effort data from the 1970s and early 1980s, when recruitment of this species was found to have been affected by low spawning stock, was used to develop a SRR for this species in Exmouth Gulf (Figure 8.1; Penn & Caputi 1985, 1986; Penn et al. 1995). From these data, catch rate-based reference points have been developed into a set of robust performance measures for this species. Although developed for brown tiger prawns, they have also been demonstrated to be equally suitable for king prawns, a species that is inherently less vulnerable to the fishery due to its behaviour and life history characteristics.

Subsequent to the development of SRR for brown tiger prawns in the 1980s, the harvest strategy for the EGPMF became more conservative. Therefore, the catch rates to which this species (and also western king prawns) were fished have been adjusted upwards so that they are now set well above the values experienced when the brown tiger prawn stock collapsed. The current set of reference points have proved robust in enabling brown tiger prawns to be successfully managed using a constant escapement harvest strategy for the past 30 years.

To ensure that the reference points have remained appropriate through various enhancements to fishing methods for improving efficiency, the Department has routinely completed direct comparative trials between boats when different gear configurations (e.g. twin and quad gear) before they have been fully adopted. This ensures that changes in fishing efficiency have been incorporated into all catch rate-based reference points and control rules (see Appendix B). These comparisons have been a crucial aspect for ensuring that the reference points have remained appropriate (adjusted so it was still based on the original SRR) for the continued protection of brown tiger prawn spawning stocks, while also enabling the fishery to adopt efficiency increases.

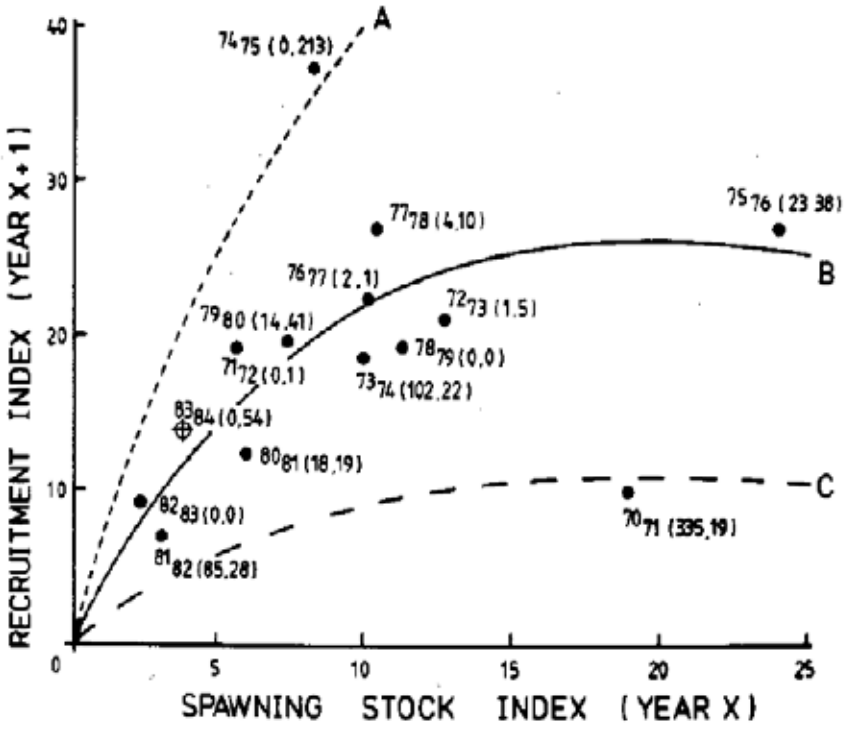


Figure 8.1. Relationship between spring spawning stock, autumn recruitment and January-February rainfall for the Exmouth Gulf brown tiger prawn stock, including three regression lines representing the expected recruitment under January and February rainfall conditions of (A) 0 and 200 mm, (B) 0 and 0 mm, and (C) 300 and 0 mm, respectively. Data points are given as 75/76 (23, 38) where the numbers in parentheses represent in sequence, January rainfall and February rainfall (in mm) in the recruitment year (1983/84 data point included but not used in regression) (Source: Penn & Caputi 1985)

8.2.2 Level of Target Reference Points

8.2.2.1 Brown Tiger Prawns

The recruitment target reference point for brown tiger prawns is set at 40 kg/hr to ensure that fishing grounds for this species are not fully opened to fishing unless the catch rate is above this level.

The spawning stock target catch rate of 25 kg / hr for brown tiger prawns is well above the point of inflection in the current SRR curve (Figure 8.1). This target was originally set at a lower level but has been modified through time, based on the robust fishing gear comparisons, to account for fishing gear and efficiency changes (Table 8.2). The relatively low catch rate associated with this target level is consistent with prawns being able to be fished to reasonably low abundance levels due to their life history strategies (short life span, high fecundity and high natural mortality), and that the stock has recovered from these low stock levels in the past.

Table 8.2. Explanation of target level adjustments in the EGPMF implemented since 1998

Year	Level	Explanation
Prior to 1998	14 kg / hr	Twin gear nets 15 ftm
1998	16 kg / hr	Efficiency increase twin gear
2001	19 kg / hr	Net size increase 20% twin (7.5 ftm) to quad (4.5 ftm)
2007	25 kg / hr	Net size increase 33% from 4.5 ftm to 6 ftm quad gear

8.2.2.2 Western King Prawns

The recruitment target catch rate of 30 kg / hr for western king prawns is used, in combination with a size-based target (> 50 % of prawns larger than 21/30 grade), to determine when to commence fishing for this species during the season. Because this fishery operates under an escapement policy, this effectively means that the western king prawn fishing grounds are not fully opened to fishing unless the recruitment target levels for this species are achieved.

The size-based target for western king prawns is economically driven and represents the optimum market size for this species, but also prevents growth and recruitment overfishing during the first part of the fishing season (April to July). Because the spawning period of the western king prawn is protracted, some individuals will have had a chance to spawn in the previous spring/summer and contribute to egg production. The same reference point is used to determine the closure of western king prawn fishing grounds at the end of the fishing season, which occurs when small individuals (smaller than 21/30 grade) increase in abundance (i.e. contribute > 50 % of the catch). This reference point is based on biological information and industry input, allowing these small prawns to grow to a larger size for the commencement of the fishery in the following season.

The spawning stock target level catch rate for western king prawns of 25 kg / hr is considered to be a conservative reference point because there is no clear SRR for this species (see below in Section 8.2.4.2) and represents the catch rates observed between 2002 and 2013 (excluding the lowest values), when recruitment has been relatively consistent. Note that the target reference point for the western king prawn is the same as for the brown tiger prawn, which is more vulnerable to overfishing.

8.2.3 Level of Threshold Reference Points

Consistent with the Harvest Strategy Policy (DoF in press), threshold reference levels have been adopted for brown tiger and western king prawns in the EGPMF, which are designed for management actions (and review) to be instigated well before the limit reference point is breached.

8.2.3.1 Brown Tiger Prawns

The recruitment threshold level that is currently used for brown tiger prawns in Exmouth Gulf is 10 – 40 kg / hr and the spawning stock threshold level is 10 – 25 kg / hr.

8.2.3.2 Western King Prawns

The recruitment threshold level for western king prawns in Exmouth Gulf is 15 – 30 kg / hr and the spawning stock threshold level is 15 – 25 kg / hr.

8.2.4 Level of Limit Reference Points

8.2.4.1 Brown Tiger Prawns

The limit catch rate level of 10 kg / hr for brown tiger prawns applies to both the recruitment index (below which fishing for this species does not commence) and the spawning stock index (Table 8.1). This current limit reference point is considered to be sufficiently conservative because values of the spawning stock index between the target (25 kg / hr) and the limit (10 kg / hr) have still generated acceptable recruitment levels of this species the following year (Figure 8.2).

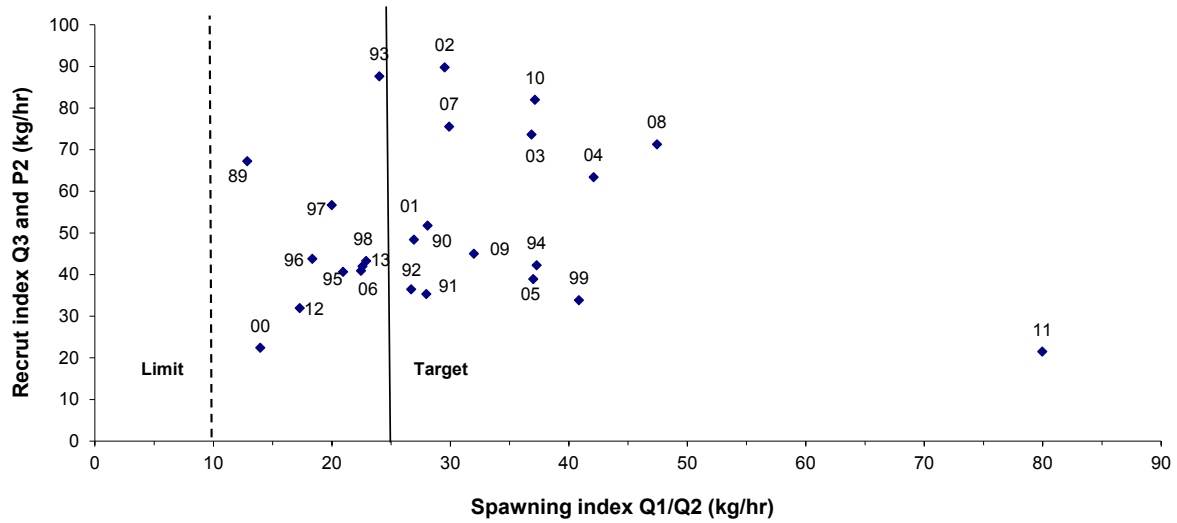


Figure 8.2. Spawning stock index (year Y) and recruitment index (year Y+1) for brown tiger prawns in Exmouth Gulf between 1989/90 and 2011/12. The current spawning stock target level of 25 kg / hr, limit reference point of 10 kg / hr, and the year of spawning are shown

8.2.4.2 Western King Prawns

In contrast to brown tiger prawns, there is no evidence to suggest that western king prawns have been overfished in Exmouth Gulf. There was no negative impact on catches or recruitment levels of this species in the period after the early the 1980s, when increased effort was shifted onto western king prawns (after the brown tiger prawn collapse).

The current limit catch rate level of 15 kg / hr for western king prawns applies to both the recruitment index (below which fishing for this species does not commence) and the spawning stock index. This is at the lower end of the range of recruitment index values observed over the last 12 years (Figure 8.3), when there has been no evidence of recruitment overfishing.

The comparison between the spawning stock index for western king prawns in August and September (i.e. during the spring spawning period and when fishing effort is directed on this species) and the recruitment index the following April does not show any declining trend (Figure 8.3). This indicates that the stock is not likely to have experienced spawning stock levels which would impact recruitment levels and therefore the 15 kg / hr limit reference point is conservative.

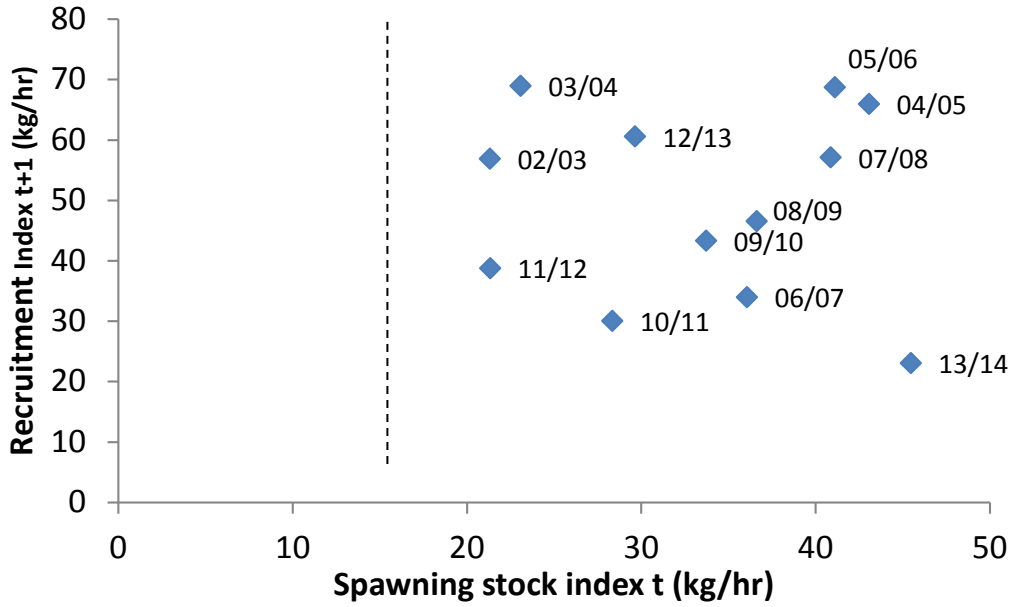


Figure 8.3. Spawning stock index for western king prawns in August and September (year t) and recruitment index in April (year t+1) in Exmouth Gulf between 2002 and 2013, with the limit reference point (15 kg / hr) represented as the dashed line

8.3 Control Rules and Tools

8.3.1 Design and Application

Harvest control rules are in place for the EGPMF that are consistent with the constant escapement harvest strategy for the fishery (DoF 2014a). The control rules are directly responsive to changes in the catch rate and size-based performance measures for brown tiger prawns and western king prawns, which are critical for ensuring the sustainability of the stocks of these species.

The harvest control rules for the EGPMF are designed to meet the ecological objectives of the fishery by minimising fishing of vulnerable life stages (e.g. pre-spawning and small prawns), whilst also optimising economic efficiencies. In-season control rules govern the timing and duration of fishing in particular areas of the fishery throughout the season, with annual control rules in place to ensure that the season arrangements are effective in maintaining sufficient spawning stock so that recruitment is not impaired. Table 8.1 outlines the control rules in place for the EGPMF and Figure 8.4 illustrates how they guide the annual operations of the fishery.

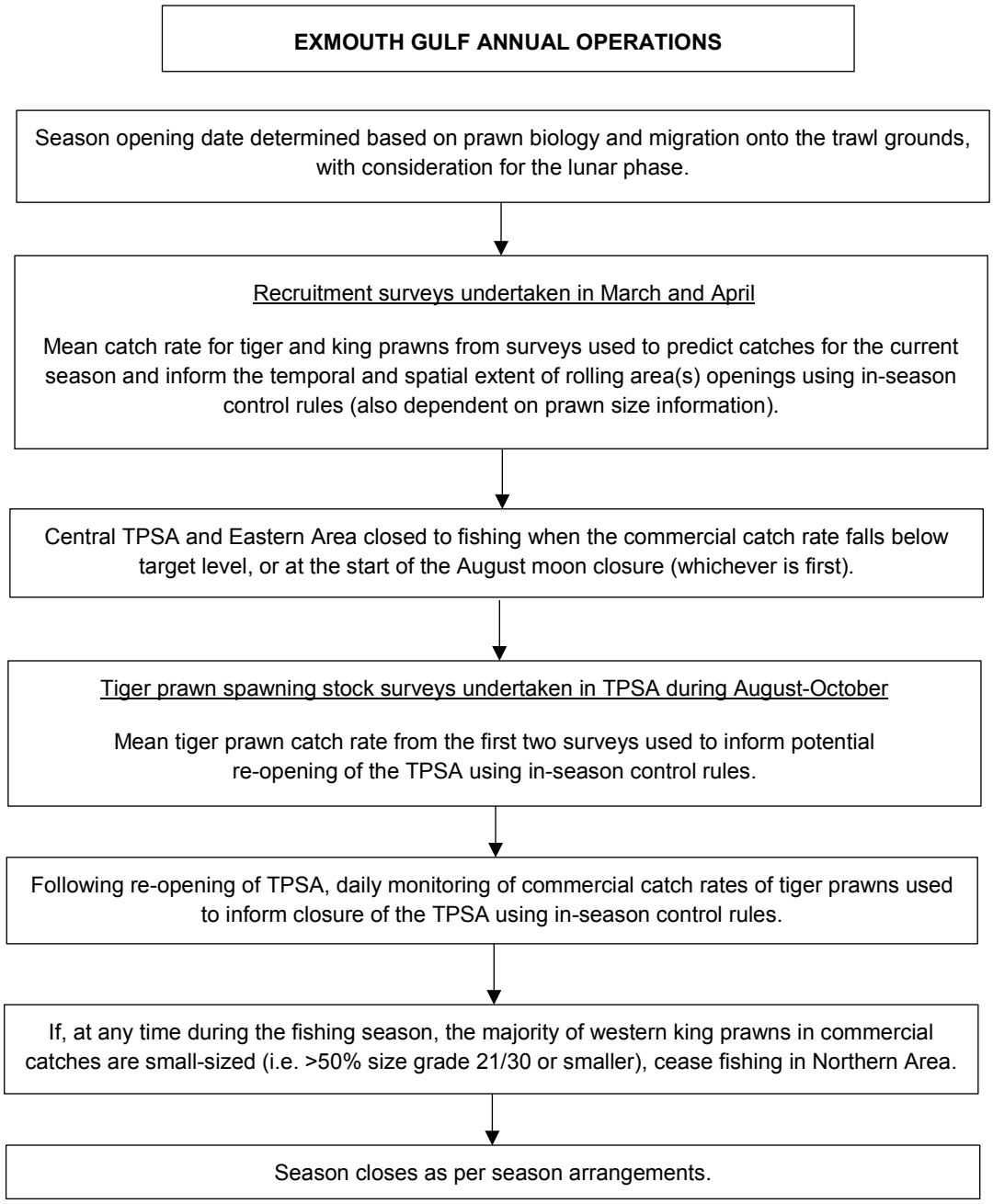


Figure 8.4. Flowchart of the general annual harvest strategy operations in the EGPMF

8.3.1.1 In-season Control Rules

- **Season opening**: The legislated season start date in the EGPMF is set based on the historical understanding of the prawn biology and migration onto the trawl fishing grounds, which includes consideration of the lunar phase. Commencement of fishing, however, does not occur in Exmouth Gulf until results are available from fishery-independent recruitment surveys (see below).

- **Northern Area, Central TPSA and Eastern Area opening**: Catch rates (and, for western king prawns, size information) from recruitment surveys determine when and what areas of the fishery open to fishing for the first part of the season. As detailed in

Table 8.1, catch rates above the target levels for brown tiger and western king prawns allow areas to open, while catch rates below the targets (but above limits, i.e. in the threshold range) trigger a review of the spatial and temporal extent of areas opened. Catch rates below the limit result in an area remaining closed to fishing.

Note that, in addition to the above harvest strategy control rules, industry may decide to maintain some additional 'industry closures' for economic reasons. The involvement with industry in making decisions ensures that the economic outcomes are explicitly considered. Note that these economic decisions are secondary to any management decisions required for conserving the stocks.

- **Central TPSA and Eastern Area closure**: During the early part of the fishing season, the commercial catch rate of brown tiger prawns is monitored approximately weekly using data from the fishery-dependent monitoring program, along with informal discussions with industry. When the commercial catch rate falls to around 45 kg / hr, i.e. 20 kg / hr above the target spawning stock level, it becomes monitored daily as catch rates may then decline more rapidly.

  Each season, the key brown tiger prawn spawning areas (i.e. the Central TPSA and Eastern Area) are closed to fishing on either (a) when commercial catch rate in the Central TPSA has fallen to near the target catch rate level of 25 kg / hr (over two consecutive nights), or (b) on 1 August (or appropriate moon phase), whichever comes first.

- **Central TPSA and Eastern Area re-opening**: Fishery-independent brown tiger prawn spawning stock surveys are undertaken in the closed spawning areas between August and October to obtain a standardised index of spawning stock abundance of this species. If the brown tiger prawn spawning stock index is well above the target level (25 kg / hr) after the second spawning stock survey, then the timing and re-opening of the Central TPSA and Eastern Area is considered in consultation with industry.

  If the areas re-open, fishing is once again ceased in the Central TPSA and Eastern Area when the daily commercial catch rate of brown tiger prawns declines to the target level of 25 kg / hr prior to 1 November, or to a level of 19 kg / hr after 1 November (i.e. outside of the key spawning season for this species).

- **Season closure**: Towards the end of the EGPMF fishing season, when small western king prawns (smaller than 21/30 grade) start to increase in abundance (i.e. contribute ~ 50 % or more of the catch), fishing on western king prawn grounds (Northern Area) ceases to prevent growth and recruitment overfishing. Note, however, that fishing for brown tiger prawns in the Central TPSA and Eastern Area may still continue until the end of the fishing season if commercial catch rates in these areas are high and they remain open to fishing (see above).

8.3.1.2 Annual Control Rules

Control rules associated with the spawning stock indices for brown tiger and western king prawns are in place to ensure the effectiveness of the annual operations of the fishery in maintaining sufficient spawning stock. Catch rates above target levels result in no changes to season management arrangements for the following year. Catch rates below the target level (in the threshold range) trigger a review of management arrangements for the next season, which may subsequently result in management action if sustainability is considered to be at risk. Catch rates below the limit will trigger a review of the fleet's spatial fishing patterns and catch rates to investigate why stock abundance is low. This will either result in more severe management action to protect the stock, or a change in monitoring if spawning stock index is considered to be inaccurate.

8.3.2 Accounting for Uncertainty

Fishery-independent (survey) and fishery-dependent (commercial) catch rates are used as the key performance measure for sustainability of the target stocks in the EGPMF, and have been shown to provide robust indices of recruitment and spawning stock levels for brown tiger and western king prawns in Exmouth Gulf (see Sections 7.1.1 and 7.1.2).

One source of uncertainty in the EGPMF harvest strategy is whether the commercial catch rates monitored throughout the fishing season (Section 7.1.3) to inform, for example, the tiger prawn spawning area closure, reflect the true abundance of prawns. Uncertainty in the estimation of commercial catch rates can occur due to inter- and intra-annual variability in how the fleet responds to inter- and intra-annual variations in the prawn stocks (e.g. due to recruitment, growth, movement patterns). The variability dictates that a detailed assessment of catch rates, accounting for all areas occupied by the stock for each species, is required to ensure that they continue to provide a robust index of prawn stock abundance.

Brown tiger prawn catch rates (i.e. which constitute the key performance measure linked to in-season control rules) are verified through comparing the commercial catch rate estimates near the time of spawning closure for this species with those obtained from the fishery-independent spawning stock surveys undertaken between August and October. If considered necessary to ensure adequate spatial representation of the stock, the use of data from these fishery-independent surveys are stratified for areas not being fished, further accounting for a potential source of uncertainty. Because the control rules are highly responsive to the estimated commercial catch rate for brown tiger prawns, by default they also take into account the key uncertainties for managing the sustainability of this species.

The harvest control rules are designed to account for the ability of the fleet to rapidly deplete the prawn stocks within an area. A rapid response is available (i.e. closure of part of, or all, the fishery within 24 hours) if it appears likely that the catch rate will go below the target (for either species) before the scheduled season closing date. In the last decade, industry has always agreed to cease fishing when advised and there has been no need for legislative action. The maintenance of the brown tiger prawn spawning stock above the limit in nearly

all years over the last 30 years indicates that uncertainty is being taken into account adequately in the decision-making process.

8.3.3 Evaluation

The control rules have ensured that the objective of maintaining the brown tiger prawn spawning stock been at or above the specified target reference point has generally been achieved since 2001 (Figure 6.1). The low spawning stock of this species in 2012 is not related to the failure of control rules but rather to environment / habitat. In accordance with the harvest strategy, catch and fishing effort on brown tiger prawns in Exmouth Gulf in that low recruitment year was maintained at very low levels (by delaying fishing and conservative area openings). Control rules for western king prawn have ensured that the objective of maintaining catch rates of this species near or above the target level has been achieved in all years since 2000. In summary, there is strong evidence that the harvest control rules for both species are working effectively for achieving acceptable exploitation levels.

8.4 Information and Monitoring

8.4.1 Range of Information

Research and monitoring of the prawn fishery in Exmouth Gulf has been conducted since the commencement of the fishery in the early 1960s, and there is a comprehensive range of information available to support the harvest strategy for brown tiger and western king prawns (Table 8.3).

Commercial catch and effort statistics (for both target and byproduct species) have been collected from the Exmouth Gulf trawl fleet since 1963 using daily logbooks. These data, which are validated by processor unloads and VMS, provide a valuable long-term data set spanning varying effort levels and environmental conditions. The information collected from these logbooks provided the basis for assessing the causes of the brown tiger prawn stock collapse in Exmouth Gulf in the 1980s and was subsequently used to develop the stock-recruitment-environment relationship for this species (Caputi et al. 1998); however, as the biology and movement patterns of brown tiger and western king prawns in Exmouth Gulf became better understood and spatial and temporal fishery closures were implemented to protect spawning prawns, the fishery-dependent data alone were no longer considered adequate to monitor these stocks.

Fishery-independent surveys for brown tiger prawns have been undertaken annually since the 1980s to determine the recruitment and spawning stock levels of this species in Exmouth Gulf (Penn & Caputi 1986; Penn et al. 1997; Caputi et al. 1998). Additionally, after a risk assessment in 2003 identified the need to also monitor the recruitment levels of western king prawns, recruitment surveys have been extended to include sites in the northern area of the fishery, which are important western king prawn fishing grounds. These different measures of prawn abundance are used to assess the performance of the fishery each year and ensure that there is a sufficient level of escapement of prawns to sustain a sufficient level of breeding stock.

Table 8.3. Summary of monitoring activities in the EGPMF

Data type	Fishery-dependent or independent	Analyses and purpose	Areas of data collection	Frequency of collection	History of collection
Daily logbooks	Dependent	Catch and effort trends, calculation of commercial catch rates and area trawled	Detailed, by shot latitude and longitude	Daily (shot-by-shot since 1998)	Since 1963 Compulsory since 2008
Processor unloads	Dependent	Validation of logbook catches	Exmouth Gulf	Monthly	Since 1963
VMS	Dependent	Verification of boat locations for logbook analysis	Exmouth Gulf	Every fishing season	Since 2001
Recruitment surveys	Independent	Catch rates provide indices of recruitment strength for brown tiger and western king prawns and are used to predict catches for season Catch rates and size composition data are also used to inform the rolling opening / closures of different fishery areas during season	Parts of northern, central and eastern Exmouth Gulf	March and April	Since 1985 for brown tiger prawns Since 2003 for western king prawns
Spawning stock surveys (for brown tiger prawns only)	Independent	Catch rates provide an index of spawning stock abundance, which is used to update the SRR Provides information on sex ratios and the reproductive stage of female prawns	TPSA (Q1 and Q2 fishing grounds)	August, September and October	Since 1984
Biological information	Dependent and independent	Patterns of growth and reproduction, stock structure	Exmouth Gulf	Occasional	Since 1970s

In addition to an abundance of biological information available from studies of brown tiger and western king prawns in Exmouth Gulf (see Section 2.1), several other research projects focusing on this fishery have been undertaken over the past two decades. As part of an FRDC-funded study on brown tiger prawn stock enhancement, the distribution of seagrass and algal communities in both the eastern and western parts of Exmouth Gulf were sampled between 1999 and 2001 (Kenyon et al. 2003). Continued surveys in 2003, 2005 and 2006 demonstrated the importance of inshore structured habitats (seagrass / algae) for survival of juvenile brown tiger prawns (Loneragan et al. 2013).

The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing, with bycatch composition and abundance most recently sampled in Exmouth Gulf during square mesh panel trials in 2008 and 2009. This information supplements data collected in 2004 through an FRDC-funded project on biodiversity monitoring systems for key WA trawl fisheries (Kangas et al. 2007).

Data on environmental variables (e.g. rainfall, temperature, cyclone events) that have shown to be important drivers of recruitment of prawns are collected in Exmouth Gulf annually.

8.4.2 Monitoring

8.4.2.1 Fishery-Dependent Monitoring

Licensees involved in fishing operations and / or the master of every licensed fishing boat in WA are required by law to submit accurate and complete catch and effort returns on forms approved by the Department. Daily logbooks (see example provided in Appendix C) have been completed by all skippers in the Exmouth Gulf prawn fishery since 1963 and have been a compulsory requirement since 2008. Prior to 1998, catches and nominal effort were reported by 10×10 nm blocks or fishing grounds but are now recorded by the latitude / longitude of the start location for each trawl shot. Fishers record the start position, start time, duration and mean depth of each trawl, as well as the catches of each retained species in each trawl, interactions with any ETP species and environmental data (water temperature and moon phase). Logbook sheets are completed daily and returned to the Department after each fishing period (approximately monthly).

The daily logbook data are entered into a database, with various computer-automated checks applied to ensure the data are entered accurately (e.g. to detect if required fields are missing). The data are also examined visually by experienced research staff to detect any unusual entries that may not have been picked up by computer validation procedures. Any anomalies that cannot be easily dealt with are followed up directly with the relevant vessel skipper.

Unload information and prices have been provided by processors since the early 1960s and are used to validate the logbook data. Daily logbook estimates of catches are adjusted (scaled up or down) to actual landings as recorded in processor returns, which provide the most accurate measure of the total retained catch in the fishery.

8.4.2.1.1 Commercial Catch

The catches recorded in the daily logbooks are often analysed according to historical fishing grounds in Exmouth Gulf (Figure 8.5). Analyses of the catches recorded by fishers in the EGPMF between 1998 and 2013 (excluding 2000) demonstrate that the majority of the total catch of prawn species was taken in only four of the 10 grounds; Q1, Q2, R1 and S2 (Figure 8.6a). It is for this reason that assessments and surveys are mainly focused on catch rate data from these grounds.

The analyses further demonstrate that the vast majority of the total catch is comprised of brown tiger prawns and western king prawns, with the exception of substantial catches of

blue endeavour prawns in the R1 fishing ground (Figure 8.6b). Prawns catches in Q1 and Q2 are clearly dominated by brown tiger prawns, whereas those in S2, and to a lesser extent in R1, are dominated by western king prawns (Figure 8.6b). Additionally, the majority of the catch of brown tiger prawns is taken from Q1, Q2 and R1 (Figure 8.6c), whereas the majority of the catch of western king prawns is taken in R1 and S2 (Figure 8.6d). The large percentage of western king prawn catch taken from R1 highlights the importance of this fishing ground for this this species.

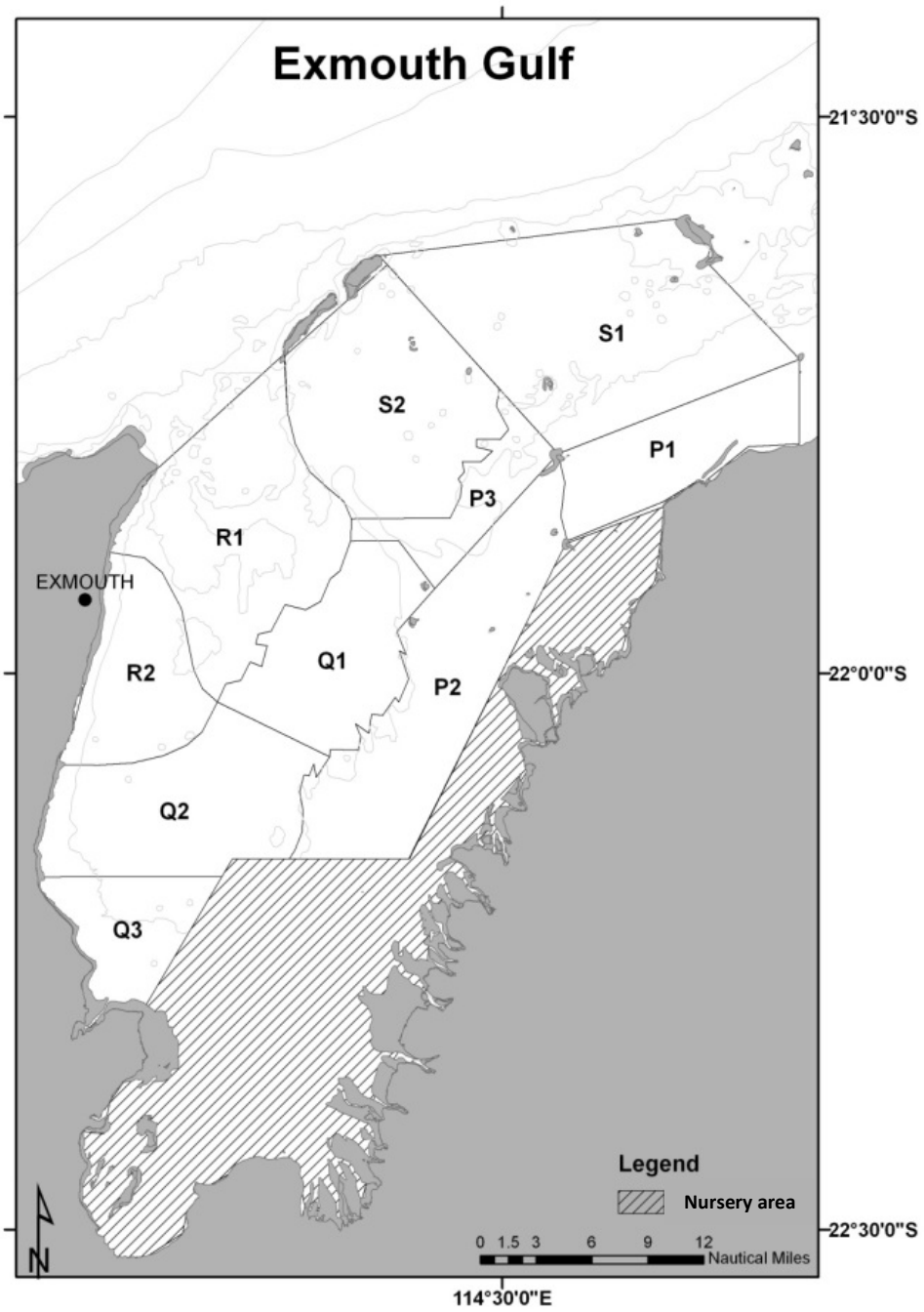


Figure 8.5. Fishing grounds in Exmouth Gulf used for analysis of catch and effort data

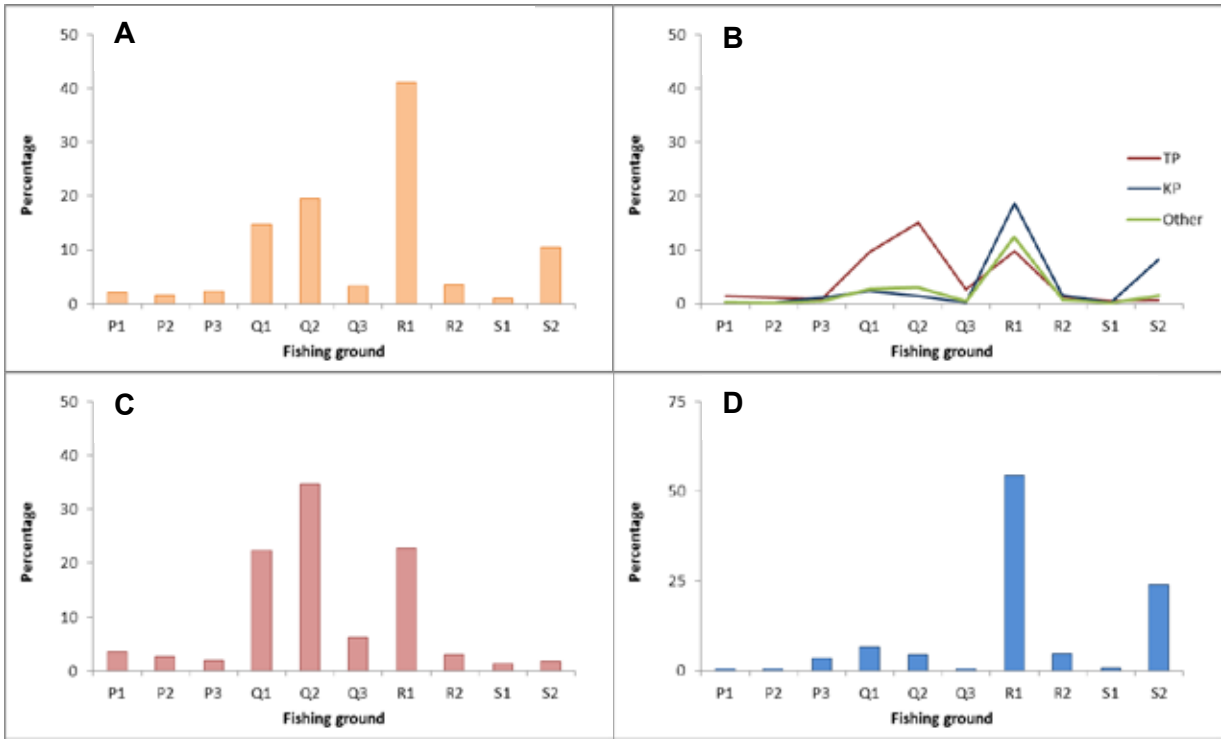


Figure 8.6. Percentage of total (a) prawn catch and percentage of each species (b) in the total catch and species-specific catch for brown tiger prawns (c) and western king prawns (d) by each fishing ground in Exmouth Gulf between 1998 and 2013 (excluding 2000)

Additional analyses have been undertaken to understand the extent to which, among years, the catches of prawns in the key fishing grounds are dominated by one species. Results clearly show that prawns catches in Q1 and Q2 have been dominated by brown tiger prawns in most years (Figure 8.7a, b). In Q1, brown tiger prawns were the most abundant species in all years, except in 1998 and 2006 when the catches of brown tiger prawns were at their lowest in the time series and were only marginally exceeded by another species (Figure 8.7a). Catches in Q2 were even more dominated by brown tiger prawns (Figure 8.7b). In both Q1 and Q2, brown tiger prawns often contributed ~ 60 – 80 % to the total catch, i.e. in seven of the 15 years in Q1 and in 10 of the 15 years in Q2. The catch data for Q1 and Q2 also indicate the highly variable annual recruitment in brown tiger prawns, with the exceptionally high catch in 2011 being followed by very low catch in 2012 (which appears linked to changes in seagrass cover in recruitment areas).

In the case of R1 and S2, catches were generally dominated by western king prawns (Figure 8.7c, d). Western king prawns were most abundant in R1 in all but one year, 2011, which represented an exceptionally-high abundance year for brown tiger prawns (Figure 8.7d). It is also noteworthy that in 1999, blue endeavour prawns were exceptionally abundant in R1 and in that year, despite a good abundance of western king prawns, blue endeavour prawns were the most abundant species on this fishing ground (Figure 8.7d). In R1, western king prawns contributed ≥ ~ 60 % of the catch in nine of the 15 years. The fishing ground S2 is clearly dominated by western king prawns, with this species contributing over 60 % to the total catch in all but one year, and often contributing over 80 % to the total catch (Figure 8.7c). It is thus

concluded that commercial catch rates in Q1 and Q2 provide good indices of abundance of brown tiger prawns and that those in R1 and S2 provide good indices of abundance of western king prawns.

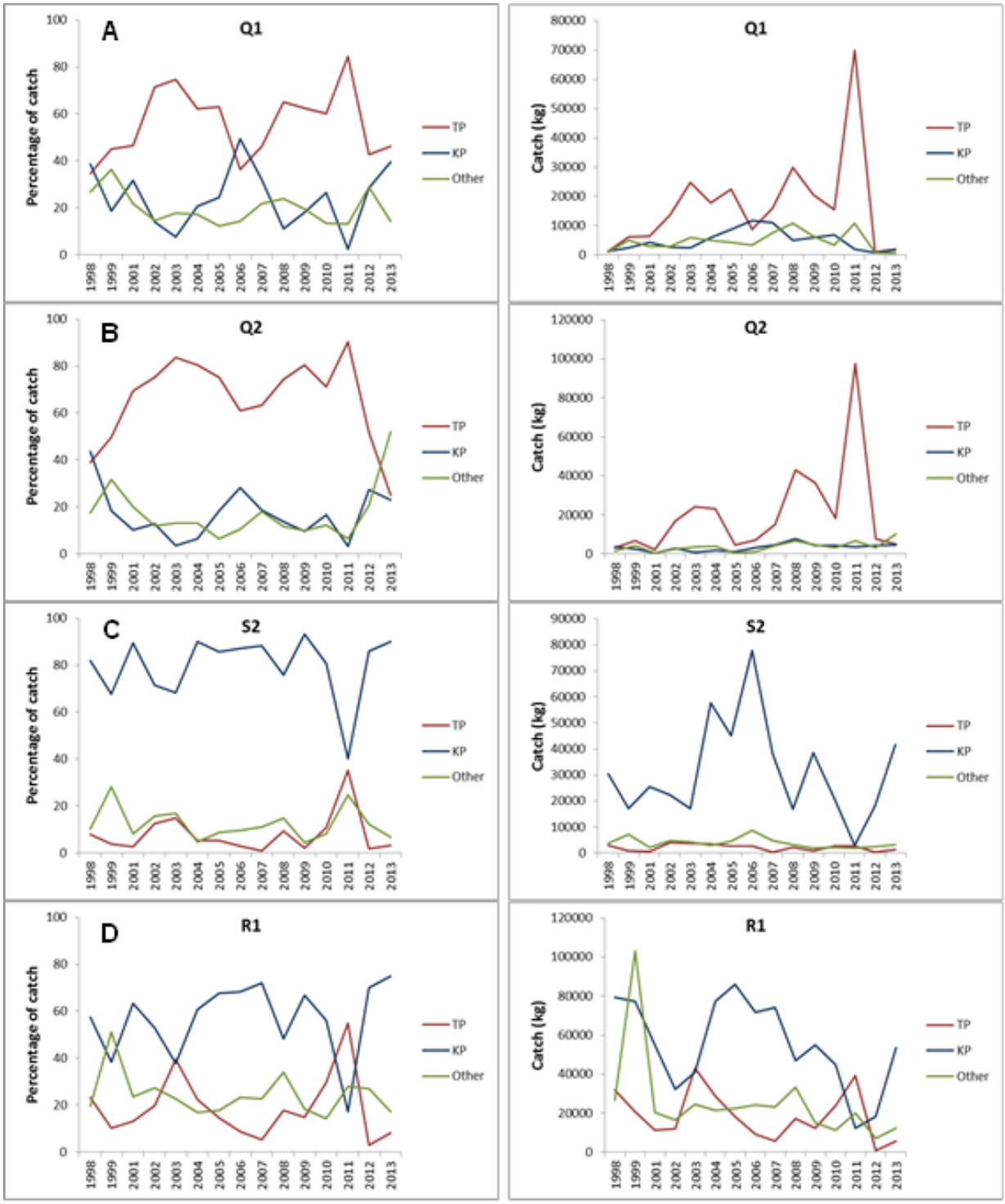


Figure 8.7. Percentages of catches (right) and total catches (left) of brown tiger prawns (TP), western king prawns (KP) and other prawns (blue endeavour prawns and banana prawns combined) in each year between 1998 and 2013 (except 2000) in the four key fishing grounds of the Exmouth Gulf prawn fishery: Q1 (a), Q2 (b), S2 (c) and R1 (d)

The above trends are illustrated further by analyses of catch data at a finer spatial scale (i.e. by 1 nm blocks) for years of differing abundances. For example, in years of both low (2006) and high (2011) brown tiger prawn abundance catches were most concentrated within the central fishing area (i.e. in fishing grounds Q1 and Q2) and in R1, which lies adjacent to Q1 (Figure 8.8). For western king prawns, catches in the same two years were concentrated in the northern fishing area, in the grounds R1 and S2 with less in the central fishing area (Figure 8.9).

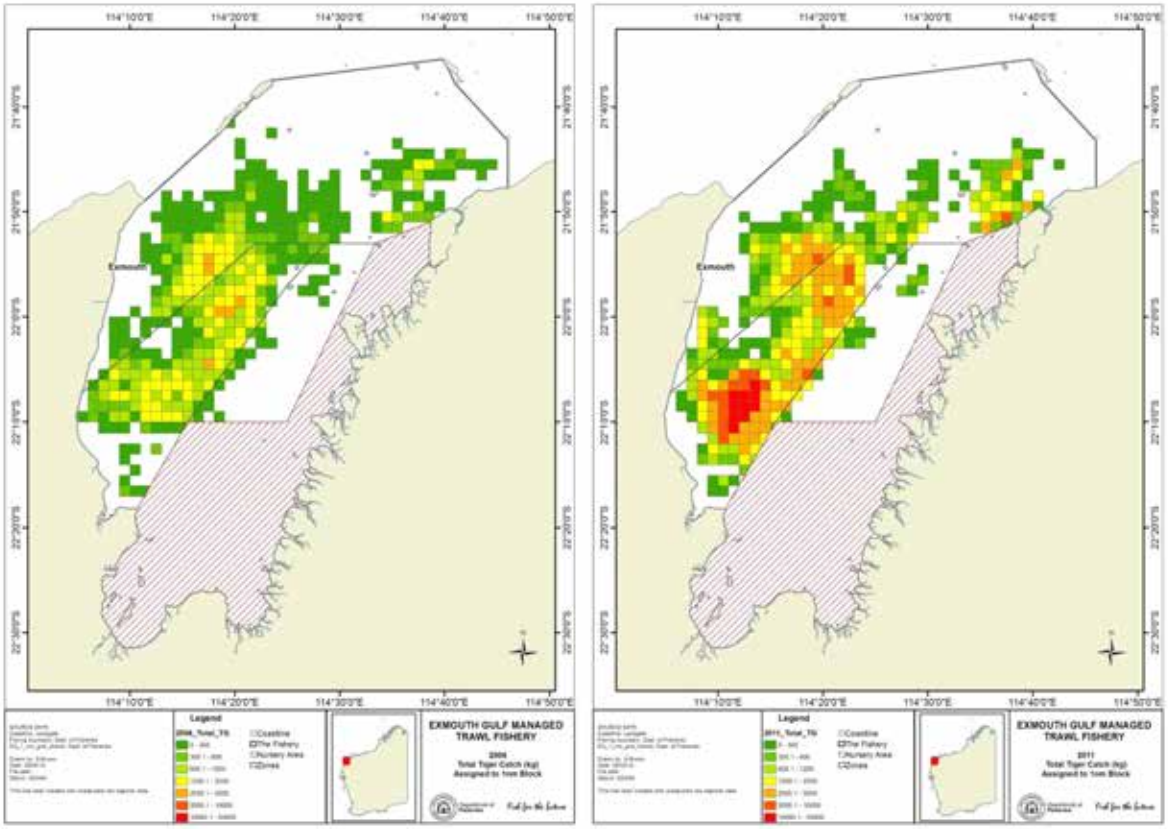


Figure 8.8. Spatial distribution of catches of brown tiger prawns in Exmouth Gulf in a year of low catches (2006, left) and a year of high catches (2011, right)

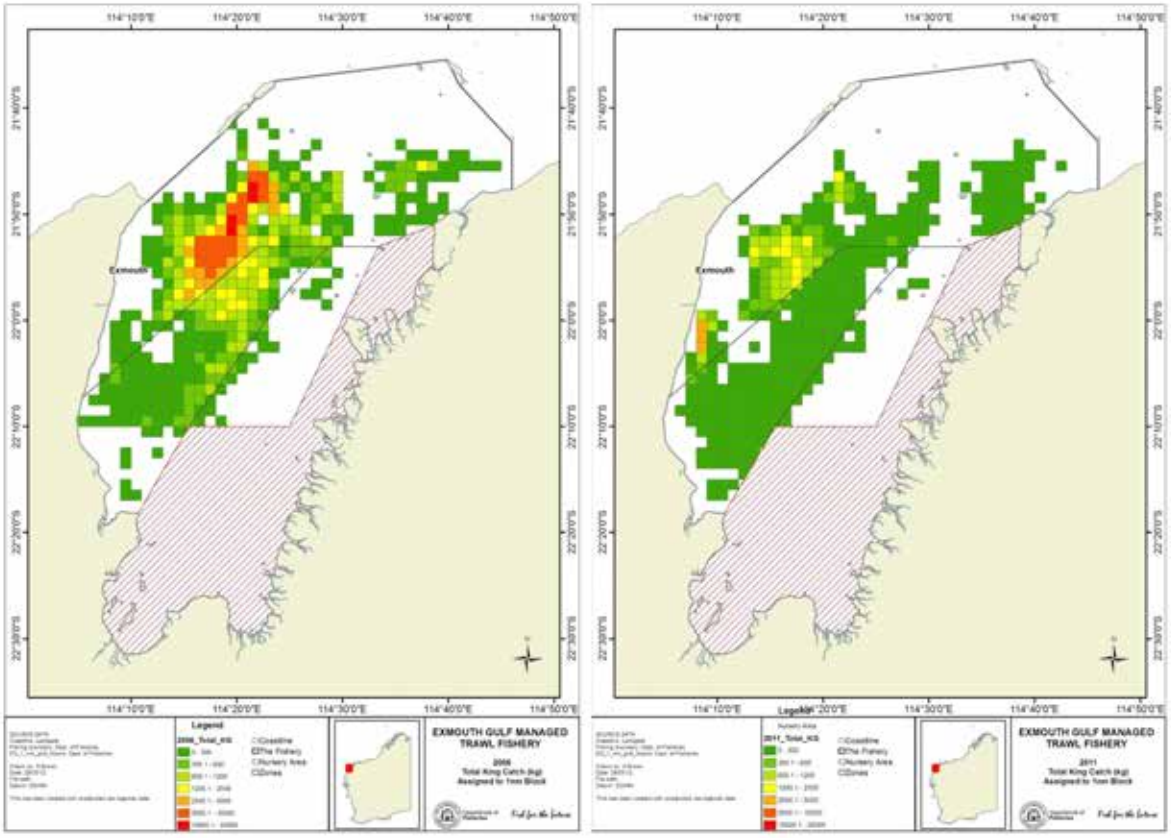


Figure 8.9. Spatial distribution of catches of western king prawns in Exmouth Gulf in a year of high catches (2006, left) and a year of low catches (2011, right)

8.4.2.1.2 Commercial Effort

Nominal effort in the EGPMF is obtained from the daily logbook sheets completed by all skippers and is recorded as hours trawled. Since changes in gear configuration from twin to quad-rigged gear in 1998, effort has been adjusted so that the entire time series is comparable and related to twin gear (2 x 7.5 ftm nets; Table 8.4).

A range of analyses have been undertaken to account for changes in the efficiency of fishing effort over time (Appendix B). Effort has also been adjusted to account for changes in headrope length (net capacity) for the fleet.

Table 8.4. Swept area (nm^2), nominal and adjusted (to twin gear) effort and number of boats operating in the EGPMF between 1963 and 2013

Year	Area swept (nm^2)	Thousand hours		Number of boats	Year	Area swept (nm^2)	Thousand hours		Number of boats
		Nominal effort	Adjusted effort				Nominal effort	Adjusted effort	
1963		1.8	1.8	12	1990	1280.9	36.0	36.0	16
1964		2.1	2.1	6	1991	1285.4	36.2	36.2	16
1965		8.4	8.4	13	1992	1221.0	34.4	34.4	16
1966		11.1	11.1	15	1993	1341.0	37.7	37.7	16
1967		16.7	16.7	17	1994	1307.0	36.8	36.8	16
1968		17.7	17.7	17	1995	1290.7	36.3	36.3	16
1969		26.2	26.2	17	1996	1246.9	35.1	35.1	16
1970		38.8	38.8	20	1997	1308.5	36.8	36.8	16
1971		29.7	29.7	20	1998	1265.7	34.0	35.6	15
1972	1130.5	45.0	45.0	22	1999	1240.0	32.8	34.9	15
1973	1236.3	47.3	47.3	22	2000	1168.7	27.4	33.4	13
1974	1168.5	41.5	41.5	22	2001	1152.9	27.0	33.0	13
1975	1332.0	45.1	45.1	22	2002	1123.7	26.4	32.2	13
1976	1486.0	49.7	49.7	22	2003	1157.9	27.2	33.2	13
1977	1764.0	51.0	51.0	22	2004	1122.9	24.9	32.2	12
1978	1847.5	54.4	54.4	22	2005	1085.7	24.0	31.1	12
1979	1767.5	51.1	51.1	23	2006	960.5	21.2	27.5	12
1980	1997.2	52.7	52.7	23	2007	860.6	16.3	24.2	9
1981	1896.2	46.7	46.7	23	2008	981.7	18.1	27.6	9
1982	1519.8	42.2	42.2	23	2009	972.3	17.9	27.4	9
1983	1343.6	37.7	37.7	21	2010	900.3	16.6	25.3	9
1984	1365.1	38.5	38.5	19	2011	716.8	13.2	20.2	9
1985	1541.7	43.1	43.1	19	2012	273.0	7.0	12.6	6
1986	1577.5	44.6	44.6	19	2013	247.0	9.5	17.1	6
1987	1616.9	46.0	46.0	19					
1988	1518.9	42.8	42.8	19					
1989	1402.7	39.5	39.5	19					

8.4.2.1.3 Commercial Catch Rates

Commercial catch rates for brown tiger and western king prawns in the EGPMF are calculated based on validated catch and effort data obtained from the daily logbooks. Due to the relatively clear spatial separation of catches of the two target species in Exmouth Gulf, the effort in the fishery can be apportioned by species when determining catch rates. Comparison of in-season commercial catch rates with catch rates observed during fisher-independent spawning stock survey in the same areas at specific times (when they close and re-open) during the fishing season assists in ensuring the consistency between the two measures of abundance.

Real-time monitoring of commercial catch rates brown tiger prawns in Exmouth Gulf is used for determining when to cease fishing in the Central TPSA and Eastern Area prior to the key spawning period of this species (August – October). That is, brown tiger prawn catch rates in the Central TPSA are monitored daily as they fall closer to the target level (25 kg / hr), with

the area closing to fishing once it reaches this level over two consecutive nights. If the Central TPSA and Eastern Area re-opens to fishing for the latter part of the fishing season (dependent on spawning stock survey catch rates), the commercial catch rates will also be used to determine when these areas close at the end of the season.

As logbook information is only provided by skippers at the end of each fishing period (typically every 3 – 4 weeks), the real-time monitoring of catch rates in the EGPMF is achieved through daily boat catch electronic reporting (i.e. spreadsheets) as well as regular phone communication with research staff. This enables nightly trawl activity and catches to be assessed against the performance indicators to decide when areas open and close. Note that industry at times initiates area closures to prevent capture of small prawns but they notify the Department so these are documented. The industry cannot open any areas without consultation.

Comparisons of daily commercial catch rate data between years demonstrate how fleet dynamics are influenced by the relative abundances of brown tiger and western king prawns in Exmouth Gulf and the in-season management actions and area openings / closures. The annual area openings and trends in effort and catch rates (for both species) are described below, for three fishing seasons between which the relative abundance of each species varies.

The northern fishing grounds in Exmouth Gulf represent most of the western king prawn stock and the catch rates and size of this species generally peak from August onwards when prawns are aggregating, primarily in the R1 and S2 areas, for spawning. The southern fishing grounds consist of primarily brown tiger prawns and these areas are fished early in the fishing season as the brown tiger prawns at this time are generally a larger size than western king prawns, and the time to fish brown tiger prawns is limited given these areas close during the key brown tiger prawn spawning period from August.

Area openings and closures in 2006

There were five area openings in 2006 (Figure 8.10). The season commenced on 24 April and, based on recruitment survey information, half of the northern grounds were opened to fishing along with a small section of the Central TPSA for two weeks. Then, for a further two weeks, another part of the northern grounds was opened to fishing as industry survey indicated a reasonable catch rate and prawn size in this area. On 19 May, more area in the Central TPSA and northern grounds were opened to fishing until 20 June, but maintaining the Eastern Area closure where the prawns were still small at this time. On 21 June, most of the Central TPSA was opened to fishing (except Q3) because there was limited time to fish on brown tiger prawns and, in conjunction with this, all of the Northern Area opened. On 1 August, the Central TPSA and Eastern Area were closed to fishing and the boats fished in the Northern Area until the end of the season on 31 October.

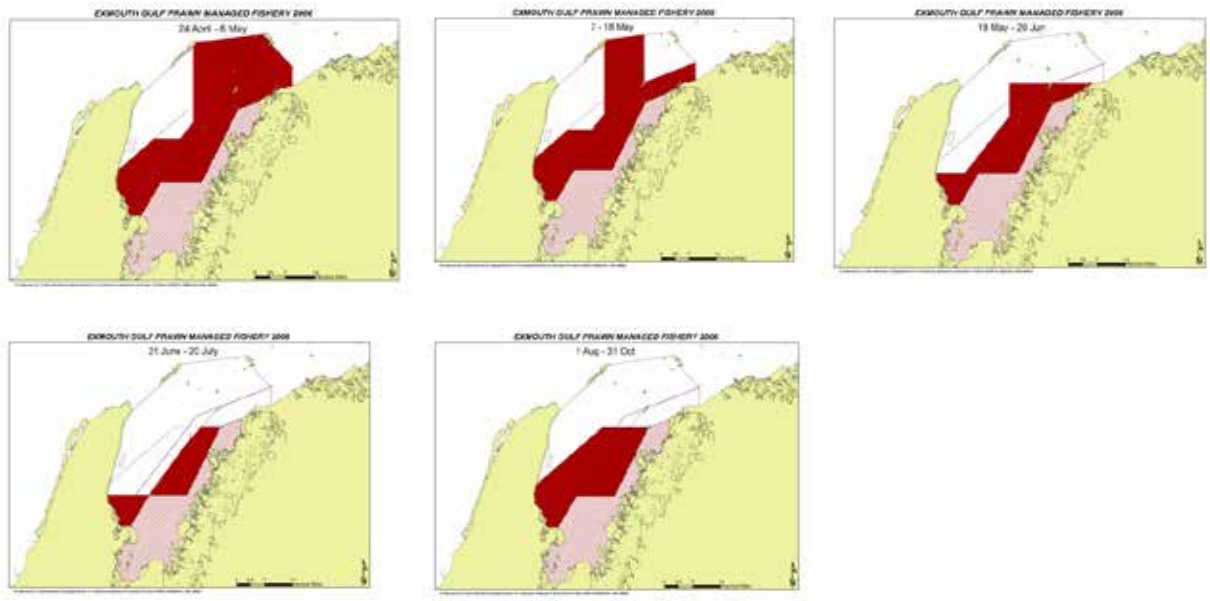


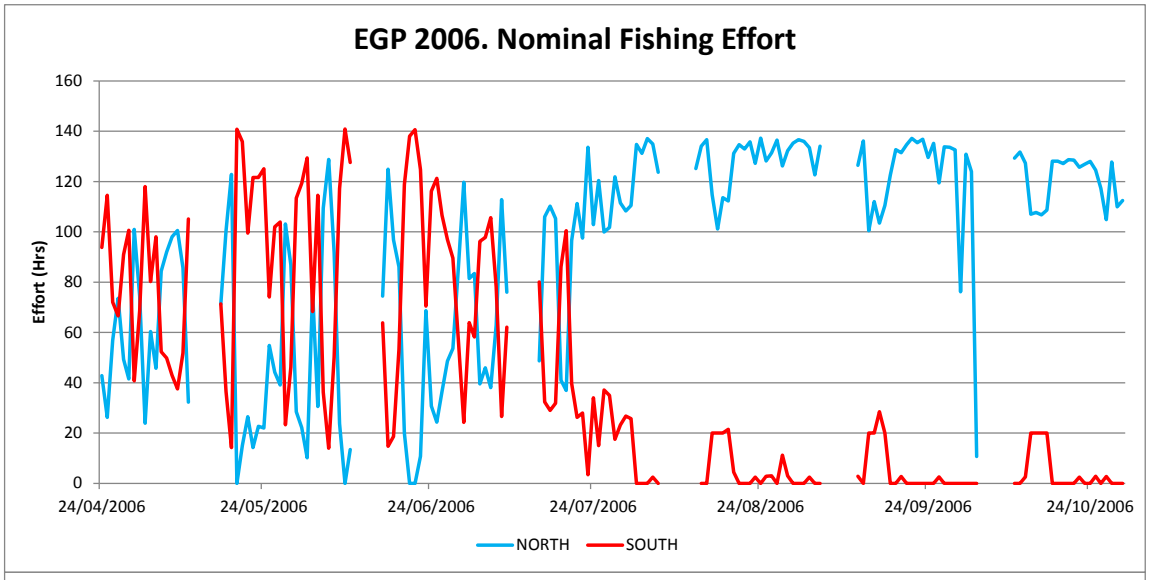
Figure 8.10. Area openings (white areas) in the EGPMF during 2006. Note closure of the Central and Eastern areas from 1 August for the remainder of the fishing season

Daily catch rate trends in 2006

In 2006, the annual landings of brown tiger prawns were moderate (258 t) and landings of western king prawns were relatively high (442 t). During the first three fishing periods, fishing effort was targeted towards the two species alternately until early August, when the Central TPSA and Eastern Area closed and effort became mostly directed towards western king prawns (Figure 8.11). The low levels of effort on brown tiger prawns after the start of August represents the fishery-independent survey periods within the TPSA (carried out by commercial boats with research staff on board). The TPSA did not re-open after the September spawning stock survey.

In the first fishing period (end of April to early May), the catch rates of western king prawns were slightly higher than brown tiger prawns and declined prior to the moon closure period (Figure 8.11). The area available for fishing at this time was constrained (see above). In the second and third fishing periods, southern areas that had previously been closed were opened, resulting firstly in a spike in brown tiger prawn catch rates and then spikes in catch rates of both species (Figure 8.11). Throughout the rest of the season, western king prawn catch rates were higher than brown tiger prawns with a declining trend evident (Figure 8.11).

a)



b)

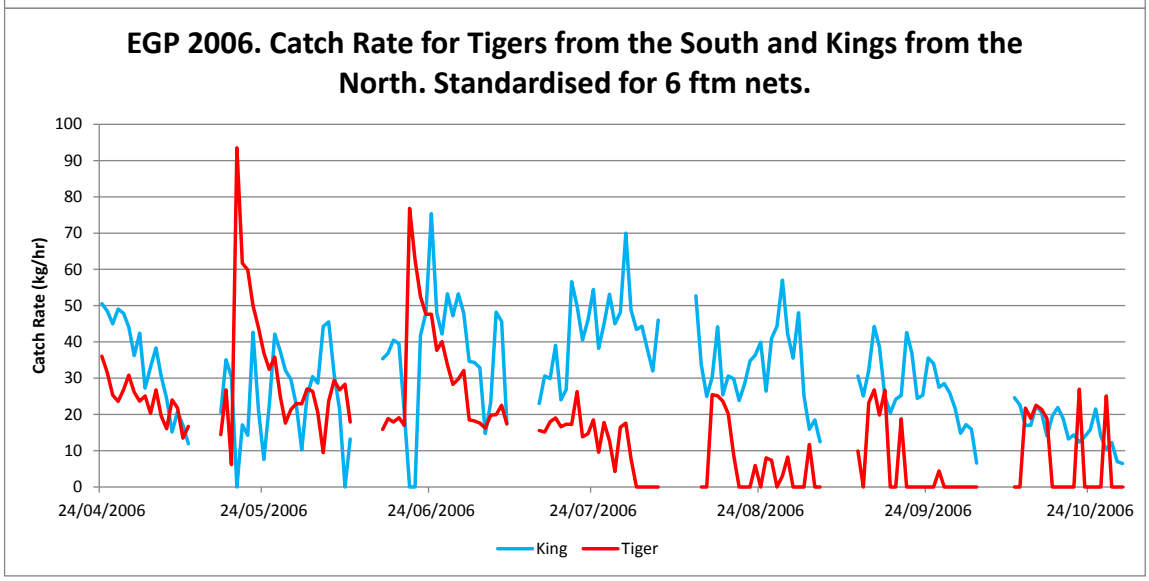


Figure 8.11. (a) Total daily fishing effort (hours trawled) directed towards brown tiger prawns in southern fishing areas (including most of P1, P2, P3, Q1, Q2, Q3) and directed towards western king prawns in northern fishing grounds (including most of R1, R2, S1, S2) during the 2006 fishing season. Zero effort during the season represents moon closures; (b) Daily commercial catch rates (kg / hr) of brown tiger prawns and western king prawns during 2006 using directed effort on each species according to hours trawled in either northern grounds (western king prawns) or southern grounds (brown tiger prawns)

Area openings and closures in 2011

There were nine area openings in 2011 (Figure 8.12). Because recruitment surveys provided a very high catch prediction for brown tiger prawns and a low catch prediction for western king prawns, fishing prior to August was primarily focused in the Central TPSA. However, some of the Northern Area remained open to fishing to allow boats to assess the abundance and size of western king prawns. After the brown tiger prawn spawning closure, the Central TPSA was re-opened to fishing between 2 and 9 October and closed again until 22 October. Virtually all but the western side of the fishery re-opened on 23 October and on 1 November all the Northern Area was closed to fishing due to control rules for western king prawns. The fleet fished the entire southern areas until the end of the season on 8th November.

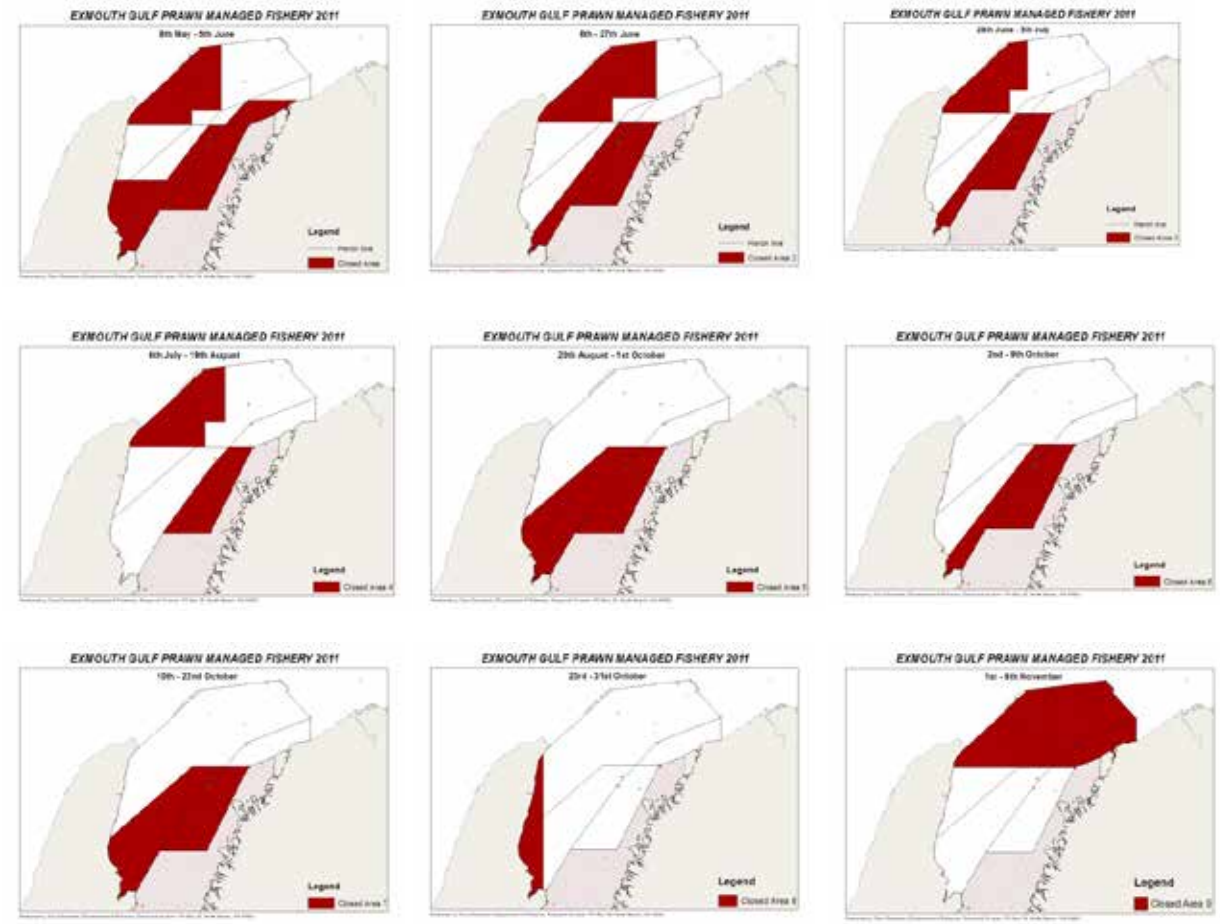


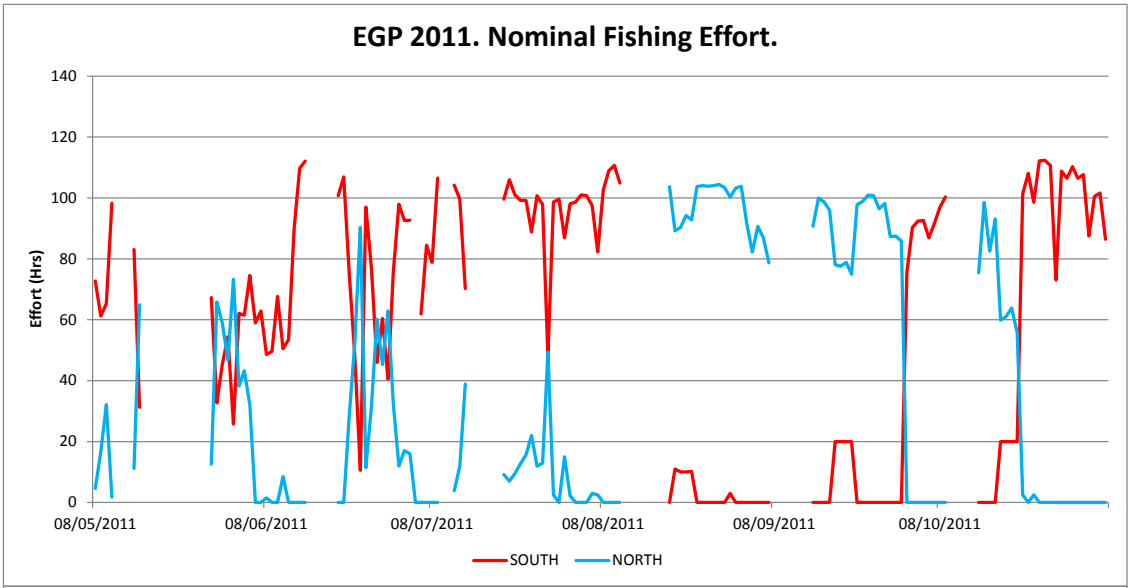
Figure 8.12. Area openings (white areas) in the EGPMF during 2011

Daily catch rate trends in 2011

In 2011, the annual landings of brown tiger prawns were very high (749 t) and western king prawn landings were very low (97 t). Therefore, much of the fishing effort in 2011 was based on brown tiger prawns, except in August and September when the key brown tiger prawn spawning area was closed to fishing (Figure 8.13). As explained above, the small peaks in fishing effort for brown tiger prawns during this time are attributed to the spawning stock surveys. In the first fishing period (early May), the catch rates of brown tiger prawns were moderate but not as high as observed in the second fishing period when more area was

opened to fishing and very high catch rates were observed for seven days (Figure 8.13). Western king prawn catch rates peaked in the fourth fishing period but were generally low, particularly in comparison with brown tiger prawn catch rates (Figure 8.13). During the last two fishing periods, the brown tiger prawn fishing grounds were re-opened and high catch rates were achieved. Despite a general decline, brown tiger prawn catch rates were still above the target level when the fishery closed on 7 November (Figure 8.13).

a)



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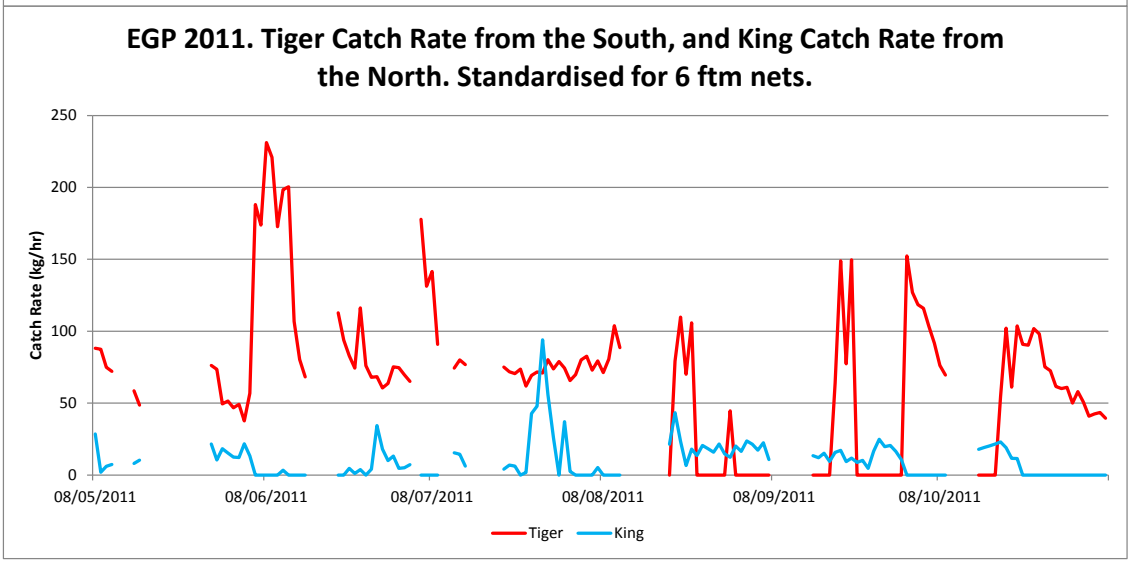


Figure 8.13. (a) Total daily fishing effort (hours trawled) directed towards brown tiger prawns in southern fishing areas (including most of P1, P2, P3, Q1, Q2, Q3) and directed towards western king prawns in northern fishing grounds (including most of R1, R2, S1, S2) during the 2011 fishing season. Zero effort during the season represents moon closures; (b) Daily commercial catch rates (kg / hr) of brown tiger prawns and western king prawns during 2011 using directed effort on each species according to hours trawled in either northern (western king prawns) or southern grounds (brown tiger prawns)

Area openings and closures in 2013

There were eight area openings in 2013 (Figure 8.14). As the catch prediction for brown tiger prawns from the recruitment surveys was low and the size of western king prawns were small fishing was delayed until 15 May. Between 15 and 25 May the area opened to fishing was restricted to mainly where the brown tiger prawns were of a large size. From 26 May nearly all of the Central TPSA was closed to allow the brown tiger prawn catch rates to increase and all of the Northern Area opened until the end of the season. The Central TPSA was then re-opened for a short period of fishing between 31 May and 6 June. Then, between 7 June and 1 July the Central TPSA and part of the Eastern Area were opened to fishing until 2 July when all of the Central TPSA and Eastern Areas was closed. The western part of the Central TPSA re-opened between 16 and 25 July and then closed until the end of the season on 10 November. Brown tiger prawns were fished in very small pulses over the entire season to maintain catch rates.

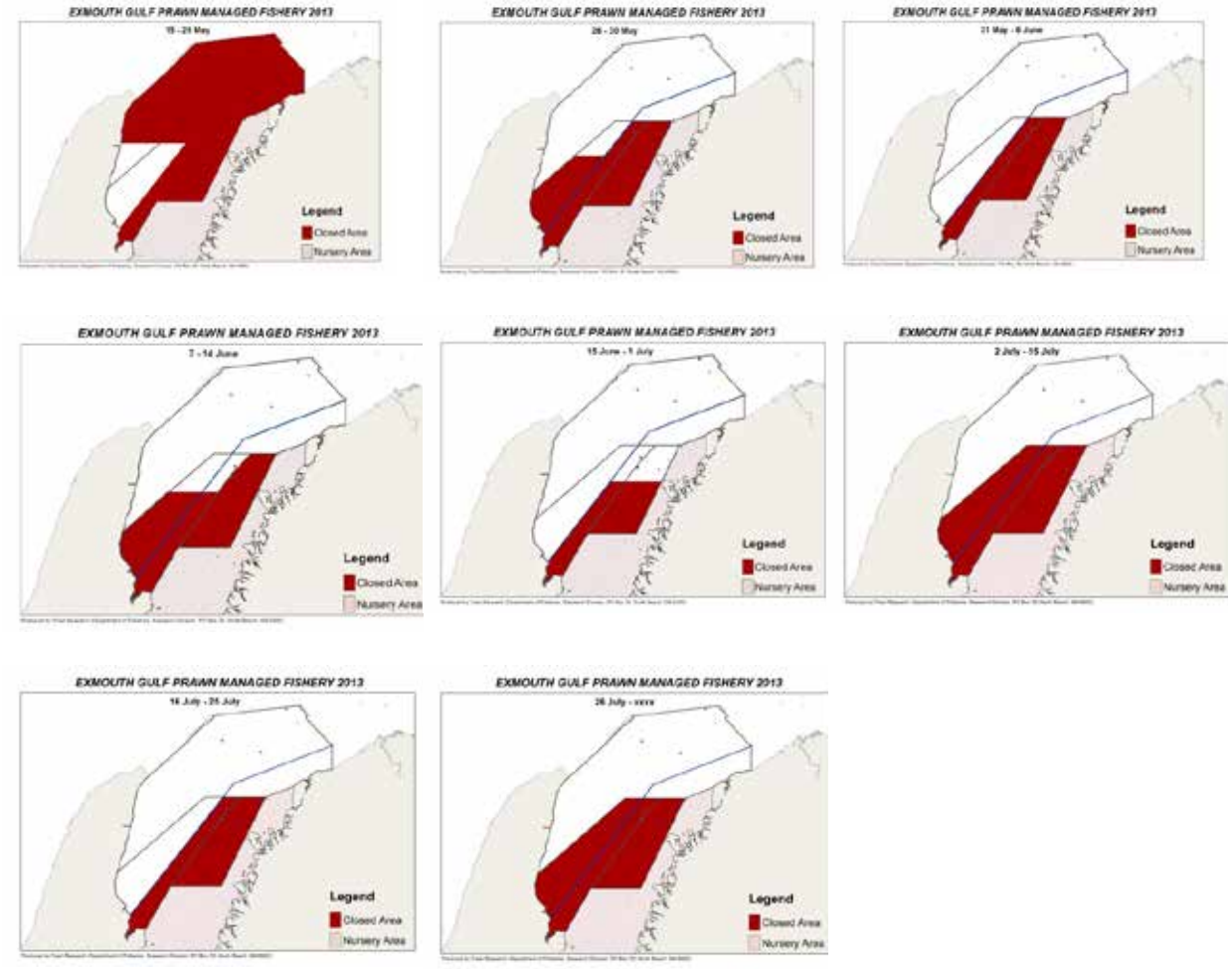
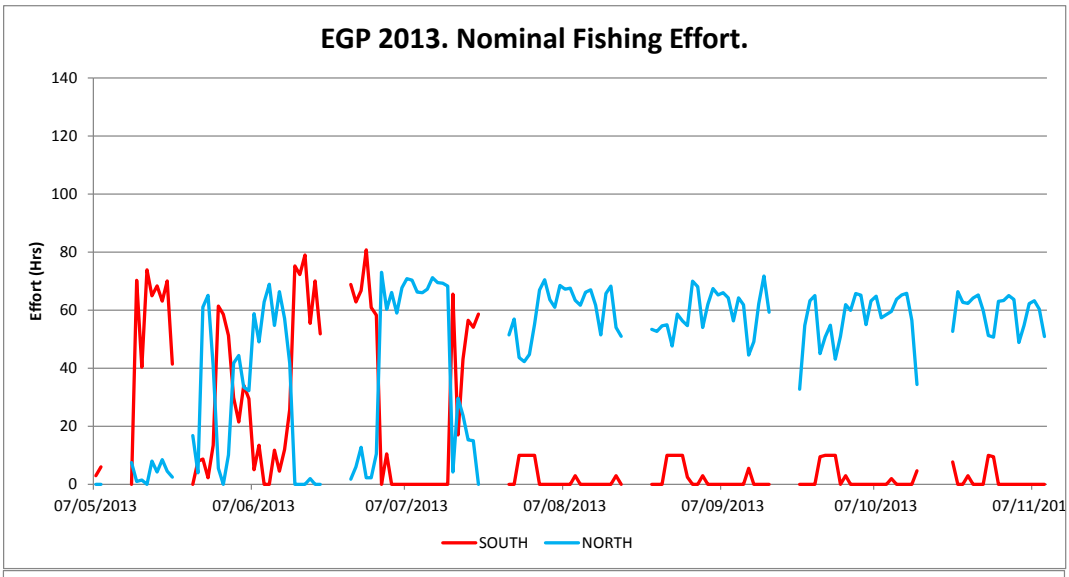


Figure 8.14. Area openings (white areas) in the EGPMF during 2013. Note closure of the Central TPSA and Eastern Area from 25 July until the end of season

Daily catch rate trends in 2013

In 2013, the annual landings of brown tiger prawns were very low (95 t) and western king prawn landings were just below average (331 t). Therefore much of the fishing effort (and higher catch rates) in this year was based on western king prawns, with short pulses of fishing on brown tiger prawns (Figure 8.15). From August onwards, the small peaks in fishing effort in the southern grounds are attributed to the brown tiger prawn spawning stock surveys (four surveys). The season was closed when the size of western king prawns met the size-based control rule.

a)



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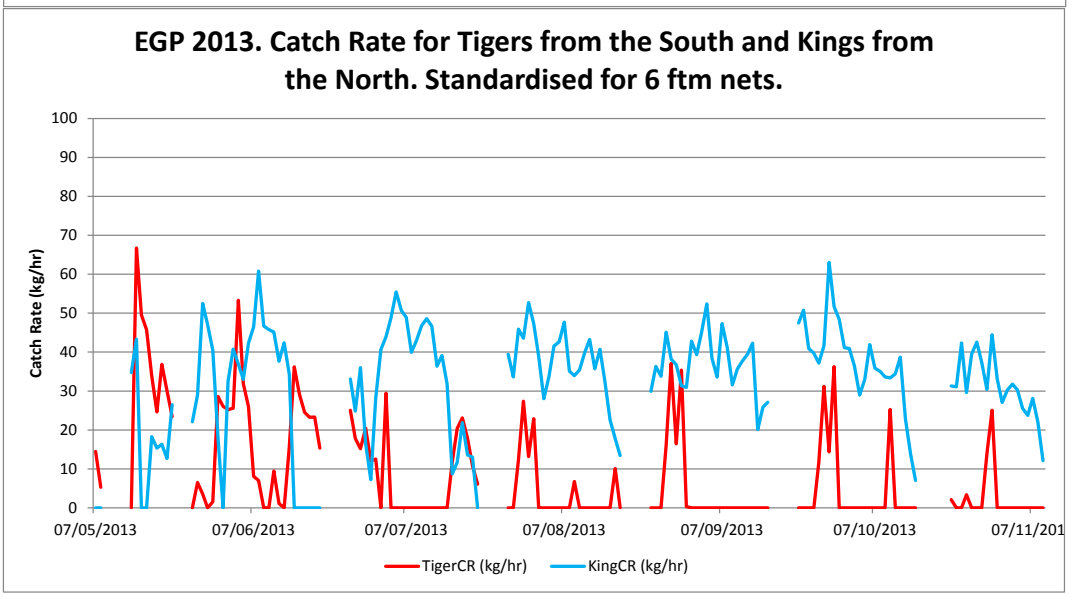

Figure 8.15. (a) Total daily fishing effort (hours trawled) directed towards brown tiger prawns in southern fishing areas (including most of P1, P2, P3, Q1, Q2, Q3) and directed towards western king prawns in northern fishing grounds (including most of R1, R2, S1, S2) during the 2013 fishing season. Zero effort during the season represents moon closures; (b) Daily commercial catch rates (kg / hr) of brown tiger prawns and western king prawns during 2013 using directed effort on each species according to hours trawled in either northern (western king prawns) or southern grounds (brown tiger prawns)

8.4.2.2 Fishery-Independent Monitoring

Several fishery-independent trawl surveys are undertaken in Exmouth Gulf each year to monitor the recruitment and spawning stock levels of brown tiger and western king prawns. Sampling is carried out using commercial fishing boats, with the intention to use the same boat(s) throughout the year for all surveys. As the net headrope length and gear configuration has changed over the years in the fishery, adjustments to survey catch rates have been made to take these changes into account. Since 2003, all nets have also been fitted with grids and secondary BRDs.

The timing of surveys and the sites sampled (see below) have been determined based on an extensive understanding of the biology and movement patterns of the target species in Exmouth Gulf, historical fishing patterns, early research surveys and the natural topography of the embayment. Each site is a box (see figures below) in which one trawl is undertaken, generally in a north to south direction due to prevailing wind conditions. Although the location of the boxes are fixed from survey to survey and year to year, the locations of the trawl transects within a box is likely to vary between surveys. For each survey, the duration of trawls are standardised at each site, but varies between sites in any one survey (generally ranging between 0.5 and 2.5 hours), depending on the extent of the trawlable area within the site (box). Occasionally, shorter trawls than the standard durations are used when very high abundances of small-sized prawns are encountered in the area. Note that, during spawning stock surveys, each site is typically sampled twice to account for short-term temporal variability.

For each site surveyed, the start and end latitude and longitude of the trawl shot, and the location of any turns made, are noted so that trawl distance can be calculated. The estimated catch of each prawn species is recorded and a representative sample of ~ 200 brown tiger or western king prawns is collected from each trawl to provide information on size compositions and sex ratios. During brown tiger prawn spawning stock surveys, data are also collected on the reproductive stage of females in the survey catch. Weather and sea conditions and moon rise are recorded each night, as well as any protected species interactions. All data are entered into a database for validation, analysis and reporting.

8.4.2.2.1 Recruitment surveys

Recruitment surveys in Exmouth Gulf have historically been undertaken three times in each year (in March and April, with timing depending on moon phase). The surveys initially focused on brown tiger prawns, which are considered the more vulnerable of the two target species to overfishing, although they have also included western king prawns since 2003. For each survey, 18 sites across the four main fishing grounds (Q1, Q2, Q3, and P2) are sampled for brown tiger prawns (Figure 8.16). The sites are located adjacent to the permanently closed nursery area in the south-eastern Gulf and cover the trawl grounds into where the recruits migrate at around this time. A further seven sites in the northern area of Exmouth Gulf are sampled in each survey to collect recruitment information on western king prawns (Figure 8.17).

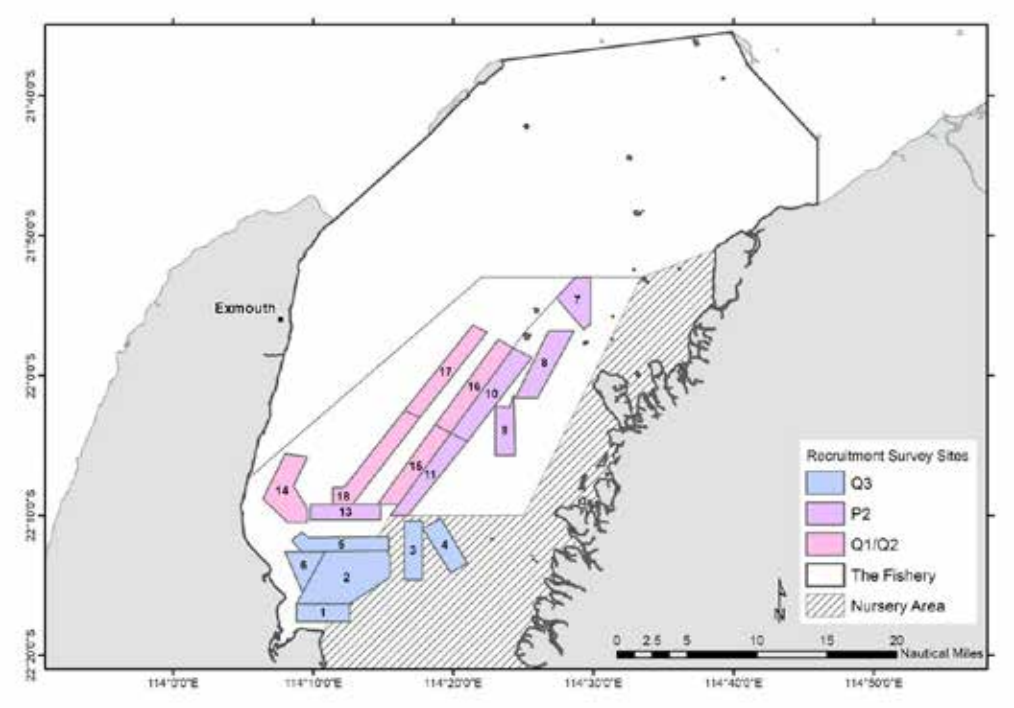

Figure 8.16. Brown tiger prawn recruitment survey sites in Exmouth Gulf

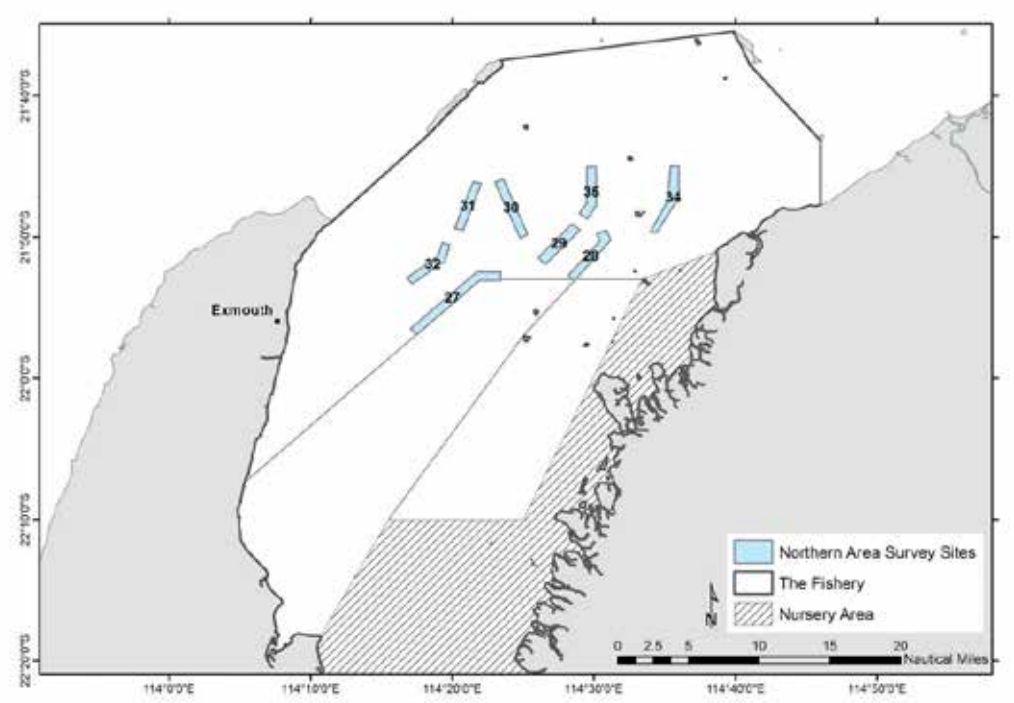

Figure 8.17. Western king prawn recruitment survey sites in the northern area of Exmouth Gulf. Note that site 27 was omitted from the sampling regime in 2011

In response to recent changes to the funding arrangements for the Exmouth Gulf surveys, a review of the sampling methodology was undertaken in 2012 to determine whether eliminating the middle survey would influence the robustness of the recruitment indices for brown tiger and western king prawns. Results from data analyses clearly demonstrated that recruitment indices calculated for the two species using catch rate data only from the first and

third surveys were very similar to those calculated using catch rates from all three surveys. However, as industry to date has been keen to undertake the middle survey to provide additional information used for determining what areas of the fishery to focus on during the first part of the fishing season, the data from all three surveys are still incorporated into the current recruitment indices.

At each survey site, catch rate and size structure information (grades and length frequencies) are collected for prawns. The catch rate data obtained for each of the two species from surveys are used as indices of recruitment strength and provide an indication of likely catch ranges for the season. For the brown tiger prawn recruitment, only catch rates from the P2 and Q3 survey sites are included in the recruitment index as these areas have been found to best reflect the levels of recruits moving onto the trawl grounds from the closed nursery areas. The western king prawn recruitment index is based on information collected from the April survey(s) only, which may include one or two surveys depending on the moon phase for that year. Moderate correlations between the recruitment survey indices and actual annual landings of brown tiger prawns and western king are evident (Figure 8.18 and Figure 8.19, respectively).

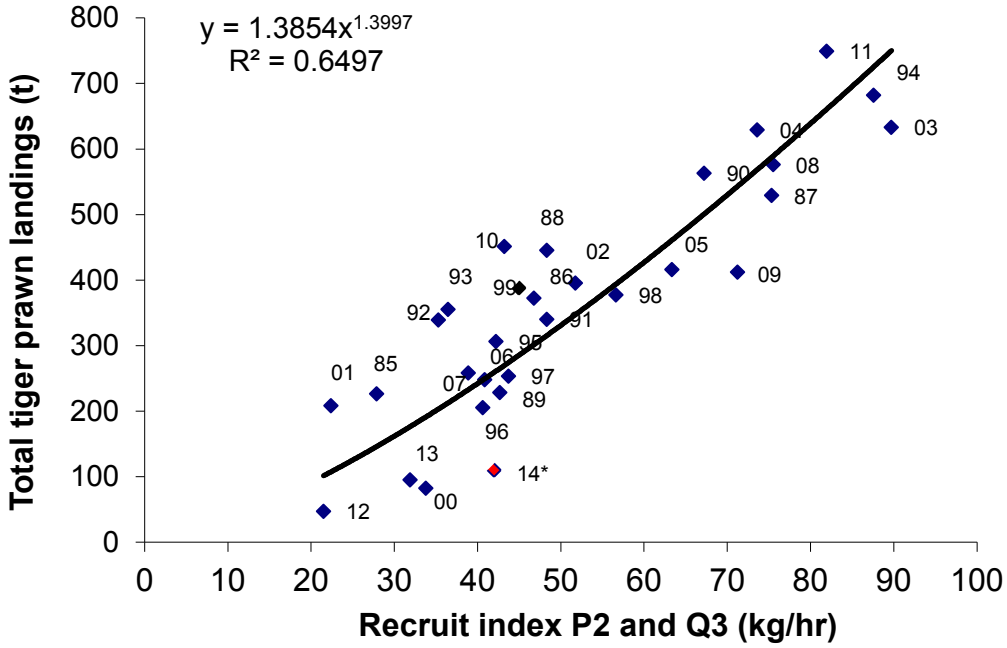

Figure 8.18. The relationship for brown tiger prawns between the fishery-independent recruitment index (kg / hr) and annual landings (t) in the EGPMF between 1985 and 2014. *Annual landings for 2014 are estimated as the season is not complete

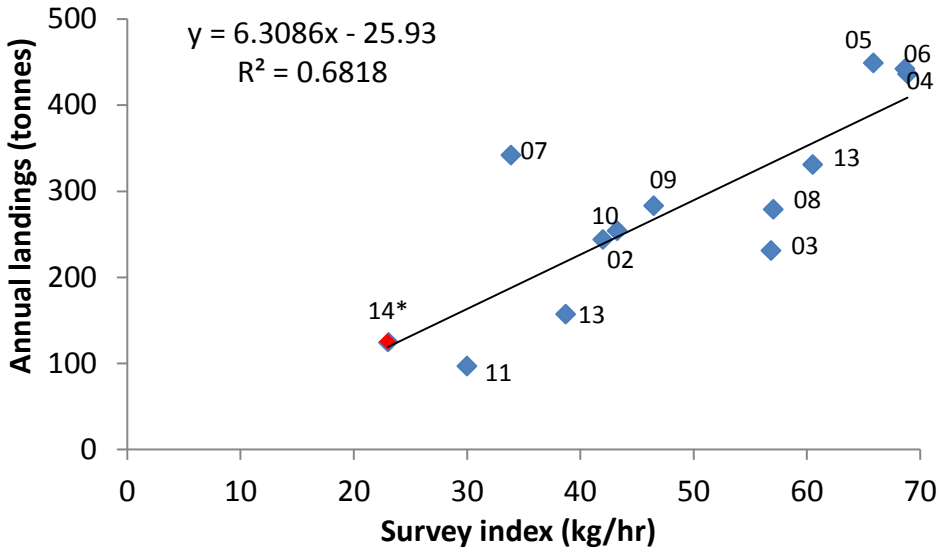

Figure 8.19. The relationship for western king prawns between the fishery-independent recruitment index (kg / hr) and annual landings (t) in the EGPMF between 2002 and 2014. *Annual landings for 2014 are estimated as the season is not complete

Combined with information collected on the movement patterns and growth of prawns among the survey sites, catch rate data for brown tiger and western king prawns are also used to inform the timing of the rolling openings of the defined areas within the fishery for the season. The timing of each area opening is based on the in-season control rules and aims to provide industry with the opportunity to optimise the size (grade) and quality of prawns and, hence, the value of catches. Generally industry is seeking to market prawns at grade sizes from 16 – 20 count per pound (1 pound = 454 grams) or larger.

8.4.2.2.2 Spawning stock surveys

Fishery-independent spawning stock surveys for brown tiger prawns are undertaken annually during the key spawning period of this species in Exmouth Gulf. No such surveys are undertaken to monitor western king prawn spawning levels in Exmouth Gulf as commercial catch rate data from the two key western king prawn fishing grounds (R1 and S2) during August and September are used to determine an index of spawning stock abundance for this species (see Section 7.1).

Brown tiger prawn spawning stock surveys in Exmouth Gulf are typically carried out a month apart between August and October each year. Note that the September survey is industry-funded but is still typically undertaken. The surveyed areas within the TPSA have been refined over time in response to an increased understanding of the where brown tiger prawns are spawning. From 1983 to 1988, four fixed sites in the Q1 area were surveyed on five nights in each month, and in 1989, the survey was extended to include an additional four sites in the Q2 fishing area (Figure 8.20). Sampling in each survey month is currently undertaken on two nights in each of the Q1 and Q2 areas, on an alternate basis.

The mean catch rates of brown tiger prawns from the spawning stock surveys (for all the months undertaken) are used as a spawning stock index to monitor the performance of the

fishery and can provide an early indicator of how to manage the stock in the forthcoming season. The catch rate information from the first two surveys is also used to determine if the TPSA will re-open to fishing for the latter part of the season (i.e. if well above the target reference point of 25 kg / hr).

At each survey site, the representative sample of brown tiger prawns collected from the trawl is sexed (to provide sex ratio information), measured and the occurrence of parasites noted. The reproductive stage (White 1975) of females is also recorded. Sex ratio information during the spawning period can be important to supplement catch rate information when assessing the performance of the fishery.

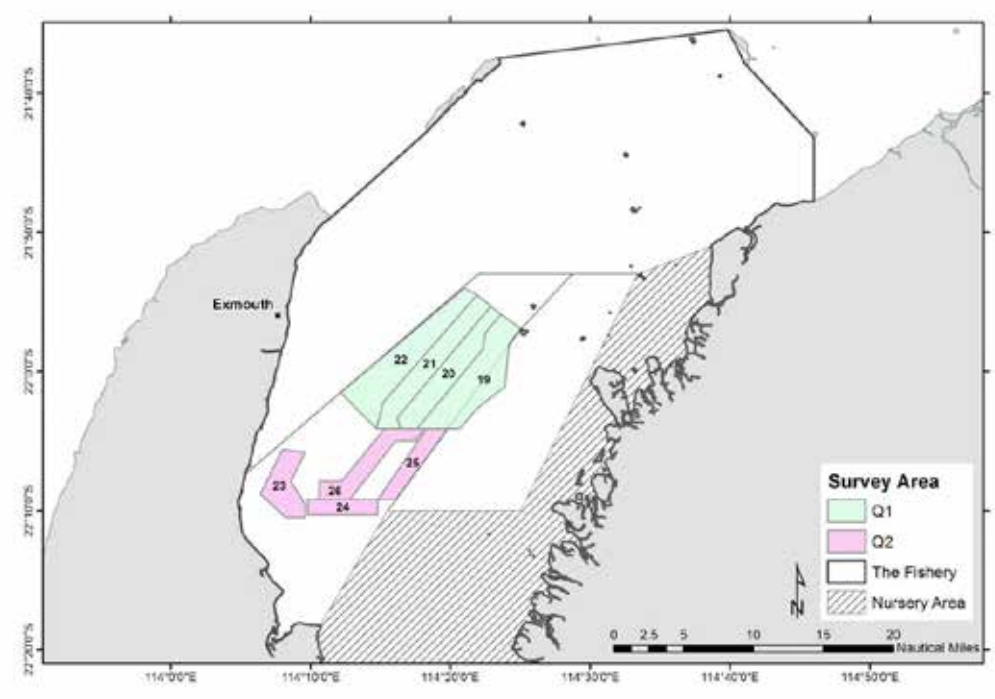

Figure 8.20. Brown tiger prawn spawning stock survey sites in Exmouth Gulf

8.4.3 Comprehensiveness of Information

All information required by the harvest strategy control rules is monitored with high frequency and a high degree of certainty. The management approach for the EGPMF has developed based on a strong biological understanding of the two target species in relation to recruitment dynamics, movement and growth patterns, and productivity. Brown tiger prawns and western king prawns are both considered as functionally-independent stocks within Exmouth Gulf and in the waters around Onslow. Therefore, as the EGPMF and the OPMF are the only fisheries in this region that catches prawns, there is detailed and reliable information available on all removals from the stocks of these two species.

Catch and effort levels in the EGPMF have been monitored since the commencement of the fishery in the early 1960s, with this information currently reported on a shot-by-shot basis. There is a good understanding of the uncertainties present in these data and they therefore have a high level of robustness. Fishery-independent research surveys are now undertaken

periodically throughout the year (March-April and June-September) in Exmouth Gulf and provide robust measures of recruitment levels of brown tiger and western king prawns and of spawning stock levels for brown tiger prawns. These data are used to evaluate the performance of the fishery and ensure that the harvest strategy is effective in maintaining a sufficient level of breeding stock during the spawning season so that recruitment is not impaired.

A preliminary biomass-dynamics model has been developed to be fitted to annual fishery-dependent catch and effort data, and an age-structured model is being developed to be fitted to a combination of commercial catch and effort data and catch rate data (kg / hr) from fishery-independent recruitment and spawning stock surveys. The age-structured model employs a short (weekly) time step and may be fitted to annual and / or monthly commercial data (depending on the type of data that are available for different time periods). The preliminary model estimates annual trends in spawning biomass, the levels of spawning biomass that correspond to currently-used empirical target and limit catch-rate based reference points, as well as maximum sustainable yield (under equilibrium conditions).

MSC Principle 2

MSC Principle 2 (P2) focuses on minimising environmental impact, such that fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which it depends (MSC 2013).

9. Fishery-Specific Research on Environmental Impacts

A substantial amount of research has been done on the environmental impact of trawl fisheries both globally and throughout Australia. Within Exmouth Gulf, the Department and the Exmouth Gulf prawn fishing industry have conducted research on:

- The use of BRDs (i.e. grids and square mesh panels) to reduce trawl bycatch, ETP species interactions and improve the quality of retained species catch;
- Trawl bycatch species composition; and
- The impact of trawling on faunal abundance and assemblages within the Gulf.

9.1 BRD Trials and Bycatch Composition

Trawling is a relatively non-selective method of fishing, resulting in the discard of non-commercially important species that are captured as bycatch.

In December 1998, the Australian Standing Committee on Fisheries & Agriculture finalised the *National Policy on Fisheries Bycatch* (SCFA 1998). This Policy was developed to provide a national framework for coordinating action to address bycatch issues and in June 1999 the WA government adopted this national policy as its own. As part of this policy, the Department commenced trialling and the implementation of BRDs into all WA prawn and scallop trawl fisheries in 2001 (Bunting 2002).

BRDs fall into two categories: primary BRDs are those that physically exclude large organisms allowing them to pass out of the net (i.e. grids) and secondary BRDs, such as square mesh panels ('fish exclusion devices' [FEDs]), are more passive devices that take into account the behavioural differences between target and bycatch species in order to allow for bycatch species to escape (Broadhurst et al. 2002).

In 1998/99, experimental trials of grids were undertaken in WA using grid types used in other Australian trawl fisheries and in the United States (Watson & Taylor 1996; Robins & McGilvray 1999; Olsen 1999). A few fishers also trialled several grids independently, however, subsequent adoption by industry of some of the grid-types trialled during this experimental phase showed that these grids were not effective in eliminating large animals and / or bycatch without substantial loss of target species under some conditions.

Hence, an FRDC-funded project (i.e. Kangas & Thomson 2004) was initiated to tailor BRD usage to the specific requirements of a number of WA trawl fisheries, including the EGPMF, the Shark Bay Scallop Managed Fishery (SBSMF) and the Shark Bay Prawn Managed Fishery (SBPMF). Although there are some similarities in fish species between Shark Bay

and Exmouth Gulf, there are differences in bottom type and bycatch affecting the efficiencies of BRDs and their impact in the fishery. In order to tailor BRDs to the different fisheries, key fleet personnel travelled to Queensland and met with personnel experienced in the design, construction and use of BRDs and used this information to decide which BRDs to trial in each fishery (Kangas & Thomson 2004).

Skippers began trialling this BRD gear in 2001, in conjunction with the change from twin (two 7.5 fathom nets) to quad (four 4.5 fathom nets) trawl gear. Two BRDs (i.e. Popeye and Fitti) were purchased from Queensland for trialling; bottom opening grids were also trialled during 2001, but some prawn losses were experienced, and boats moved to trialling top-opening grids in the 2002 season (Kangas & Thomson 2004).

Commercial catch and bycatch information for the EGPMF is available from these grid trials. Departmental observers were used to record commercial catch and bycatch for most trawl shots conducted , with a 'shot' defined as the trawl of four nets with two 'control nets' on one side of the vessel and two 'BRD nets' on the other side of the vessel, lasting between 30 minutes and three hours. The categories recorded for each side were: total bycatch weight or volume (including small or juvenile fish, crustaceans, echinoderms and molluscs); target species catch and component that was soft and broken (western king, brown tiger, endeavour and coral prawns); and numbers of sharks, rays, sea snakes, sponges and turtles (i.e. ETP species; Kangas & Thomson 2004).

During the trials, a total of 246 trawl shots comprising 590 hours were recorded by on-board observers in the EGPMF. There were significant differences between grid-types for the proportion of total bycatch (baskets) taken on the grid side compared to that of the control side, with a 9 % reduction in overall bycatch for the most commonly used grids compared to the control nets (Kangas & Thomson 2004).

There was no significant difference between shark catches in nets with and without a grid. This is mostly likely because the majority of sharks captured in the EGPMF are less than 1.5 m in length and are able to pass through the gaps between the grid bars. Ray catches were reduced by 56 % in nets with grids (Kangas & Thomson 2004).

From all observations, six turtle captures were observed on the control side, with no captures observed in nets with grids installed; however, there was no significant difference between sea snake catches in the nets with a grid compared to the control nets. The grids were also shown to reduce the capture of sponges by 95 % (Kangas & Thomson 2004).

Two experimental trials of grids and secondary BRDs were also completed on established prawn-trawl grounds in Exmouth Gulf in August 2000 using two chartered commercial prawn trawlers. The experiments were done using two port nets in a quad-rig system (each with a headline length of 8.2 m), with a standard mesh size of 52 mm in the body and 47 mm in the codend. All tows were done over a combination of sandy and light coral bottoms in depths ranging from 13.7 to 18.5 metres and at speeds (across the bottom) of between 3.5 and 4.6 knots to match normal trawl speeds (Kangas & Thomson 2004).

In these experiments, a grid was tested on its own and in combination with a modified composite square mesh panel aft (CSMPA) codend against a control net. The grid comprised an aluminium grid (Figure 9.1) sewn at an angle of 45 ° into an extension piece made from 47 mm diamond-shape mesh measuring 100 meshes in circumference and 20 meshes in length. A zipper was attached to the posterior end of the extension to facilitate changing codends. Two rectangular panels of flexible mesh were sewn anterior to the grid and bottom opening escape exit, respectively. The first panel extended to the grid, while the second extended past the base of the grid (Kangas & Thomson 2004).

Two codends were constructed and rigged with zippers so that they could be attached posterior to the extension containing the super shooter grid. The first codend was a conventional design and comprised 47 mm diamond-shaped mesh with a circumference of 80 meshes and a length of 70 meshes. The second codend was identical in materials, circumference and length, but included a composite square-mesh panel located in two positions in the net. The control codend represented normal commercial codends and was made entirely from 47 mm diamond-shaped mesh measuring 80 meshes in circumference and 100 meshes in length. The zippers were used to alternately attach the conventional and CSMPA codends posterior to the extension containing the grid. These configurations were compared against the control codend, using only the two port-side nets of the quad-rigged gear (i.e. two separate paired comparisons: grid only – with no secondary BRD vs. the control; and the grid with the CSMPA codend vs. the control). Three replicate 90-minute tows of each paired comparison were made on each night, providing a total of six replicate comparisons over two nights (Kangas & Thomson 2004).

Results from the experimental trials indicated that compared to the control, the grid only and the grid in combination with the CSMPA-codend significantly reduced the weight of bycatch (by 8 % and 53.5 %, respectively) and the numbers and weights of some finfish species (i.e. leatherjacket, heart-headed flathead, small-toothed flounder, trumpeter whiting, goatfish and trumpeter). Slightly fewer total prawns were retained in both the codends with the BRDs than in the controls (Kangas & Thomson 2004).

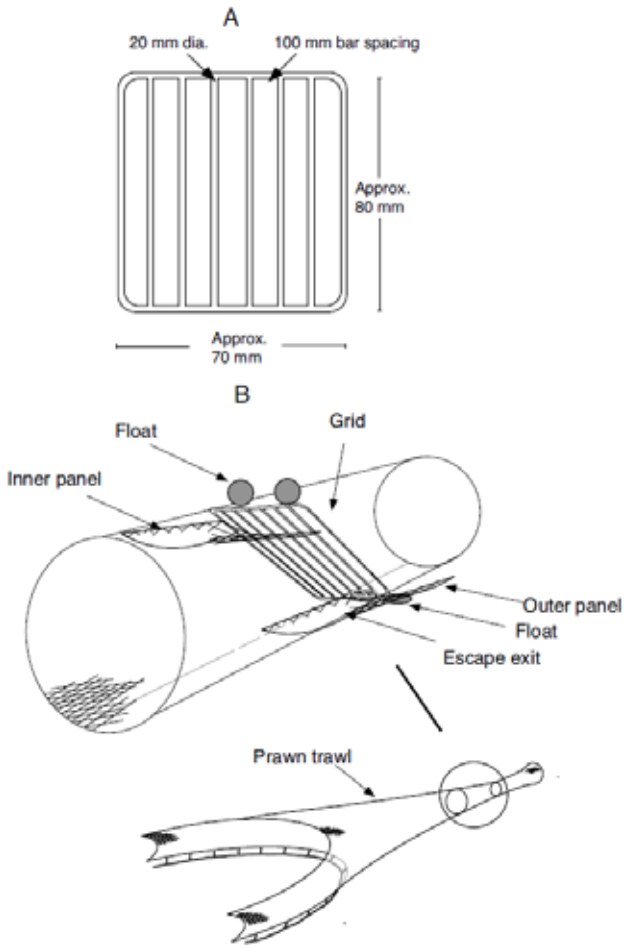

Figure 9.1. Diagrammatic representation of (a) the super shooter grid used in Exmouth Gulf and (b) its location in the prawn trawl net (Source: Kangas & Thomson 2004)

More recent information on bycatch in the EGPMF is available from square mesh panel trials conducted in the fishery in 2008 and 2009. A list of bycatch species and numbers caught is provided in Appendix D. Main bycatch species observed during these trials included:

- Large-scaled grinner (brushtooth) lizardfish (*Saurida undosquamis*);
- Whipfin ponyfish (*Equulites leuciscus*);
- Common silver belly (*Gerres subfasciatus*);
- Spotted stinkfish (*Repomucenus clacaratus*);
- Fourlined trumpeter (*Pelates quadrilineatus*);
- Trumpeter whiting (*Sillago maculata*); and
- Multiple crab species (i.e. *Portunus rubromarginatus*; *P. armatus*; *Charybdis truncata*; and *C. anisodon*).

For 18 of the fish species recorded, total numbers caught were reduced by 28 – 47 % (with a 33 % reduction in weight) when using square mesh panels compared to standard diamond codends (see Appendix D). Fish species with over a 50 % reduction in individual numbers

caught using square mesh panels included catfish, monocle bream, javelinfish, threadfin bream, trevally, lethrinids and small sharks (DoF, unpublished data).

In 2014, the licensee pioneered the bigger JW grid to suite its larger vessels (FV Portland Road and FV Latitude). In September 2014, Austral grids were deployed on one of the trawlers towing 8-fathom nets, and the skipper was pleased with the results (cleaner catch with less net damage in the throat). During the 2015 season, the JW grid will also be evaluated against the Austral grid, with parameters of interest being: bycatch reduction, prawn loss, prawn size composition, prawn quality and quantification of the debris present in the grid region and cod end. The results will determine whether the licensee adopts the Austral grid or JW grid in future seasons, keeping in mind that one or the other may be better for specific applications.

Currently, the square mesh panel is made from 160 mm stretched mesh and measures 3 bar wide by 5 bar long (c. 240 x 400 mm; Figure 9.2). Previous studies (Broadhurst et al. 2002, Wakeford 2006; Heales et al. 2008) with such devices have shown that it is quite common for fishermen / net-makers to underestimate how closed up the cod end meshes become when fishing, and as a consequence, an insufficient number of meshes are attached to the lateral edges and too many are attached to the longitudinal edge. The former error results in the window being compressed laterally, and as a consequence, pleats form through the large mesh section. These pleats reduce the size of the large mesh openings and compromise the effectiveness of the device. The licensee in the EPGMF has now adapted the square mesh panel to prevent a reduction in size and in a central position. FEDs are currently being inserted in the same position (centrally in the top panel at 20 meshes posterior to the leading edge of the cod end) and in the same fashion (30 meshes across, 9 meshes deep) according to appropriate Company guidelines.

Figure 9.2. Austral grid equipped with an appropriate sized Dynex netting extension and codend (i.e. 150 meshes around)

9.2 Bioregional Risk Assessment

The cumulative risk to bycatch from multiple fisheries in the Gascoyne Coast Bioregion was assessed as part of a Ranked Risk Assessment for Multiple Fisheries (RRAMF; Evans & Molony 2010). The RRAMF is designed to overcome the differences in fisheries data collection methods that include use of a variety of measures and variable observer coverage ranging from < 1 % to 20 % of the actual fishery catch in WA fisheries. To overcome these issues the RRAMF method compares the ranks of the relative amount of bycatch from each fishery and compares the ranks of the species catch within each fishery. This method provides a rapid and relatively inexpensive method to conduct a multi-fishery risk assessment. It also enables managers to prioritise which fisheries have the greatest impact and which species may require more biological and ecological study to understand the risks of multiple fisheries (Evans & Molony 2010).

Of the 11 fisheries (commercial and recreational) identified in the Gascoyne Coast Bioregion, data was available for only five, i.e. the EGPMF, the SBPMF, the Shark Bay Snapper Fishery, the Gascoyne charter fishery and the Gascoyne recreational fishery; however, much of these data were from relatively old studies and many changes in gear and / or fishing effort have occurred in the fisheries since the time of collection (Evans & Molony 2010). For example, the EGPMF data was collected during the BRD trials in 2001, using nets without

grids. As BRDs are now mandatory in the fishery, the bycatch data used in the study does not reflect the commercial bycatch of the contemporary trawl fishery (which is lower than the amount that was used by Evans & Molony [2010]). The study focused on teleosts and elasmobranchs, due to the limited data available on invertebrates.

The RRAMF was conducted as a three-step process; firstly, four initial variables were used to reduce the number of species to a manageable list. For the Gascoyne Coast Bioregion, the list reduced from 412 to 122 (See Appendix 1 in Evans & Molony 2010 for a complete species list). The second stage involved assignment of the biological and fishery impact parameters to the sub-set of species and the weighting of these parameters based on comparative catch abundance in each fishery. The overall risk was calculated using a formula to present the most vulnerable species (Evans & Molony 2010). The third step was an arbitrary notation for each of the species based on the latest scientific and fisheries knowledge of that species. This list focussed on only the top twenty ranked species for each Bioregion, with the notation providing advice on the species' risk assessment relative to other species (Evans & Molony 2010).

No species from either Bioregion scored higher than ~ 45 % of the maximum risk assessment score (i.e. 23). Elasmobranchs featured highly in the risk assessment, and held nine of the 20 top places in the Gascoyne Coast Bioregion. Many elasmobranchs had higher scores than most teleosts due to their life history characteristics rather than the impact of fisheries. *Taeniura meyeni* (black-blotched sting-ray) and *Rhyncobatus* spp. (white spot shovelnose ray) had the highest average score (8.59), non-weighted score (8.5) and the highest overall score with the parameters 'size and management' (10.06) in the Gascoyne Coast Bioregion. The *Rhyncobatus* spp. result is the accumulation of a number of species and therefore is not the most vulnerable in this Bioregion. The scores for these species vary between low-moderate to moderate depending on which of the parameters were double weighted (see risk scores in Evans & Molony 2010).

It is important to note that the risk assessment scores for the teleosts and elasmobranchs are not directly comparable to the risk assessment scores for ETP species, as different parameters and data sets were used. The biological scores for all ETP species were relatively high; however, the fishery impact profile was very low. This was driven by the low reported catch rates, relatively low mortality rates and very wide distributions. Thus, the risk assessment maintained low to moderate risks categories for most species groups. Turtles in the Gascoyne Coast Bioregion had a moderate risk category, while all other species (i.e. sea snakes, cormorants and syngnathids) were low or low-moderates risks (Evans & Molony 2010).

9.3 Ecosystem Impacts of Trawling

Baseline data of faunal abundance and composition in Exmouth Gulf in areas that are both currently open to trawling and adjacent areas closed to trawling is available from an FRDC-funded study conducted in 2004 (Kangas et al. 2007).

This information was collected as part of a project to develop biodiversity and habitat monitoring systems for key trawl fisheries in WA. Within Exmouth Gulf, daily fisher

logbook information from was used to map trawled and untrawled areas in order to identify 17 sample sites within the Gulf and seven sites in the Onslow Area 1 (Figure 9.3). All of the selected sites were fixed for the survey period and were sampled during three different seasons, i.e. during the start (March), middle (June / July) and end (November) of the trawl season in 2004. Sampling was conducted at night in order to simulate commercial prawn trawling activities. During each sample, trawls were undertaken using twin-rig demersal otter trawl nets, with a six fathom (10.97 m) headrope length. Net mesh size was 50 mm, with a 45 mm mesh codend. No BRDs were included in trawl nets. For each trawl, all species of fish and invertebrates were identified, counted and abundance determined as number per nautical mile trawled. Sediment samples were also taken from each sample site, covering trawled, lightly trawled and untrawled areas (Kangas et al. 2007).

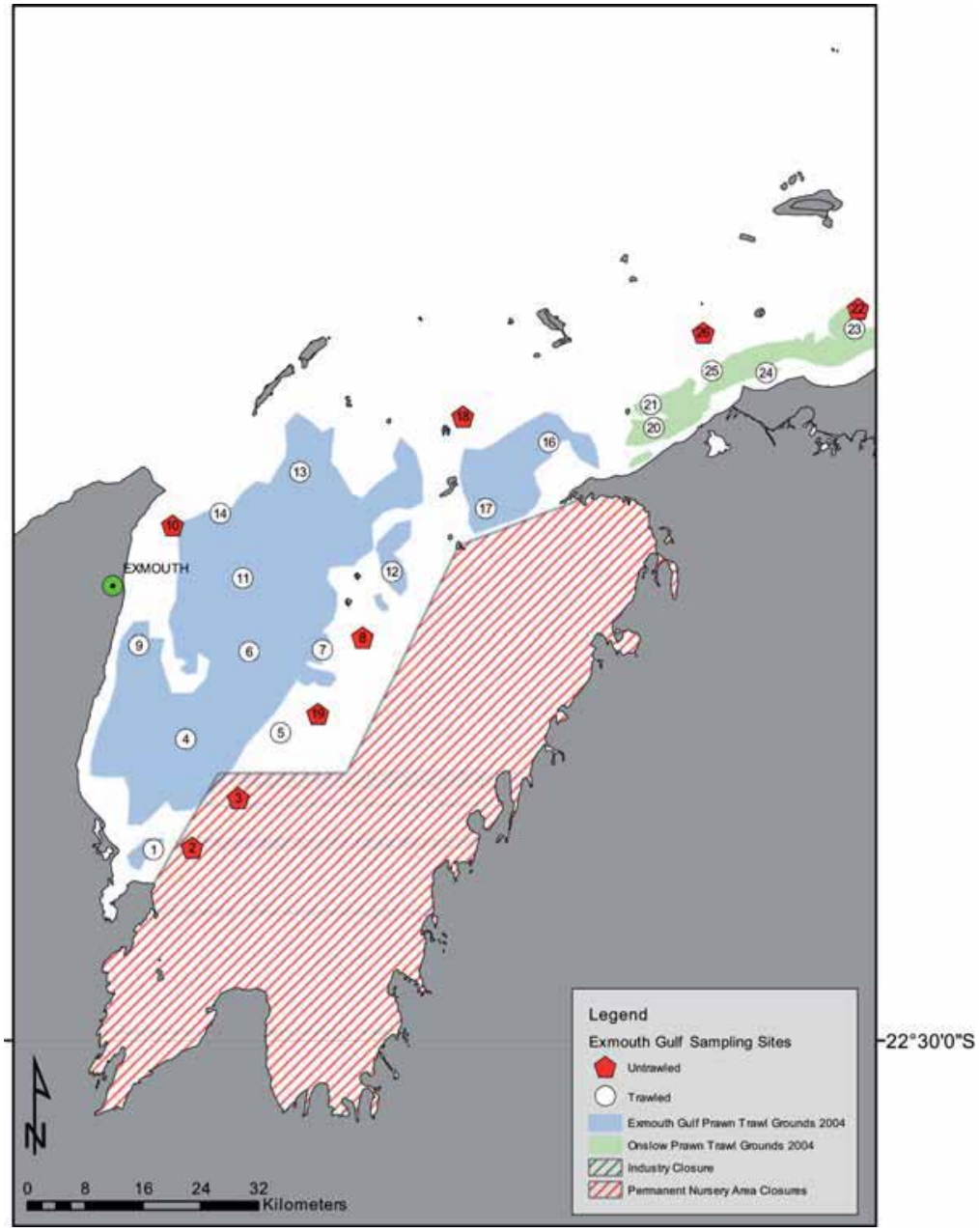

Figure 9.3. Sampling sites in Exmouth Gulf and Onslow Area 1 used by Kangas et al. (2007)

In total, 298 fish and 365 invertebrate species were recorded in Exmouth Gulf and Onslow Area 1 during this study (see full species list in Kangas et al. 2007). The 10 – 20 most abundant fish (Table 9.1) and invertebrate (Table 9.2) species represented around 90 % of the total catch for the majority of survey sites within Exmouth Gulf.

Fifteen of the 20 most abundant fish species were extremely widespread and occurred at 92 – 100 % of the sites sampled. Of the 20 most abundant invertebrate species, 11 were widespread throughout the region and occurred in 92 – 100 % of the sites. As these most-abundant species occurred in large numbers, with the majority being widespread, it would be anticipated that these core groups are dominant in the various regions from year to year (Kangas et al. 2007).

Table 9.1. Twenty most abundant fish species in Exmouth Gulf and Onslow (Source: Kangas et al. 2007)

	Scientific Name	Common Name	Ave. no / nm
1	*Paracentropogon vespa*	Bullrout	130
2	*Leiognathus moretoniensis*	Zigzag ponyfish	98
3	*Upeneus asymmetricus*	Asymmetrical goatfish	95
4	*Inegocia japonica*	Rusty flathead	79
5	*Calliurichthys grossi*	Gross's stinkfish	78
6	*Paramonacanthus choirocephalus*	Hair-finned leatherjacket	60
7	*Pomadasys maculatus*	Blotched javelinfish	56
8	*Engyprosopon grandisquama*	Spiny-headed flounder	53
9	*Pentapodus vitta*	Western butterfish	46
10	*Terapon theraps*	Banded grunter	45
11	*Sillago burrus*	Trumpeter whiting	43
12	*Plotosus lineatus*	Striped catfish	41
13	*Repomucenus sublaevis*	Multifilament stinkfish	39
14	*Lethrinus genivittatus*	Threadfin emperor	36
15	*Upeneus sulphureus*	Sunrise goatfish	35
16	*Saurida undosquamis*	Large-scaled lizardfish	31
17	*Monacanthus chinensis*	Fan-bellied leatherjacket	30
18	*Sillago lutea*	Mud whiting	30
19	*Parapercis nebulosa*	Red-barred grubfish	29
20	*Pelates sexlineatus*	Six-lined trumpeter	28

Table 9.2. Twenty most abundant invertebrate species in Exmouth Gulf and Onslow (Source: Kangas et al. 2007)

	Scientific Name	Common Name	Ave. no / nm
1	*Penaeus esculentus*	Brown tiger prawn	461
2	*Penaeus latisulcatus*	Western king prawn	153
3	*Metapenaeus endeavouri*	Endeavour prawn	130
4	*Metapenaeus rosea*	Rosy prawn	110
5	*Portunus tenuipes*	Swimmer crab	110
6	*Portunus rubromarginatus*	Swimmer crab	59
7	*Portunus pelagicus*	Blue swimmer crab	52
8	*Trachypenaeus anchoralis*	Northern rough prawn	51
9	*Trachypenaeus curvirostris*	Southern rough prawn	46
10	*Charbybdis truncate*	Crab	38
11	*Metapenaeus crassissima*	Coral prawn	29
12	*Eduarctus martensi*	Slipper lobster	23
13	*Annachlamys flabellate*	Fan scallop	22
14	*Portunus hastatoides*	Swimmer crab	19
15	*Comatula solaris*	Crinoid	18
16	*Prionocidaris bispinosa*	Pencil urchin	16
17	*Breynia desorii*	Heart urchin	16
18	*Penaeus longistylus*	Red spot king prawn	15
19	*Portunus curipenis*	Swimmer crab	15
20	*Sepia papuensis*	Papuan cuttlefish	12

Divisive clustering analysis of the abundance of fish species indicated four main groupings of sites, with each group containing both trawled and untrawled sites (Figure 9.4). There were significant differences in the richness, evenness and diversity indices of the four groups. Water temperature was a significant co-variate on the Shannon's diversity index; salinity and season were found to have significant effect on the species richness; and salinity was a significant co-variate for species evenness (Kangas et al. 2007).

Divisive clustering analysis of the abundance of invertebrate species in Exmouth Gulf indicated five groupings of sites (with site 19 being unique; Figure 9.4) that generally ran from the south-west to north-east direction. Results indicated significant differences in the richness, evenness and diversity indices of the four main groups, with season found to be significant for species richness, Simpson's diversity index and species evenness (Kangas et al. 2007).

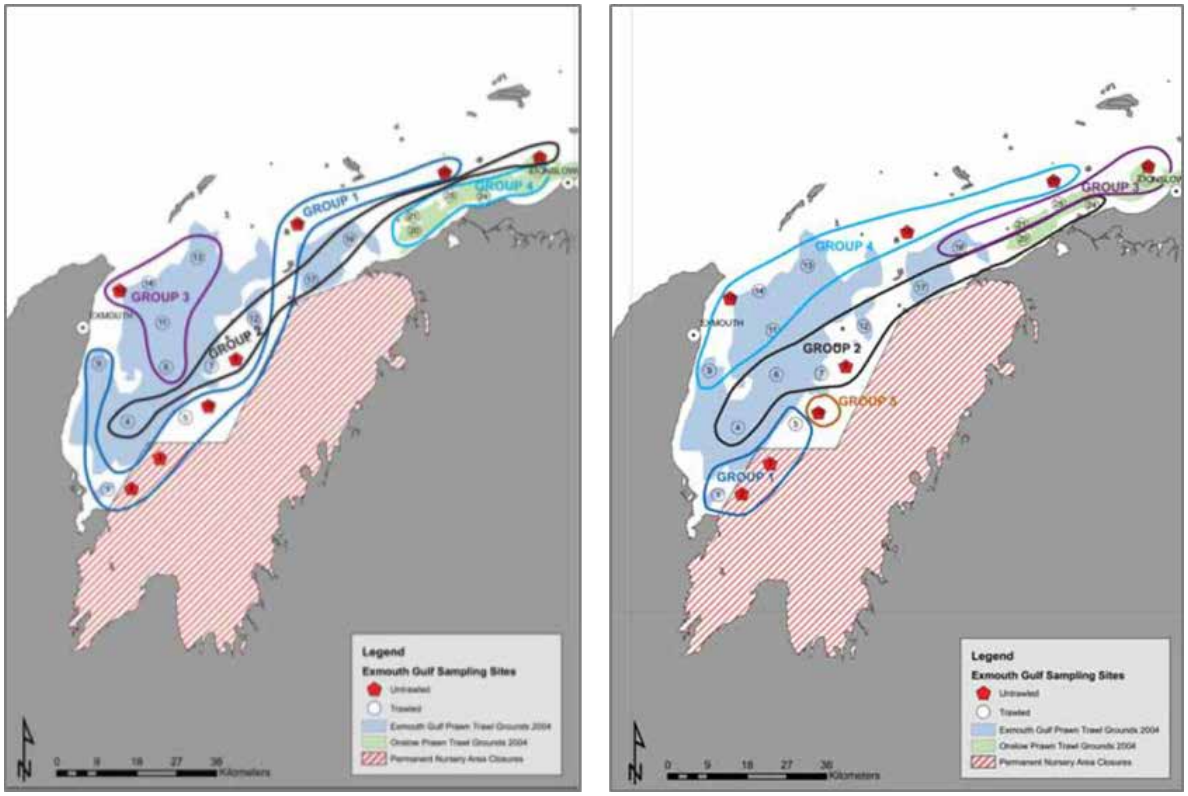

Figure 9.4. Exmouth Gulf and Onslow site groupings from cluster analysis for fish (left) and invertebrate (right) abundance data (Source: Kangas et al. 2007).

Divisive clustering analyses of the combined fish and invertebrate data resulted in clustering of sites into approximately three main groups (Figure 9.5). Each group contained a mixture of trawled, lightly trawled and untrawled sites. Both the combined and separate analyses of fish and invertebrate abundance and species richness indicated that the similarities and dissimilarities between sites could depend more on the geographical location and environmental parameters of Exmouth Gulf and Onslow than the level of trawling (Kangas et al. 2007).

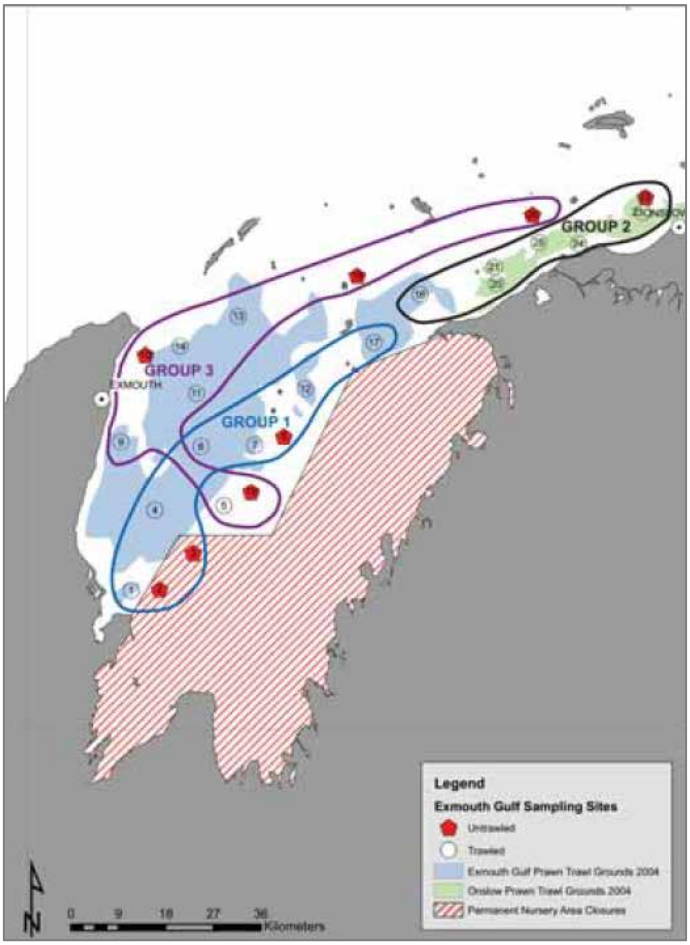

Figure 9.5. Grouping of sites from cluster analysis in Exmouth Gulf and Onslow for fish and invertebrates combined (Source: Kangas et al. 2007)

There was no significant seasonal decline for fish species abundance within the Gulf, although there was a seasonal decline in fish species richness (all other biodiversity measures were similar throughout the year). For invertebrate species, there was a significant seasonal decline in abundance between the start, middle and end of the 2004 season for both trawled and untrawled sites (Kangas et al. 2007).

No significant differences were found for pooled data between trawled and untrawled sites in Shark Bay, Exmouth Gulf and Onslow Area 1 with respect to fish and invertebrate abundance, species richness, evenness or diversity. Some spatial differences were seen, although in Exmouth Gulf there was low correlation between faunal assemblages and depth, temperature and salinity, most likely due to the stable environmental regime throughout the Gulf (Kangas et al. 2007).

Depletion experiments were also conducted in Shark Bay, where a similar prawn trawl fishery occurs. Results indicated that demersal prawn trawling has variable impacts on species on trawl grounds and that these impacts can differ for a single species between different time periods. For a few fish species, it was obvious that movement into the experimental area occurred during the experiment with significant increases in abundance over consecutive days, instead of an expected decline. For several invertebrate species their

abundance also increased, possibly due to the trawl disturbance making them more catchable on subsequent trawls (Kangas et al. 2007).

The results indicated that some fish and invertebrate species were relatively vulnerable to trawl gear. These had depletion rates of greater than 50 % over the four nights of the experiments and included the fish species *Pelates sexlineatus*, *Parupeneus chrysopleuron*, *Lethrinus genivittatus*, *Synodus sageneus*, *Pentapodus vitta*, *Choerodon cephalotes* and *Sillago robusta* and the invertebrate species *Luidia maculata* and sponges. Of the highly 'catchable' species, the majority occurred in both trawled and untrawled areas with only three species in less than 70 % of sites sampled in Shark Bay (Kangas et al. 2007).

10. Retained (Non-Target) Species

10.1 Fishery Impacts

In addition to brown tiger and western king prawns, the EGPMF retains variable quantities of other prawn species, finfish and small invertebrates as byproduct. In 2013, catches included: 84.9 t of blue endeavour prawns (*Metapenaeus endeavouri*), 74.3 t of banana prawns, 2.4 t of coral prawns, 2.9 t of squid, 7.4 t of blue swimmer crabs (*Portunus armatus*), 2.7 t of cuttlefish, one tonne of bugs (*Thenus australiensis*) and less than one tonne of octopus (Table 10.1). The retained byproduct as a percentage of the total annual retained catch is provided in Table 10.2. Catches of retained species other than brown tiger, western king and blue endeavour prawns rarely exceed 5 % of the total annual retained catch.

Table 10.1. Retained catch (tonnes) for the Exmouth Gulf Prawn Managed Fishery 2003 – 2013. N/A indicates data not available. Blue shading indicates target (P1) species. *Note fishers have not been permitted to retain sharks since November 2006

Species	Catches (t)										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brown tiger prawns	633	629	416	258	248	576	412	388	749	46	95
Western king prawns	231	436	449	442	342	279	284	254	97	157	331
Blue endeavour prawns	225.0	282.0	203.0	199.0	200.1	315.1	132.4	137.6	130.1	50.6	84.9
Banana prawns	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.8	33.5	74.3
Coral prawns	N/A	47.0	32.0	58.0	39.0	12.0	25.2	18.0	0.8	11.5	2.4
Bugs	5.8	6.8	9.6	1.3	1.6	3.3	2.0	2.2	1.2	0.5	1.0
Blue swimmer crabs	20.8	32.8	18.1	10.8	8.0	25.3	10.1	16.4	57.4	2.1	4.7
Squid	76.0	77.3	58.1	6.1	9.5	7.6	5.7	17.2	5.7	2.6	2.9
Cuttlefish	12.5	8.8	10.1	2.5	0.5	0.0	0.0	0.0	0.0	1.4	2.7
Octopus	0.6	1.3	1.3	1.2	0.9	0.6	0.7	1.5	0.3	0.0	0.4
Fish	2.1	7.4	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sharks*	1.2	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1208**	**1528.7**	**1200.9**	**978.9**	**849.6**	**1218.9**	**872.6**	**834.9**	**1044.3**	**305.2**	**599.3**

Table 10.2. Retained species as a percentage of the total annual retained catch for the Exmouth Gulf Prawn Managed Fishery 2003 – 2013. N/A indicates data not available. Blue shading indicates target (P1) species. *Note fishers have not been permitted to retain sharks since November 2006

Species	Percent (%) of Annual Retained Catch										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brown tiger prawns	52.4	41.1	34.6	26.4	29.2	47.3	47.2	46.5	71.7	15.1	15.9
Western king prawns	19.1	28.5	37.4	45.2	40.3	22.9	32.5	30.4	9.3	51.4	55.2
Blue endeavour prawns	18.6	18.4	16.9	20.3	23.6	25.9	15.2	16.5	12.5	16.6	14.2
Banana prawns	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	11.0	12.4
Coral prawns	N/A	3.1	2.7	5.9	4.6	1.0	2.9	2.2	0.1	3.8	0.4
Bugs	0.5	0.4	0.8	0.1	0.2	0.3	0.2	0.3	0.1	0.2	0.2
Blue swimmer crabs	1.7	2.1	1.5	1.1	0.9	2.1	1.2	2.0	5.5	0.7	0.8
Squid	6.3	5.1	4.8	0.6	1.1	0.6	0.7	2.1	0.5	0.9	0.5
Cuttlefish	1.0	0.6	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.5	0.5
Octopus	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.2	0.0	0.0	0.1
Fish	0.2	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sharks*	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Although there is no formal stock assessment process for retained non-target species, total catch is used to assess the annual level of exploitation of each species' stock. For each species, acceptable catch ranges / levels have been set to reflect the historical catches of these species as follows:

- Minor prawn species (i.e. banana, coral and blue endeavour prawns): annual catch ranges based on historical catches during the period 1989 – 1998; and
- All other retained non-target species: annual upper catch range based on historical catches during the period 1990 – 2010, with catch level modified by removing the highest catches from the range to reflect the opportunistic nature of retention of these species by fishers.

The acceptable catch levels / ranges are as follows:

Blue endeavour prawns:	120 – 300 t
Coral prawns:	20 – 100 t
Banana prawns:	0 – 60 t
Squid:	≤ 80 t

Blue swimmer crabs:	≤ 40 t
Cuttlefish:	≤ 25 t
Bugs:	≤ 15 t
Octopus:	≤ 5 t

Blue endeavour prawn catches have averaged around 18 % of the total retained catch over the last 10 years (see Table 10.2). The annual catch of blue endeavour prawns since the mid-1990s has generally been around 200 t, which is within its target range (120 – 300 t). The lower catches in 2012 and 2013 (51 t and 85 t, respectfully) are considered to be due to the shorter season and lower effort targeting brown tiger prawn areas where blue endeavour prawns are commonly caught.

Banana prawn catches have not exceeded 5 % is most years but have reached over 10 % of the annual retained catch in 2012 and 2013. Catches of banana prawns are highly variable and relate to the amount of rainfall in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. Banana prawns are only targeted in those years when abundance is higher and aggregations are evident, and the higher banana prawn landings in 2012 (34 t) and 2013 (74 t) correspond to the relatively higher rainfall experienced by the region over the summer months in these years.

The total catch of both coral prawns and blue swimmer crabs has exceeded 5 % of the total annual retained catch at least once in the last 10 years; however, these species generally comprise less than 3 % of the total annual catch (see Table 10.2). Catches of coral prawns throughout the past two decades have ranged from 0 t to 116 t. Since 2008, coral prawns have not been generally retained by fishers due to low market values (Sporer et al. 2013). Additionally, coral prawns are small and many of them pass through the codend mesh and are not retained. Only 2 t were retained in 2013, likely due to the shorter season and low effort targeting these prawns. Blue swimmer crabs, like other non-target species, are incidentally captured by the fishery, and catches vary depending on local abundance. The high catch of blue swimmer crabs in 2011 is considered to be due to high crab abundance on the trawl grounds, possibly caused by crabs being flushed into the central gulf area and onto the trawl grounds due to high rainfall in the early part of the fishing season (Sporer et al. 2012). Since this time, catches have been maintained at acceptable levels, with 4.7 t of blue swimmer crabs retained in 2013.

Catches of all other retained non-target species have been below their maximum acceptable annual catch level since 2010, with the exception of blue swimmer crabs in 2011 (58 t), which was above the maximum catch level.

10.1.1 Main Retained Species

Blue endeavour prawns consistently comprise over 5 % of the total annual catch and are therefore considered a ‘main’ retained species in this fishery. The EGPMF catches the majority of commercial blue endeavour prawn catch in WA. Annual catches ranged from 130

to 320 t in the period from 2003 through 2011; however, in recent years catches have declined to less than 100 t annually (see Table 10.1) due to lower effort in the fishery.

Blue endeavour prawns are not directly targeted by the EGPMF but are retained as a byproduct, as their distribution partly overlaps that of brown tiger prawns and to a lesser extent, western king prawns. Blue endeavour prawns are considered to be more resilient to fishing pressure due to their smaller size and lower catchability, as well as the lower level of targeting in Exmouth Gulf compared to brown tiger and western king prawns (Kangas et al. 2006).

As part of the fishery-independent recruitment surveys of brown tiger and western king prawns at key fishing grounds (see Section 8.4), researchers also record the abundance of blue endeavour prawns, providing a potential annual recruitment abundance index for this species. In 2013, the mean abundance index (catch rate) for blue endeavour prawn on the brown tiger prawn grounds of 9 kg / hr was below the 15-year mean (13 kg / hr) but within the range observed during these years (6 to 35 kg / hr; Flood et al. 2014). On the western king prawn grounds, the mean abundance index of 7 kg / hr was also below the 6-year mean (2007 – 2012) of 14 kg / hr but was within the range observed (2 – 38 kg / hr) during those years. There has been no declining trend in the fishery-independent survey catch rates over the periods sampled on either of these fishing grounds. As a result, the biomass of the management unit is not considered to be recruitment overfished.

As blue endeavour prawns are primarily caught by fishers when targeting brown tiger prawns, their catch is linked to fishing effort in the brown tiger prawn fishing grounds. The level of fishing effort on the brown tiger prawn fishing grounds is normally around 60 % of the total annual effort. In 2013, it constituted only 25 % of total effort, indirectly resulting in a lower-than-average fishing effort on blue endeavour prawns. In 2014, the preliminary catch of blue endeavour prawns (to late October) was 94 t, with effort again being low for the year (Fletcher and Santoro 2014). Additionally, the breeding biomass of blue endeavour prawns in the EGPMF is likely to be at sustainable levels because a significant portion of the biomass is protected by the brown tiger prawn spawning closures.

10.1.2 Risk Assessment Outcomes

10.1.2.1 Blue endeavour prawns (*Metapenaeus endeavouri*)

2008 Risk Rating: Impact on breeding stocks (C2 L5) **Low**

2014 PSA assessment: (2.59) **Low**

Blue endeavour prawns are restricted to northern Australian waters between northern New South Wales and Exmouth Gulf, WA, (Grey et al. 1983) and are generally found in coastal waters down to approximately 50 m in muddy or sand / mud substrates. Blue endeavour prawns are considered to be more resilient to fishing pressure in Exmouth Gulf due to their smaller size and lower catchability, as well as the lower level of targeting compared to brown tiger and western king prawns (Kangas et al. 2006).

The distribution of blue endeavour prawns in Exmouth Gulf overlaps that of brown tiger prawns, and they are fished to varying levels depending on the abundance of (and hence fishing effort applied to) the more valuable brown tiger prawns. As their distribution overlaps brown tiger prawns, the permanent nursery area closure and seasonal TPSA closure protect a significant portion of the endeavour prawn breeding stock each year.

10.1.2.2 Banana prawns (*Penaeus merguiensis*)

2008 Risk Rating: Impact on breeding stocks (C1 L2) **Negligible**

2014 PSA assessment: (2.59) **Low**

Banana prawns are at their southern distribution limit in Exmouth Gulf, with more regular abundances occurring further north. This species prefers shallow estuarine and intertidal areas to depths of 45 m. They live in turbid waters most of their lives, inhabiting sheltered mangrove creeks as juveniles and medium and low-energy coastlines as adults. Banana prawns tend to aggregate during daylight hours, so the normal daylight fishing ban that operates for this fishery greatly reduces the potential effort on banana prawns in the EGPMF (Kangas et al. 2006).

Low levels of banana prawns are present in Exmouth Gulf each year, but these levels occasionally increase when environmental conditions are favourable (i.e. consecutive years of higher rainfall levels). Therefore, the fishery only catches this species in reasonable numbers during years when cyclonic activity and associated high rainfall has occurred (Kangas et al. 2006).

Catches of banana prawns have been sporadic with a maximum of 62 t in 2000, after Cyclone Vance in 1999 and Cyclone Steve in 2000, when daylight fishing was permitted for a short period of time to take advantage of the increased abundance of banana prawns. In most years the catch level is close to zero (see Table 10.1). In 2013, 74 t banana prawns were landed. The higher banana prawn landings in 2013 correspond to the relatively higher rainfall experienced by the region over the summer months.

Under current arrangements the fishery is considered to have only a remote likelihood of even having a minor impact on this stock, which results in a negligible risk. Thus, no further targeted management is required (Kangas et al. 2006).

10.1.2.3 Coral prawns (various species)

2008 Risk Rating: Impact on breeding stocks (C1 L5) **Low**

2014 PSA assessment: (2.59) **Low**

Coral prawns are distributed throughout Exmouth Gulf. They are generally small, with many passing through the cod end mesh and therefore not captured by the fishing gear.

Coral prawn landings are highly variable due to their low value and therefore, lack of targeting by the fleet and generally low rate of retention. Landings of coral prawns tend to supplement the catch when the target species are in low abundance, particularly in a year

when brown tiger prawn abundance is low (Kangas et al. 2006). However, it is considered unlikely that this species will be fished to maximum acceptable levels, generating a low risk to coral prawn stocks in Exmouth Gulf (Kangas et al. 2006).

10.1.2.4 Blue swimmer crabs (*Portunus armatus*)

2008 Risk Rating: Impact on breeding stocks (C0 L5) **Negligible**

2014 PSA assessment: (2.59) **Low**

In WA, blue swimmer crabs are found from Albany in the southwest region of WA to the Northern Territory border. Blue swimmer crabs inhabit a wide range of inshore and continental shelf areas, from the intertidal zone to at least 50 m depth (Department of Fisheries 2002). There is a comparatively small area of Exmouth Gulf where blue swimmer crabs are captured by trawlers, with extensive refuge areas provided within the permanently closed nursery areas and in the deeper waters of the continental shelf adjacent to the Gulf.

Fishers retain blue swimmer crabs at a minimum size of approx. 115 mm carapace width (CW; 137 mm spine to spine). This is well above the size at maturity (90 – 110 mm CW) in Exmouth Gulf and larger than the legislated minimum size of 127 mm. The larger commercial minimum size limit was introduced on a voluntary basis in the fishery in 2007, although all fishers adhere to it. Fishers are also not allowed to retain egg-bearing females under the Management Plan.

In 2012 and 2013, recorded landings of blue swimmer crabs were extremely low (2 t and 7.4 t, respectfully) and below the historical catch range of 8 – 58 t. This is likely to be due to the low effort in the fishery during these years and the spatial distribution of fishing activities throughout the Gulf.

It was considered likely that the fishery would only have a negligible impact on the breeding stock levels of blue swimmer crabs, resulting in an overall negligible risk rating (Kangas et al. 2006).

10.1.2.5 Bugs (*Thenus australiensis*)

2008 Risk Rating: Impact on breeding population (C0 L5) **Negligible**

2014 PSA assessment: (2.59) **Low**

Bugs have an extensive distribution and wide geographical range. Small amounts of bugs are generally caught in the central and northern portion of Exmouth Gulf (Kangas et al. 2006).

In 2013, the EGPMF caught one tonne of bugs. Under current arrangements, the fishery is considered to have only a remote likelihood of having even a minor impact on this stock resulting in a negligible risk to the stock, and no further targeted management is required (Kangas et al. 2006).

10.1.2.6 Cephalopods

2008 Risk Rating: Impact on breeding populations (C0 L5) **Negligible**

2014 PSA assessment: (2.45) **Low**

Over the past 20 years, the catches of squid, cuttlefish and octopus have ranged between 6 – 99 t, 0 – 31 t and 0 – 3 t, respectively. The low value of squid since 2008 has meant low retention by fishers over this period (see Table 10.1). Given the biological characteristics (i.e. short life span, fast growing, and high fecundity), population size, wide distribution, and the small catches of these species by the EGPMF, the fishery has only a remote chance of even having a minor impact on cephalopod stocks resulting in a negligible risk (Kangas et al. 2006).

10.2 Retained Species Management

There is a strategy in place to manage fishery impacts on retained non-target species, which utilises a number of management measures under the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* and operational activities (as per the *EGPMF Harvest Strategy 2014 – 2019*) including:

- Limited entry;
- Gear controls;
- Seasonal closures;
- Spatial closures;
- Temporal closures; and
- Reporting.

These management measures reduce the impact of the fishery on retained non-target species stocks by limiting the annual amount of fishing activity via seasonal, temporal and spatial closures. For example, permanent nursery closures protect non-target prawn stocks in addition to the targeted brown tiger and western king prawns. Daylight bans on trawling also reduce the potential effort on banana prawns, which tend to aggregate during daylight hours (Kangas et al. 2006).

The *Exmouth Gulf Prawn Managed Fishery Harvest Strategy 2014 – 2019* includes the long-term management objective of: *maintaining spawning stock biomass of each retained non-target species at a level where the main factor affecting recruitment is the environment*. As such, appropriate performance indicators, reference levels and control rules have been developed for all retained species in the EGPMF (DoF 2014a).

The harvest strategy includes acceptable catch levels for all retained non-target species. Blue endeavour prawns are the main non-target species taken by the fishery, averaging approximately 18 % of the total catch over the last 10 years. Reference points for blue endeavour prawns have not been developed to the same extent as for brown tiger prawns and western king prawns; however, the measures in place to manage brown tiger prawns (and to a lesser extent, western king prawns) are considered to adequately limit the extent of fishing on blue endeavour prawns. Information on blue endeavour prawn recruitment levels is collected

during recruitment surveys, which may provide the basis for more formal reference levels in the future.

Testing supports high confidence that the management strategy in place will work. Catches of main retained non-target species have been stable of the history of the fishery, with any decrease in catch has been generally due to effort reductions or environmental factors influencing species abundance on trawl grounds (e.g. banana prawns). Additionally, there are additional measures in place to reduce the impact of the fishery on blue swimmer crab populations, including a voluntary minimum commercial size (137 mm spine to spine) for blue swimmer crabs, which is larger than the legal minimum size (127 mm spine to spine), and a prohibition on the retention of egg bearing females.

At-sea and aerial patrols are conducted by the Department to monitor compliance with regulations. If monitoring indicates a need to reduce trawl impacts on byproduct species in Exmouth Gulf, this may be achieved through extending the use of current management tools, such as spatial and temporal closures, targeted harvesting strategies to optimise expenditure of effort, a reduction in overall fishing effort and the use of mechanical or other devices, such as BRDs and hoppers / handling techniques.

Overall evidence that the strategy is achieving its objective is provided by (1) the stable catch histories of the main retained non-target species and (2) an experimental survey-based study that found no difference in the abundance, species richness, evenness or diversity of fish and invertebrates (including each of the main retained species) between trawled and untrawled areas in Exmouth Gulf (Kangas et al. 2007).

10.3 Retained Species Information and Monitoring

Research and monitoring of the EGPMF has been conducted since the commencement of the fishery in the early 1960s (see Sections 8.4 and 9). Catches of all retained non-target species have been reported by fishers to the Department in daily logbooks since the fishery began (see example in Appendix C). These logbooks became compulsory in the fishery in 2008 and include information on all retained species, effort, ETP species interactions and fishing location (detailed shot-by-shot longitude and latitude).

The logbooks are checked by the Department's Research staff on a monthly basis and any possibly erroneous entries or gaps are checked directly with skippers or the fishing company. The information provided in logbooks is also verified by unload data, which have been provided to the Department on a monthly basis since the fishery began.

Additionally, a Vessel Monitoring System (VMS) has been in place in the EGPMF since 2001. VMS enables the Department to monitor a boats location and speed with particular attention paid to the surveillance of closed areas. VMS monitoring of boats is undertaken for the entire season. Annual spatial data validation is undertaken using GIS, and random checks of data entry are made through using VMS location records.

11. Bycatch

11.1 Fishery impacts

Bycatch levels for the EGPMF are variable, and bycatch is comprised of mixed finfish and invertebrates (Kangas & Thomson 2004). Bycatch species are returned to the water following capture; survival rates of returned fish are thought to be low, but are high for many invertebrates (e.g. crustaceans; Kangas et al. 2007).

The most recent bycatch sampling was conducted during square mesh panel trials in 2008 and 2009, with approximately 18 species groups identified (a full species list provided in Appendix D). Primary bycatch species observed during these trials included:

- Large-scaled grinner (brushtooth) lizardfish (*Saurida undosquamis*);
- Whipfin ponyfish (*Equulites leuciscus*);
- Common silver belly (*Gerres subfasciatus*);
- Spotted stinkfish (*Repomucenus clacaratus*);
- Fourlined trumpeter (*Pelates quadrilineatus*);
- Trumpeter whiting (*Sillago maculata*); and
- Multiple crab species (i.e. *Portunus rubromarginatus*; *P. armatus*; *Charybdis truncata*; and *C. anisodon*).

Elasmobranchs rarely occur in the bycatch, and many large sharks excluded from trawl nets by grids (Kangas & Thomson 2004). A very small number of elasmobranchs have been reported in previous monitoring, including brown reticulated stingarees (*Dasyatis leylandi*). Catches of this species were around 0.1 % of the total catch (Kangas et al. 2007).

The 2014 PSA assessment included nine bycatch species, which were identified as species of high abundance (> 3 % of total catch) within Exmouth Gulf (and Onslow) during the biodiversity study undertaken in 2002 – 2003 (Kangas et al. 2007). All species were assessed as being at low risk, with individual species scores provided below (see Appendix A for PSA information).

It should be noted that the latest bycatch survey (Kangas et al. 2007) also occurred in areas where trawling does not occur, so it may include species not taken by the EGPMF. In addition, the shallows of Exmouth Gulf support an abundant and diverse invertebrate community, which is attributed to the spatial isolation, high organic productivity and extensive seagrass beds and carbonate sand flats. While many of these species may reside on / in the seafloor where trawl gear operates, overall levels of interaction are likely to be low.

11.1.1 Risk Assessment Outcomes

11.1.1.1 Discarded Fish

2008 Risk Rating: Impact on breeding populations (C1 L4) **Negligible**

2014 PSA assessment:

Asymmetrical goatfish *Upeneus asymmetricus* (2.09) **Low**

Hair-finned leatherjacket *Paramonacanthus choirocephalus* (2.01) **Low**

Trumpeter *Pelates quadrilineatus* (2.18) **Low**

Scorpionfish *Paracentropogon vespa* (2.09) **Low**

Gross' stinkfish *Callionymus grossi* (2.09) **Low**

Rusty flathead *Inegocia japonica* (2.09) **Low**

Zig-zag ponyfish *Equulites moretoniensis* (2.01) **Low**

Blotched javelinfish *Pomadasys maculatus* (2.09) **Low**

Trawling contributes to the mortality of several non-commercial fish species that are incidentally caught and die due to the damage and disturbance they experience in the trawl net or from being out of water during the sorting process. These fish are discarded overboard.

Small fish species make up the majority (70 – 80 %) of the bycatch in the EGPMF (Kangas et al. 2006), and the risk to these species has been considered collectively in the 2008 Risk Assessment. Very few of the species captured in the EGPMF are subject to other fishing mortality, thus the EGPMF is the only human activity directly impacting these species. Juvenile fish caught by trawlers have a naturally high mortality rate, and as such, the additional fishing mortality from the EGPMF is highly likely to have little impact (Kangas et al. 2006). In addition, these species are known from survey results to also occur in the extensive areas of the Gulf where trawling does not occur (Kangas et al. 2007).

The management measures and fishing methods in place (e.g. use of grids, fish exclusion devices and hopper sorting systems, the restricted area in which fishing activities can occur and the seasonality of fishing activities) are considered to maintain individual stocks of these species well above a 0.4 virgin biomass reference point, which is considered to be a highly conservative reference point for most finfish species (Kangas et al. 2006). Thus, the fishery is considered to be a negligible risk to these species' populations.

11.1.1.2 Discarded Invertebrates

2008 Risk Rating: Impact on breeding populations (C0 L4) **Negligible**

2014 PSA assessment: Portunid crabs, *P. tenuipes* and *P. rubromarginatus* (1.83) **Low**

The shallow regions of Exmouth Gulf support a diverse and abundant invertebrate community; however, anecdotal evidence suggests that the mud bottom trawl areas of Exmouth Gulf contain few large invertebrates that may be caught in trawl gear.

The trawl gear used in the EGPMF is configured in a manner that largely precludes the capture of invertebrate species living on or in the substrate. There is a gap of approximately 20 cm between the ground chain and the footrope of the net, which specifically serves to minimise the capture of immobile and slow moving benthic organisms and inanimate objects (Kangas et al. 2006).

The management measures and fishing methods in place (e.g. use of grids, FEDs and hopper sorting systems, the restricted area in which fishing activities can occur and the seasonality of fishing activities) are considered to maintain invertebrates species' stocks within biologically-based limits, based on the distribution of these species throughout the region (Kangas et al. 2007). Thus, the fishery is considered to be negligible risk to these species' populations (Kangas et al. 2006).

11.1.1.3 Sharks

2008 Risk Rating: Impact on breeding populations (C0 L5) **Negligible**

Sharks have previously been retained as byproduct in the EGPMF; however, in November 2006 all sharks in WA were commercially protected under the FRMA and cannot be retained without a permit.

The historical catch of sharks in the fishery was very low (2 – 18 t annually), with an average catch of less than 3 t annually after the implementation of BRDs in the fishery. It is likely that the number of sharks captured and discarded in the fishery is similar to or below historical levels, with most large sharks excluded from trawl nets by grids. As the shark catch is comprised of more than one species, the impact on any one species from trawl fishing activities within the Gulf is conserved to be negligible (Kangas et al. 2006).

11.2 Bycatch Management

The EGPMF has undertaken a number of management actions over the last 50 years that have contribution to reductions in bycatch in the fishery (Figure 11.1).

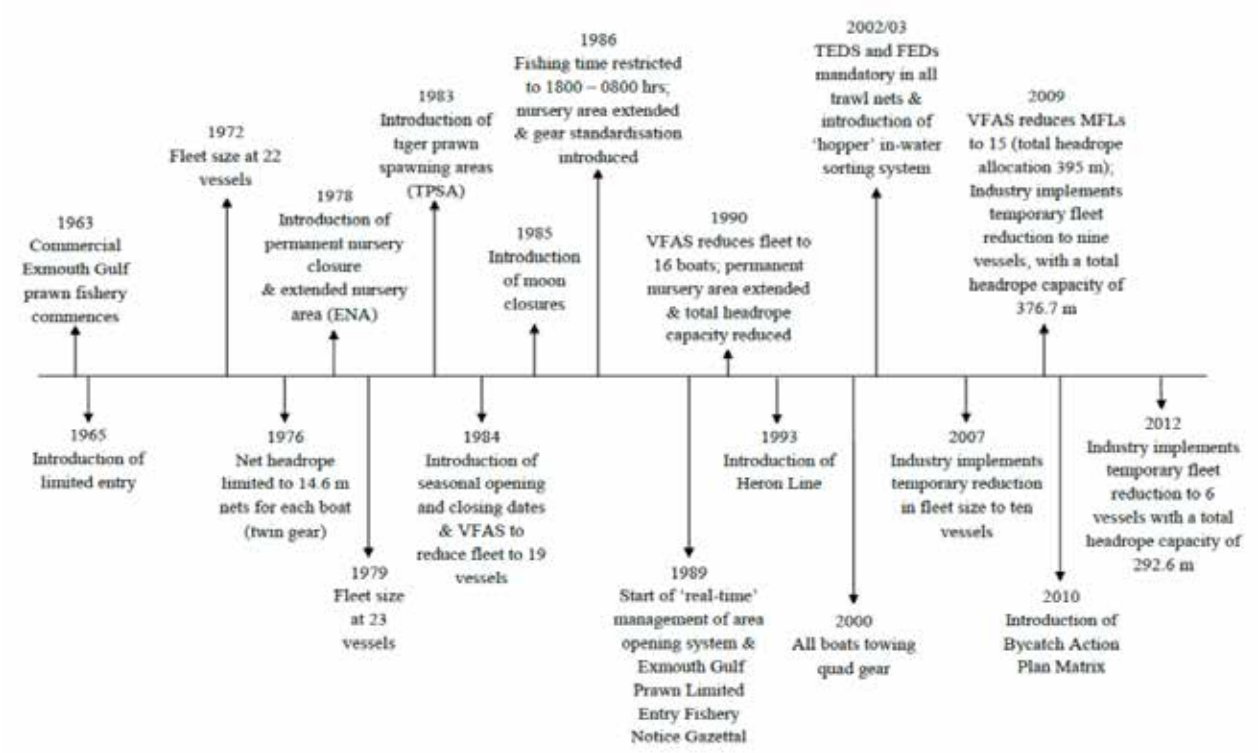

Figure 11.1. Summary of key management changes in the EGPMF that have reduced the impact of the fishery on bycatch species populations (Source: DoF 2014b)

There is a strategy in place to manage fishery impacts on bycatch species, which utilises a number of management measures in the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* and operational activities (as per the *EGPMF Harvest Strategy 2014 – 2019*) including:

- Limited entry;
- Gear controls and the use of hopper sorting systems;
- Seasonal closures;
- Spatial closures;
- Temporal closures; and
- Reporting.

Not only have these measures been used successfully in similar fisheries, but testing supports high confidence that they will work in Exmouth Gulf. The EGPMF uses a number of measures to physically reduce overall bycatch and increase the survival of bycatch through the use of gear controls, including:

- a maximum ground chain link diameter (10 mm) to address the impact the chain has on benthic habitat and non-target species;
- a maximum otter board height to restrict the vertical net opening and facilitate escapement of non-target species over the top of the net;

- a maximum board length to address shoe contact with the benthic habitat and non-target species;
- the use of a Texas drop chain arrangement to promote passage of unwanted flora and fauna underneath the net;
- the mandatory use of TEDs (grids) in all nets; and
- the mandatory use of FEDs (square mesh panels) in all nets.

The use of grids and square-mesh panels is required in all prawn trawl fisheries in WA, and has been mandatory in the EGPMF since 2002/03. During BRD trials in 2000 – 2001, there was a 9 % reduction in overall bycatch using grids alone. Compared to the control nets, the grid in combination with a square mesh panel also significantly reduced the weight of bycatch by 54 % (Kangas & Thomson 2004). Additionally, over a 50 % reduction in individual numbers caught was observed for a number of fish species during FED trials in 2008 and 2009 (DoF, unpublished data). In 2005, representatives from the United States' Department of State (National Marine Fisheries Service, 'NMFS') assessed the grid arrangement used in Exmouth Gulf and found it to be compliant with the US TED (grid) regulations in place at the time[1]. Re-assessment by the NMFS occurred in August 2014 and a number of concerns were raised, including:

- the relatively small size of the grids, especially with the larger 8 fathom nets;
- the presence of an internal netting ramp upstream of the grid; and
- the absence of sufficient buoyancy in the form of floats.

The licensee in the EGPMF has addressed these issues and modifications have been implemented for the 2015 fishing season. In-water hopper sorting systems on prawn vessels add another level of protection for bycatch survival (Dell et al. 2003). Hoppers are large, water-filled tanks that receive the catch directly from the nets, thereby reducing the time the catch spends out of water. The use of hoppers makes for more-efficient sorting, and consequently, bycatch is returned to the sea more quickly (Oceanwatch 2004). The spatial and temporal measures in place are considered sufficient to minimise impacts from fishing on vulnerable species. In Exmouth Gulf, less than 40 % of the fishery area is open to trawling (Sporer et al. 2013). This ensures that more vulnerable species are protected in areas outside the trawl grounds, as the majority of species occur in both trawled and untrawled areas (Kangas et al. 2007).

The harvest strategy includes the long-term management objective: *to ensure fishery impacts do not result in serious or irreversible harm to non-retained species populations*. As such, appropriate performance indicators, reference levels and control rules have been developed for bycatch species in the EGPMF (DoF 2014a). Although there is no formal stock assessment process for these species, the extent of trawling activities, BRD use and assessed risk is used to assess the impact of the EGPMF on these species' populations.

[1] https://www.federalregister.gov/articles/2014/06/27/2014-15164/certifications-pursuant-to-section-609-of-public-law-101-162

There is a continual monitoring and improvement process to minimise the impacts of the trawl gear in the EGPMF. This is facilitated through the Bycatch Action Plan (DoF 2014b), which supersedes the previous Bycatch Reduction Plan Matrix (DoF 2010). The 2014 Bycatch Action Plan lays out a commitment to a bycatch monitoring program through the application of fishery-independent surveys to collect bycatch species composition data every three years and providing validation through the introduction of a crew member observer program and / or the introduction of independent monitoring to validate crew reporting (e.g. cameras or observers).

At-sea and aerial patrols are conducted by the Department to monitor compliance with these regulations. The use of VMS also helps the Department monitor vessel location and speed, increasing compliance with spatial and temporal closures. If future monitoring indicates a need to reduce trawl impacts on bycatch species or biodiversity in Exmouth Gulf, this may be achieved through extending the use of current management tools, such as spatial and temporal closures, targeted harvesting strategies to optimise expenditure of effort, a reduction in overall fishing effort and the use of mechanical or other devices, such as BRDs and hoppers.

11.3 Bycatch Information and Monitoring

Like most trawl fisheries, bycatch in the EGPMF comprises of a large number of taxa in low abundance, with the majority of species being uncommon or having little biological information available (Kangas & Thomson 2004). Thus, it is not practical to monitor and evaluate the sustainability of each species using traditional methods. As bycatch cannot be eliminated entirely, however, it is important to determine and monitor which species can or cannot sustain the impact of fishing and which species may be suitable as indicator species to reflect trawl impacts on the total suite of bycatch species (Kangas et al. 2007; Kangas & Morrison 2013).

Some information on the amount of bycatch in the EGPMF is available from BRD trials (see Section 9.1). Baseline data on faunal abundance and composition in Exmouth Gulf in both trawled and untrawled areas is also available from an FRCD-funded project conducted in 2002 and 2003 (Kangas et al. 2007).

Although logbook reporting and VMS provide information on the spatial extent of fishing activities within Exmouth Gulf to ensure compliance with closed areas, fishers are not required to report on bycatch abundance or species composition. The lack of ongoing data collection and monitoring of bycatch in the EGPMF was identified as a potential issue for the fishery as part of the MSC pre-assessment process. In order to address this issue, the Department has developed a Bycatch Action Plan (DoF 2014b), which includes an overview of bycatch issues in Exmouth Gulf and a proposed work plan for future / ongoing monitoring and research (DoF 2014b).

In May 2015, camera equipment was obtained for on-board monitoring of bycatch diversity and quantity, as well as ETP species interactions. This equipment will be trialled on one vessel during the 2015 fishing season. Additionally, photographs of the total catch (prior to discarding and sorting) on the sorting tables are available from fishery-independent

monitoring surveys conducted since August 2014. These photographs provide an indication of bycatch quantities per shot and site and allow for species identification. Plans are also in place to introduce a systematic bycatch sampling regime for the EGPMF fleet in the latter half of the 2015 season. As part of this sampling, frozen bycatch samples will be collected from predetermined sites during normal fishing operations and sent to the Department's research facility at Hillarys for analyses.

12. ETP Species

Endangered, threatened and protected[1] (ETP) species in WA are protected by various international agreements and national and state legislation. International agreements include:

- *Convention on the Conservation of Migratory Species of Wild Animals 1979* (Bonn Convention);
- The *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES);
- The *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA)[2];
- The *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA)[2];
- The *Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007* (ROKAMBA)[2]; and
- Any other international agreement, or instrument made under other international agreements approved by the Environment Minister.

Primary pieces of national and Western Australian legislation include the Commonwealth EPBC Act, the *Western Australian Wildlife Conservation Act 1950* (WC Act), and the FRMA.

A number of ETP species can be found within Exmouth Gulf, including cetaceans, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish and seabirds and migratory shorebirds (see Appendix E for a comprehensive species list including CITES listing); however, not all species are likely to interact with prawn trawling considering species behaviour and fishing gear and methods.

Marine Mammals

The Gulf supports a variety of marine mammals including dugongs, whales and dolphins. Dugongs (*Dugong dugon*) are usually found in close proximity to seagrass beds, their main food source, in the northern reaches of the Gulf and move freely between Exmouth Gulf and Ningaloo Reef to feed in the different regions (Morrison et al. 2003). The most recent dugong

[1] Note that being on a protected species list does not automatically indicate that a species is either threatened or endangered.
[2] Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at www.environment.gov.au/biodiversity/migratory/index.html

survey in Exmouth Gulf concluded that dugongs in the Gulf and Shark Bay most likely belong to the same population and migrate from one place to another (Hodgson 2007). The estimated dugong population in Exmouth Gulf was 704 (± 354 se; Hodgson et al. 2008). The impact of prawn trawling activities on dugong populations in Exmouth Gulf is limited through permanent spatial closures over seagrass areas, which is the primary habitat where dugongs are found (Hodgson 2007).

Humpback whales (*M. novaeangliae*) are the only whale species commonly observed within the Gulf, although 13 species of dolphins and whales have been found within the Gulf (Preen et al. 1997). Female humpback whales and their young calves use the deeper north-westerly reaches of the Gulf as a resting area during their southerly migration to feeding grounds in the Antarctic (Jenner and Jenner 2000). Whaling and habitat degradation have been identified as the key threats to whales, and recovery plans for these species have been developed, which establish objectives and actions to ensure the ongoing recovery of these species. The most recent recovery plans for cetacean species are available at: http://www.environment.gov.au/topics/marine/marine-species/whales-dolphins-and-porpoises/legislation.

Due to the spatial and temporal closures in place the potential for capture of marine mammals in this fishery is largely diminished. These closed areas provide substantial areas of refuge, particularly over important habitats, such as seagrass. Additionally, the move to more efficient quad-rigged gear in 2007 has translated to a reduction in the total length of headrope used in the fishery, which in turn translates to fewer gear interactions between net and ETP species. A similar argument also stands for the voluntary reduction in vessel numbers in 2012 from nine to six (DoF 2014b).

In addition to direct capture in trawl gear, marine mammals are susceptible to impacts from boat strikes. Vanderlaan and Taggart (2007) found that the speed a ship is travelling when it strikes a whale is directly linked to the severity of the injury the whale will sustain. The severity of the injury to whales increased with ship speed, and the likelihood of a lethal injury was significantly higher when ships were travelling over 8.6 knots (Vanderlaan and Taggart 2007). Trawlers in the EGPMF operate at relatively low speeds (around four knots). It is believed that at such speeds, it is highly unlikely that any cetacean or dugong would come in direct contact with a trawler or gear as they would actively remove themselves from the trawler's path (Kangas et al. 2006). Based on the results of Vanderlaan and Taggart (2007), there is also a low probability of lethal injury in the case that a boat strike should occur.

Sea snakes

All sea snakes in Australia are protected under the EPBC Act as marine species and ten of the 22 sea snake species known to occur in WA have been recorded in Exmouth Gulf. Sea snakes can be found throughout the Gulf but are most common in the shallow waters of the eastern shore (Storr et al. 2002; Morrison et al. 2003). Two commonly reported species include the Shark Bay sea snake (*Aipysurus pooleorum*) and the olive sea snake (*Aipysurus laevis*; Straits Salt Pty Ltd 2006). Most sea snake species within the Gulf are considered to be abundant or

common, and populations are not known to be at vulnerable levels (Kangas et al. 2006). Sea snakes are slow growing and have few offspring. They are air breathers and must come to the surface to breathe; however, they can spend from 30 minutes to two hours diving between breaths (Heatwole 1999). Consequently, many may survive being captured by trawl nets when trawl shots are short, i.e. less than 2 hours (Milton et al. 2009).

A study of sea snake survival following capture in trawlers in the Gulf of Carpentaria (Northern Territory) indicated that greater than 60 % of sea snakes survived capture in trawl nets (Wassenberg et al. 1994). it is likely that sea snakes captured in the EGPMF have a similar level of survival due to the short trawl times (60 – 200 mins) in the fishery.

One IUCN Redlisted 'critically-endangered' sea snake, the short-nose sea snake (*A. apraefrontalis*), has been recorded in Exmouth Gulf (Storr et al. 2002; Kangas et al. 2007). This species is endemic to Ashmore and Hibernia Reefs off the north-west coast of WA, although it has occasionally been recorded from other locations in northwestern Australian waters (Shuntov 1972; Cogger 2000; Storr et al. 2002; Kangas et al. 2007). These rare records from outside Ashmore and Hibernia Reefs are considered to be vagrant individuals and not part of the breeding population of this species (Lukoschek et al. 2010); however, they may also represent a population that has not been identified. This species may also have a wider distribution outside northwest Australia, however, there are no conclusive records relating to the species distribution outside Australian waters (DotE 2011).

The short-nosed sea snake occurs primarily on the reef flats or in shallow waters of the outer reef edges to depths of 10 m (Minton and Heatwole 1975). The species is known to shelter under coral or rubble at low tide (McCosker 1975), predating on small coral reef fish and eels that it catches by poking its head into burrows in the sand and then striking at prey (Lukoschek, pers. comm., 2009 [as referenced in DotE 2011]; DEWHA 2010). All sea snakes from the genus Aipysurus give birth to a clutch of live young, reproducing annually with clutch sizes of less than 10. The species is likely to reach sexual maturity between one and two years of age with a life expectancy between eight and ten years of age. Generation length is therefore estimated to be approximately four years (DotE 2011).

Recent sea snakes surveys at Ashmore and Hibernia Reefs have indicated a severe decline in the abundance of short-nosed sea snakes (as well as other sea snake species); however, the reason for this decline is unclear (Lukoschek et al. 2013; Guinea 2013). The main threat to the sea snakes at Ashmore and Hibernia appears to be degradation of reef habitat, primarily as a result of coral bleaching (DotE 2011). Within Exmouth Gulf, individuals of *A. apraefrontalis* may be subject to incidental capture in trawl nets, although its strong association with reef habitats will minimise the likelihood of encountering a trawl vessel (Lukoschek et al. 2007).

Marine Turtles

Exmouth Gulf also supports a large marine turtle population of between 3200 and 4500 individuals (Preen et al. 1997). Green turtles (*Chelonia mydas*) are the most abundant, followed by loggerheads (*C. caretta*). Although the Gulf is well within Hawksbill (*E.*

imbricata) turtles' normal range, this species is relatively uncommon in Gulf waters (Kangas et al. 2006); however, important nesting sites for loggerhead, green and hawksbill turtles are found on the Muiron Islands, just north of the Gulf (Morrison et al. 2003). Leatherback (*D. coriacea*) and flatback (*N. depressus*) turtles are uncommon in the Gulf, as the Gulf is towards the southern end of their distributional range. All marine turtles in Australia are protected under the EPBC Act as threatened species. A recovery plan for these species has been developed by Commonwealth government and establishes objectives and actions to ensure the ongoing recovery of these species. The most recent recovery plan for these species is available at:
http://www.environment.gov.au/resource/recovery-plan-marine-turtles-australia.

EGPMF successfully reduced its interactions with turtles by introducing mandatory grids in 2002 / 2003. The grids were shown to reduce turtle capture in trawl nets by 95 – 100 % (Kangas & Thomson 2004). The grids used have also been assessed and approved by the US Department of State to comply import requirements that a fishery must demonstrate that it has taken specific measures to reduce the incidental take of sea turtles in trawl gear.

Sharks and Rays

Numerous species of sharks and rays can also be found in the Gulf (Straits Salt Pty Ltd 2006). Sharks and rays have been commercially protected in WA under the FRMA since 2007. Recovery plans have been developed for white and grey nurse sharks by the Commonwealth government and are available at:
http://www.environment.gov.au/topics/marine/marine-species/sharks.

Four of the world's seven species of sawfish are found in WA, including the freshwater sawfish (*Pristis microdon*), dwarf sawfish (*Pristis clavata*), green sawfish (*Pristis zijsron*) and narrow sawfish (*Anoxypristis cuspidata*). Sawfish generally inhabit inshore coastal and estuarine environments (Department of the Environment 2014) and are easily identified by the presence of a blade-like snout with enlarged tooth-like denticles known as rostral teeth (Last and Stevens 2009). Sawfish have undergone major global declines in both range and abundance, partially from their vulnerability to entanglement in fishing nets but also through loss of habitat (Morgan et al. 2010). Their toothed rostrum, active hunting behaviour and dependence on inshore and estuarine areas for breeding and juvenile habitat make the sawfish high susceptible to capture in fisheries using nets (Last and Stevens 2009; Department of the Environment 2014). Freshwater, dwarf and green sawfish are protected under the EPBC Act, and all four species are protected under the FRMA. Green sawfish are also listed as Schedule 1 under the WC Act.

In Australian waters, green sawfish have historically been recorded in the coastal waters off Broome, WA, around northern Australia and down the east coast as far as Jervis Bay, NSW (Stevens et al. 2005). There is little data on the species' relative abundance in northern WA waters, although given that this region is less populated by humans than the east coast, it may contain the healthiest populations of the species' in Australian waters (Stevens et al. 2005).

Green sawfish have been recorded in very shallow water (< 1 m) to offshore trawl grounds in over 70 m of water (Stevens et al. 2005).

The Australian distribution of the dwarf sawfish is considered to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in WA (McAuley et al. 2005; Stevens et al. 2008; Last and Stevens 2009); however, there is insufficient data available to estimate the total numbers of mature individuals of dwarf sawfish in Australian waters. The dwarf sawfish usually inhabits shallow (2 – 3 m) coastal waters and estuarine habitats, and the species' range is restricted to brackish and salt water (Thoburn et al. 2007). A study in north-western Western Australia found that estuarine habitats are used as nursery areas by dwarf sawfish, with immature juveniles remaining in these areas up until three years of age (Thoburn et al. 2007). Adults are known to seasonally migrate back into inshore waters (Peverell 2007), although it is unclear how far offshore the adults travel. As the majority of fishing in the EGPMF occurs in water depths between 7 and 30 m, the spatial overlap of the species' distribution and fishing effort would be restricted.

The freshwater sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, WA, to the western side of Cape York Peninsula, Queensland. While the total population of freshwater sawfish is unknown, genetic studies have shown that the species, despite high mobility when adults, should be considered as populations, rather than a single population in Australian waters (Phillips et al. 2008). Similar to the dwarf sawfish, as the majority of fishing in the EGPMF occurs in water depths between 7 and 30 m (with much of the coastal fringe protected as nursery grounds), the spatial overlap of the species' distribution and fishing effort is restricted.

Large sharks are generally excluded from the trawl nets by the grids in place (Kangas et al. 2006); however, the effectiveness of grids in reduce sawfish capture has not been tested in this fishery. The use of grids has been shown to reduce the capture of narrow sawfish (*Anoxypristis cuspidata*) in the NPF by 73 % (Brewer et al. 2006); however, other studies found only a slight effect (Griffits et al. 2006) or maintain there is no effect due to entanglement before the grid is contacted (Patterson and Tudman 2009).

Syngnathids and Solenostomids

Various species of syngnathids (sea horses and pipefish) and solenostomids (ghost pipefish) are also found within the Gulf. Syngnathid populations may be particularly susceptible to pressures because their biology is characterised by relatively low population densities, lengthy parental care combined with small brood size limiting their reproductive rate, strict monogamy, sparse distribution, low rates of adult mortality, strong association with preferred habitat, and low mobility and small home ranges (Foster and Vincent 2004; Vincent 1996). Most seahorse species are more localised than previously thought, and preserving habitats is one of the most important factors in protecting seahorses (Kuiter 2001; Shokri et al. 2009). Syngnathids tend to use only certain parts of suitable habitat; for example, they have been recorded occupying the edges of seagrass beds, leaving large areas unoccupied (Scales 2010;

Vincent 1996). Within Exmouth Gulf, they primarily occur along seagrass beds and detached algal communities (Kangas et al. 2006). All syngnathids and solenostomids are listed as Marine species under the EPBC Act.

The distribution of syngnathids appears to be specific to seagrass and detached algal communities, most of which are located in areas closed to trawling, reducing the likelihood of interaction. Additionally, evidence from researchers and anecdotal reports from fishers indicates that a low number of syngnathids are caught by the fishery, as many pass through the net mesh.

12.1 Fishery Impacts

Fishers in the EGPMF have reported interactions with sea snakes, marine turtles, seahorses and sawfish (Table 12.1). When captured, ETP species are dealt with in an appropriate fashion, ranging from ensuring turtle are revived first before returning them to the water, to a more rapid return to the water for more sensitive species. Occasionally sawfish and other dangerous species are euthanized if they are tangled in the gear and represent a threat to crew trying to untangle them.

The level of interaction reported is considered to be within limits national and international requirements for the protection of ETP species, and the EGPMF has been found the *Guidelines for the Ecologically Sustainable Management of Fisheries* (see Section 4.8 for more information). The fishery was most recently re-certified in 2013, with export approval extended to February 2018. Additionally, industry (in association with the Department) has successfully gained certification from the US Department of State for its BRD compliancy. In order to gain this certification, the fishery was required to demonstrate that it has taken specific measures to reduce the incidental take of sea turtles in trawl. The fishery was re-certified in 2012 after increases in the grid size and escape opening, following the increase in the size of the net headrope and body of the net to accommodate the reduction in boat numbers (Sporer et al. 2013). This certification allows licensees to export product to the US market.

Table 12.1. Reported interactions with ETP species by the Exmouth Gulf Prawn Managed Fishery from 2007 – 2013. Return status indicated when known (A: Alive; D: Dead; U: Unknown)[1].

Year	Marine Turtles			Sea snakes			Seahorses			Sawfish		
	A	D	U	A	D	U	A	D	U	A	D	U
2007						13						
2008	12					103			1			
2009	3					80						
2010	7			113	2	37			4			7
2011	28			449	48				4			23
2012	5		1			70						3
2013	10			105	6				1			14

[1] Since 2010, reporting in the EGPMF fishery has improved and has been able to provide returned status for some species.

Some species-specific ETP information is available from the biodiversity surveys conducted by Kangas et al. (2007). A slightly higher number of marine reptiles were caught in Exmouth Gulf and Onslow compared with Shark Bay, but the numbers were still low (Table 12.2). Species captured included flatback (*N. depressus*), green (*C. mydas*), and loggerhead (*C. caretta*) turtles and Dubois's (*A. duboisii*), golden (*A. laevis*), short-nosed (*A. apraefontalis*), olive-headed (*D. major*) and Stoke's (*D. stokesii*) sea snakes. Some of the marine fish species caught as bycatch in Exmouth Gulf and Onslow are also listed as threatened and / or protected species (Table 12.3; Kangas et al. 2007).

Table 12.2. Marine reptiles caught in Exmouth Gulf and Onslow during biodiversity sampling by Kangas et al. (2007)

Month / Year	Site	Number caught	Common name	Scientific name
Turtles				
3/04	8	1	Flatback turtle	*Natator depressus*
3/04	8	1	Green turtle	*Chelonia mydas*
7/04	23	1	Green turtle	*Chelonia mydas*
11/04	16	1	Loggerhead turtle	*Caretta caretta*
11/04	20	1	Flatback turtle	*Natator depressus*
11/04	24	1	Flatback turtle	*Natator depressus*
11/04	24	1	Flatback turtle	*Natator depressus*
Sea snakes				
3/04	4	1	Dubois' sea snake	*Aipysurus duboisii*
3/04	4	1	Dubois' sea snake	*Aipysurus duboisii*
3/04	5	3	Dubois' sea snake	*Aipysurus duboisii*
3/04	5	3	Dubois' sea snake	*Aipysurus duboisii*
3/04	19	1	Golden sea snake	*Aipysurus laevis*
3/04	2	1	Golden sea snake	*Aipysurus laevis*
3/04	2	1	Dubois' sea snake	*Aipysurus duboisii*
3/04	11	1	Short-nosed sea snake	*Aipysurus apraefrontalis*
3/04	6	1	Olive-headed sea snake	*Disteira major*
7/04	4	1	Stoke's sea snake	*Disteira stokesii*
11/04	4	1	Dubois' sea snake	*Aipysurus duboisii*
11/04	19	1	Dubois' sea snake	*Aipysurus duboisii*
11/04	12	1	Dubois' sea snake	*Aipysurus duboisii*

Table 12.3. Protected fish species caught during biodiversity sampling in Exmouth Gulf by Kangas et al. (2007).

Common name	Scientific name	Number caught
White-spotted shovelnose ray	*Rhynchobatus australiae*	5
Winged seahorse	*Hippocampus alatus*	2
Western spiny seahorse	*Hippocampus antustus*	11

Flat-faced seahorse	*Hippocampus planifrons*	5
Zebra seahorse	*Hippocampus zebra*	1

12.1.1 Risk Assessment Outcomes

12.1.1.1 Dugongs and Cetaceans

12.1.1.1.1 Indirect Impacts

2008 Risk Rating: Impact on breeding populations (C1 L3) **Low**

2014 PSA assessment (boat strikes): Cetaceans, dugongs (3.17) **Medium**

Humpback whales are found within the Gulf from July to October each year during their southward migration (Jenner and Jenner 2000); however, no interactions with whales have been reported in the EGPMF.

Trawlers operate at relatively low speeds (around four knots). At such speeds, it is highly unlikely that any cetacean would come in direct contact with a trawler or gear as they would actively remove themselves from the trawler's path (Kangas et al. 2006).

Any disturbance to marine mammals in Exmouth Gulf is likely to be localised and not widespread, as all species found within the Gulf have wide distributions throughout the region.

There have been no reported interactions with dugongs or cetaceans with the EGPMF. Thus, the EGPMF is considered to be a low risk to on the breeding populations of dugong and cetaceans in Exmouth Gulf (Kangas et al. 2006).

12.1.1.2 Sea Snakes

2008 Risk Rating: Impact on breeding populations (C0 L5) **Negligible**

2014 PSA assessment: Sea snakes, general (Family Hydrophiinae) (2.74) **Medium**

Short-nosed sea snake (*Aipysurus apraefrontalis*) (2.62) **Low**

In 2013, 111 sea snake interactions were reported, with the majority of sea snakes returned to the water alive. Anecdotal evidence suggests that most sea snakes caught in the fishery are alive and aggressive when brought to the surface, which is thought to be an indication of health and lack of damage from the trawl. A study of sea snake survival following capture in trawlers in the Gulf of Carpentaria (Northern Territory) indicated that greater than 60 % of sea snakes survived capture in trawl nets (Wassenberg et al. 1994), and it is likely that sea snakes in Exmouth Gulf have a similar level of survival.

Although grids have not been demonstrated to directly reduce the capture of sea snakes, they reduce the volume of catch in the net and reduce any negative impacts on sea snakes in the net by preventing crushing of sea snakes among the catch (Wassenberg et al. 2001). FEDs similar to those used in the EGPMF have also been shown to be successful in reducing incidental captures of sea snakes by 50 % in other fisheries (e.g. Heales et al. 2008; Milton 2001; Milton et al. 2009).

Most sea snake species are considered to be abundant or common in Exmouth Gulf, and the level of impact from the EGPMF is not considered to have any significant detrimental effects on sea snake populations in the Gulf (Kangas et al. 2006).

12.1.1.3 Marine Turtles

Turtle bycatch mitigation has been successfully addressed with the introduction of the mandatory use of grids in 2002/03. These grids have shown to be effective in the fishery with a 95 – 100 % reduction in turtle bycatch (Kangas & Thomson 2004). In 2013, fishers in the EGPMF reported interactions with ten turtles, all of which were returned to the water alive. This level of interaction is considered to be a negligible risk to marine turtle populations, as these species have wide distributions both within the Gulf and the greater Gascoyne Coast Bioregion (Kangas et al. 2006).

12.1.1.3.1 ***Green Turtles***

2008 Risk Rating (Direct Interactions): Impact on breeding population (C0 L5) **Negligible**

2014 PSA assessment: (3.04) **Medium**

Green turtles (*C. mydas*) are the most abundant turtles in Exmouth Gulf and have a large distributional range outside of the Gulf. Adult green turtles are herbivorous and are likely to forage in the shallow seagrass and macroalgal beds that are predominantly closed to trawling.

Despite their high abundance in the Gulf, very few green turtles have been reported throughout the history of the fishery (Kangas et al. 2006).

12.1.1.3.2 ***Loggerhead Turtles***

2008 Risk Rating (Direct Interactions): Impact on breeding population (C1 L4) **Low**

2014 PSA assessment: (3.17) **Medium**

Loggerhead turtles are less common than green turtles in Exmouth Gulf but have a wider distribution outside the Gulf. Loggerheads prefer to forage over open substrate, such as the mud / shell substrate that dominates the trawl grounds in the Gulf.

It has been suggested that loggerheads may be susceptible to reflex asphyxiation rather than drowning during extended periods of submersion (i.e. in the trawl net). The relatively long shot times in this Fishery (between 60 and 200 minutes) may therefore increase the risk of death for loggerhead turtles if caught in trawl gear (Kangas et al. 2006). However, there have been very few reported interactions with loggerhead turtles over the history of the fishery. All captured turtles have been returned to the water alive.

12.1.1.3.3 ***Hawksbill Turtles***

2008 Risk Rating (Direct Interactions): Impact on breeding population (C0 L5) **Negligible**

2014 PSA assessment: (3.17) **Medium**

Although Exmouth Gulf is within the distributional range of hawksbill turtles, they are relatively uncommon. The turtles prefer to forage over hard coral and rock substrate and are unlikely to occur on the trawl grounds. There have been no reported interactions with hawksbill turtles over the history of the fishery (Kangas et al. 2006).

12.1.1.3.4 Flatback Turtles

2008 Risk Rating (Direct Interactions): Impact on breeding population (C0 L5) **Negligible**

2014 PSA assessment: (3.17) **Medium**

Exmouth Gulf is the southern limit of the flatback turtle's distributional range, and they are relatively uncommon within the Gulf. Given their preferred diet and foraging behaviour, they may occur on the trawl grounds (Kangas et al. 2006).

There have been few reported interactions with flatback turtles over the history of the fishery, with all turtles were returned to the water alive (Kangas et al. 2006).

12.1.1.3.5 Indirect Impacts[1] on all Turtle Populations

2008 Risk Rating: Impact on breeding populations (C0 L5) **Negligible**

2014 PSA assessment (boat strikes): (3.17) **Medium**

The relatively low speed (around four knots) of trawl vessels in the EGPMF makes it unlikely that any turtles would come into contact with the trawler or gear, as they would be able to physically remove themselves from the trawler's path (Kangas et al. 2006).

12.1.1.4 Sawfish[2]

2014 Risk Rating: Impact on breeding populations (C1 L3) **Low**

2014 PSA assessment: Green, Freshwater and Dwarf Sawfish (*Pristis* spp.) (3.68) **High**

Interactions with saw fish have only been reported by the EGPMF since 2010, therefore it is difficult to identify any changes in abundance or interaction rates with these species. Survival rates of sawfish are unknown (Department of Fisheries 2011).

The use of grids has been shown to reduce the capture of narrow sawfish (*Anoxypristis cuspidata*) in the NPF by 73 % (Brewer et al. 2004). The reduction in sawfish landings following the implementation of grids in the EGPMF in 2007 is unquantifiable since there is no data available on sawfish interaction rates prior to grid implementation; however,

[1] This component addresses the issue of interaction between the fishery and a particular ETP species, which does not result in capture – in particular being hit by the hull of the vessels in the fishery and the disturbance of breeding aggregations.

[2] Note that Sawfish were not included in the 2001 or 2008 risk assessments but have since been added for annual reporting purposes.

anecdotal evidence from long standing skippers / crew suggests a similar level of reduction may have been achieved.

Fourteen interactions were reported in 2013, although the number of interactions has been variable over the past four years. The number of recorded interactions with sawfish in the EGPMF is low compared with other tropical trawl fisheries, such as the Northern Prawn Fishery (380 interactions reported in 2010; Barwick 2011).

12.1.1.5 Syngnathids

2008 Risk Rating: Impact on breeding populations (C1 L2) **Low**

2014 PSA assessment: *Hippocampus* spp. (2.34) **Low**

Syngnathids and solenostomids are incidentally caught by the EGPMF during trawling activities. Evidence from observers and anecdotal reports from fishers indicates that low numbers of syngnathids are caught by the fishery, as many pass through the net mesh. In 2013, one interaction with syngnathids was reported.

The distribution of syngnathids appears to be specific to seagrass and detached algal communities, most of which are located in areas closed to trawling, reducing the likelihood of interaction. Thus, it was considered unlikely that even a negligible level of consequence would result, as trawling occurs over areas unfavourable to these species (Kangas et al. 2006).

12.2 ETP Species Management

There is a strategy in place for managing the fishery's impact on ETP species that is designed to achieve national and international requirements for protection. This strategy utilises a number of management measures under the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* and operational activities (as per the *EGPMF Harvest Strategy 2014 – 2019*) including:

- Limited entry;
- Gear controls and the use of hopper sorting systems;
- Seasonal closures;
- Spatial closures;
- Temporal closures; and
- Reporting.

Fishing effort in the EGPMF has changed dramatically since the beginning of the fishery in 1963, with six boats operating in 2013. The impact on ETP species was reduced as a consequence of reducing fishing effort (DoF 2014b). Additional gear controls in place to restrict fishing effort include a maximum headrope capacity. In 2007 when the fishery moved to a quad-rigged gear configuration, the total headrope length used in the fishery was

reduced, further reducing the level of interaction between fishing gear and ETP species within the Gulf (Kangas et al. 2006).

The EGPMF also uses a number of measures to physically reduce direct ETP species interactions and increase the survival of captured ETP species, primarily through the use of primary and secondary BRDs (i.e. grids and square mesh panels). These measures have been tested within the fishery and other similar tropical trawl fisheries in Australia and are considered to work based on trial results (see Section 9.1), which indicated a reduction in the incidental capture of ETP species. The grids were not found to reduce the catch levels of sea snakes, as they can pass through the gird bars and into the cod end (Kangas & Thomson 2004); however, openings in the tops of nets (i.e. FEDs) have been shown to be successful in reducing the incidental capture of sea snakes by 50 % in other fisheries (e.g. Heales et al. 2008; Milton et al. 2009). Additionally, ETP species interaction rates reported in the fishery since the implementation of BRDs continue to be very low (see Table 12.1).

The spatial and temporal measures in place are considered sufficient to minimise impacts from fishing on vulnerable species. In Exmouth Gulf, less than 40 % of the fishery area is open to trawling (Sporer et al. 2013). The limited spatial extent of fishing activities allows for adequate areas of refuge for ETP species throughout the Gulf. Additionally, as trawling occurs over sand / mud substrates, the trawl nets are spatially separated from important habitats for many ETP species, with many of these habitats also protected in permanent fishery closures.

The harvest strategy includes the long-term management objective: *to ensure fishery impacts do not result in serious or irreversible harm to endangered, threatened and protected (ETP) species populations* (DoF 2014a). As such, appropriate performance indicators, reference levels and control rules have been developed for ETP species in the EGPMF (DoF 2014a). The annual extent of trawling activities, BRD use and assessed risk is used to evaluate the impact of the EGPMF on these species' populations. There is a continual monitoring and improvement process to minimise the impacts of the trawl gear in the EGPMF. This is facilitated through the Bycatch Action Plan (DoF 2014b).

Compliance with management arrangements is conducted by Departmental Fisheries and Marine Officers (FMOs) using at-sea and landing inspections. The use of VMS also helps the Department monitor vessel location and speed, increasing compliance with spatial and temporal closures. If future monitoring indicates a need to reduce trawl impacts on ETP species in Exmouth Gulf, this may be achieved through extending the use of current management tools, such as spatial and temporal closures, targeted harvesting strategies to optimise expenditure of effort, a reduction in overall fishing effort and the use of mechanical or other devices, such as BRDs and hoppers / handling techniques.

12.3 ETP Species Information and Monitoring

All fishers are required to report ETP species interactions in statutory daily logbooks. In order to improve reporting accuracy, fishers have been provided with a *Protected Marine Species Identification Guide* (National Heritage Trust 2005), which contains a picture and

brief description of relevant protected species, specific details to include in interactions reports and current contact details for interaction reports.

Since 2010, there has been a focus on improving ETP species reporting in the EGPMF, with many fishers now including species not previously recorded (e.g. sawfish) and return status when known. This information is monitored by the Department and is considered to be sufficient to quantitatively estimate the outcome status of ETP species with a high degree of certainty.

The lack of information on the impacts of the EGPMF on sea snake and sawfish populations in Exmouth Gulf was identified as a potential issue for the fishery as part of the MSC pre-assessment process. In order to address this issue, the Department has developed the *EGPMF Bycatch Action Plan 2014 - 2019* (DoF 2014b), which includes an overview of ETP species issues in Exmouth Gulf and a proposed work plan for future / ongoing monitoring and research. In May 2015, camera equipment was obtained for on-board monitoring of bycatch diversity and quantity, as well as ETP species interactions. This equipment will be trialled on one vessel during the 2015 fishing season.

Additional ETP species information has been collected as part of the fishery-independent surveys conducted by Departmental research staff. All ETP species captured in trawl nets during these surveys have been recorded since 1999, along with the location, time, depth, weather conditions, moon phase, water temperature and gear efficiency at time of capture. Where possible, the status of the animal at capture (alive or dead) and the release procedure, if applicable (e.g. sawfish), has also been recorded since 2005. Photographs have also been taken of all sea snakes, sawfish and turtles captured during these surveys since August 2014. Each photo log contains shot information and species-level identification.

13. Habitats and Ecosystem

13.1 Overview

Typical water depths in Exmouth Gulf range from approximately one metre along the broad, shallow southern and eastern shores to approximately 20 m towards the northern and western regions. The western shore is comprised of dune-backed beaches and sandy, shallow subtidal regions with a few rocky outcrops. There are narrow bands of coral reef at the northern end (Bundegi Reef) and near the southern end of the Gulf (Point Lefroy to Roberts Island). Subtidally, there is a rich growth of hard corals, although only 28 species have been recorded in the area (Veron and Marsh 1988).

In contrast, extensive muddy salt flats, up to 10 km wide, border the southern and eastern shores of the Gulf (McCook et al. 1995; Morrison et al. 2003). The shallows, particularly in the southern region, have very little vegetation, and some areas are completely bare and consist only of sand and gravel (Morrison et al. 2003). The intertidal mudflats are lined with dense mangrove stands, mainly *Avicennia* and *Rhizophora* spp., which make up one of the

largest mangals in WA (Johnstone 1990; Wilson 1994). The mangrove stands are the most extensive along the eastern shores of the Gulf (Johnstone 1990).

In the broad shallow waters of the Gulf fronting the mangals, extensive seagrass beds provide feeding habitats for turtles and dugongs (Wilson 1994). All of the seagrass species found in the Gulf are all of a tropical distribution and are found in very low abundances, rarely exceeding 5 – 10 % cover. Small amounts of algae (e.g. *Caulerpa, Halimeda, Udotea* and *Penicillus* spp.) have been found mixed with these seagrass beds, and large quantities of filamentous turfs, ephemeral epiphytes and perennial macrophytes, such as *Sargassum* spp., are also frequently found attached to or tangled with the seagrasses. In some places, particularly the central eastern coast, the cover and biomass of these algae exceed that of the seagrasses. On the west coast, seagrasses are more patchily distributed and do not occur below eight metres, although brown algae, e.g. *Sargassum* spp., are present down to 10 m (McCook et al. 1995). The low abundance of seagrass within the Gulf has been attributed to the lack of suitable substrate, with observed substrate consisting of either hard or mobile coarse sediments (McCook et al. 1995). Despite the low seagrass abundance, Exmouth Gulf is a highly productive ecosystem, with macroalgae, phytoplankton and salt-flat cyanobacteria the main primary producers (McCook et al. 1995).

Extensive vegetated (ephemeral seagrasses, sponges and macroalgae) shallow banks, extending predominantly south of Hope Point on the eastern coast of the Gulf, can be found generally 0.5 – 1.5 m below mean sea level and support the majority of marine fauna in the area (Straits Salt Pty. Ltd. 2006). These banks are a key component for the life cycle of prawns, and trawling is prohibited in the southern and eastern areas of the Gulf to protect this important nursery area.

In 2006, a research program was initiated in Ningaloo Marine Park with the aim of mapping the deeper waters of the Park and establishing a baseline biodiversity database for biota occurring in 30 – 125 m depths (Heyward et al. 2010). Intensive investigations at Ningaloo Reef followed to assess the distributions of the various biological communities and to determine whether they were adequately represented in the existing MPAs. Surveys revealed that sponges frequently represent the dominant component of the sessile benthic communities. Three years of cumulative fieldwork employed acoustic methods, imaging techniques and traditional sled hauls, with the identification of dominant sponges from this sampling period completed to operational taxonomic units (OTUs). Preliminary broad-scale, on-board analysis of video imagery clearly showed that sponges represent a significant proportion of the benthos in the deeper water of the Ningaloo Marine Park and are a major habitat-forming group. Various dense sponge communities or ‘hotspots’ have been identified including a few areas in the north at the Muiron Islands to Bundegi Reef and north of Tantabiddi, areas between Mandu Mandu and south of Point Cloates, and an area in the south between Gnaraloo and Red Bluff. The dominant sponges identified at the WA Museum were all in the class Demospongiae and presently comprise 155 species (a dominant sponge species was one where the total weight of the species was ≥ 1 kg wet weight per station). Many more species were collected that did not attain wet weights ≥ 1 kg per station and are

yet to be studied. The total number of sponge species present in the Ningaloo filter-feeding communities will be significantly higher when all species have been identified (Heyward et al. 2010). Note that much of the Ningaloo Marine Park sampling area does not overlap with the areas trawled by this fishery.

The warm waters of the Leeuwin Current affect the offshore waters of Exmouth Gulf, particularly during strong winter flows. This warm current maintains elevated water temperatures, depressed levels of dissolved nutrients and particle concentrations, and inhibits the growth of macroalgae (Hatcher 1991). Consequently fisheries production relies on nutrient sources from benthic habitats in near-shore waters, rather than from oceanic ecosystems (Lenanton et al. 1991).

The majority of the flora and fauna in the Gulf are tropical, but some subtropical and temperate species are also present (Hutchins 1994). Limited information is available on the extent and type of soft sediment that covers a large part of the central seabed in Exmouth Gulf or its associated fauna. Apache Energy (1998) report that soft sediment regions above 20 m depth outside commercial trawl areas have extensive invertebrate communities, of which the most abundant are echinoderms including sand dollars, *Diadema* urchins, heart urchins and crinoids, plus some areas have abundant solitary corals. The channel between the Muiron Islands and North West Cape has only a thin veneer of coarse sediment overlying limestone pavement. This area is rich in gorgonians, sea whips, bryozoans, some hard corals, crinoids, ascidians and hydroids, but few fish species were recorded (Apache Energy 1998).

Further information on the habitats and ecosystem of Exmouth Gulf in relation to prawn fishing activities are available as part of an FRDC-funded project by Kangas et al. (2007). An overview of this project is provided in Section 9.2.

13.2 Habitat Mapping

Habitat data for the North West Shelf region from North West Cape to Port Hedland, including Exmouth Gulf has been integrated to produce maps and descriptions of key ecosystems in the region as part of the North West Shelf Joint Environmental Management Study (NWSJEMS; Lyne et al. 2006). Habitat maps were derived mainly from already existing information, but survey fieldwork was also undertaken where needed to fill critical gaps in spatial coverage.

Two “levels” of habitat maps relevant to the consideration of potential fishery impacts in Exmouth Gulf were created (1) biogeomorphological units, habitat structures represented by “fields of features” and (2) primary biotopes, relatively uniform habitats. There were 12 biogeomorphological units identified within Exmouth Gulf (Table 13.1; Figure 13.1; Lyne et al. 2006).

Table 13.1. Biogeomorphological units identified by Lyne et al. (2006) within Exmouth Gulf

Geographic Unit	Description
Beach – Dune	Sandy beaches or dune shorelines above the mean water level (does not differentiate sandy substrate in the marine environment)
Sand flats – tidal flats	Landward extent of tidal zone inundated only at high tide or during elevated tidal events such as cyclones
Mud and tidal flats	Tidally inundated; intertidal zone
Mangroves	Occurrence of mangroves or mangals. Mangroves recognised as unique subset of the mud and tidal flats
Embayment – subtidal zone	Shallow water enclosed by an embayment that is not exposed at low tide
Tidal channel (subtidal)	Tidal drainage channel/s that incise tidal flats and may extend inland to form tidal creeks through coastal tidal or mud flats
Nearshore waters (< 5 m)	Undifferentiated shallow nearshore and coastal waters which are not tidally exposed
Nearshore Reef	Areas identified as reef, adjacent (connected either directly or adjacent to mudflats) to the mainland coastline or islands
Offshore waters (5 – 10 m)	Offshore waters between 5 and 10 m depth; includes water surrounded by deeper water (> 10 m)
Offshore waters (10 – 20 m)	Offshore waters between 10 and 20 m depth
Shallow island fringe	Shallow, intertidal waters adjacent to islands. Less than 5 m depth.
Offshore waters < 5 m (island, shoal)	Shallow water in areas deeper than 5 m which are less than 5 m deep; may represent shoals or reefs on navigation charts and are not surrounding or adjacent to islands

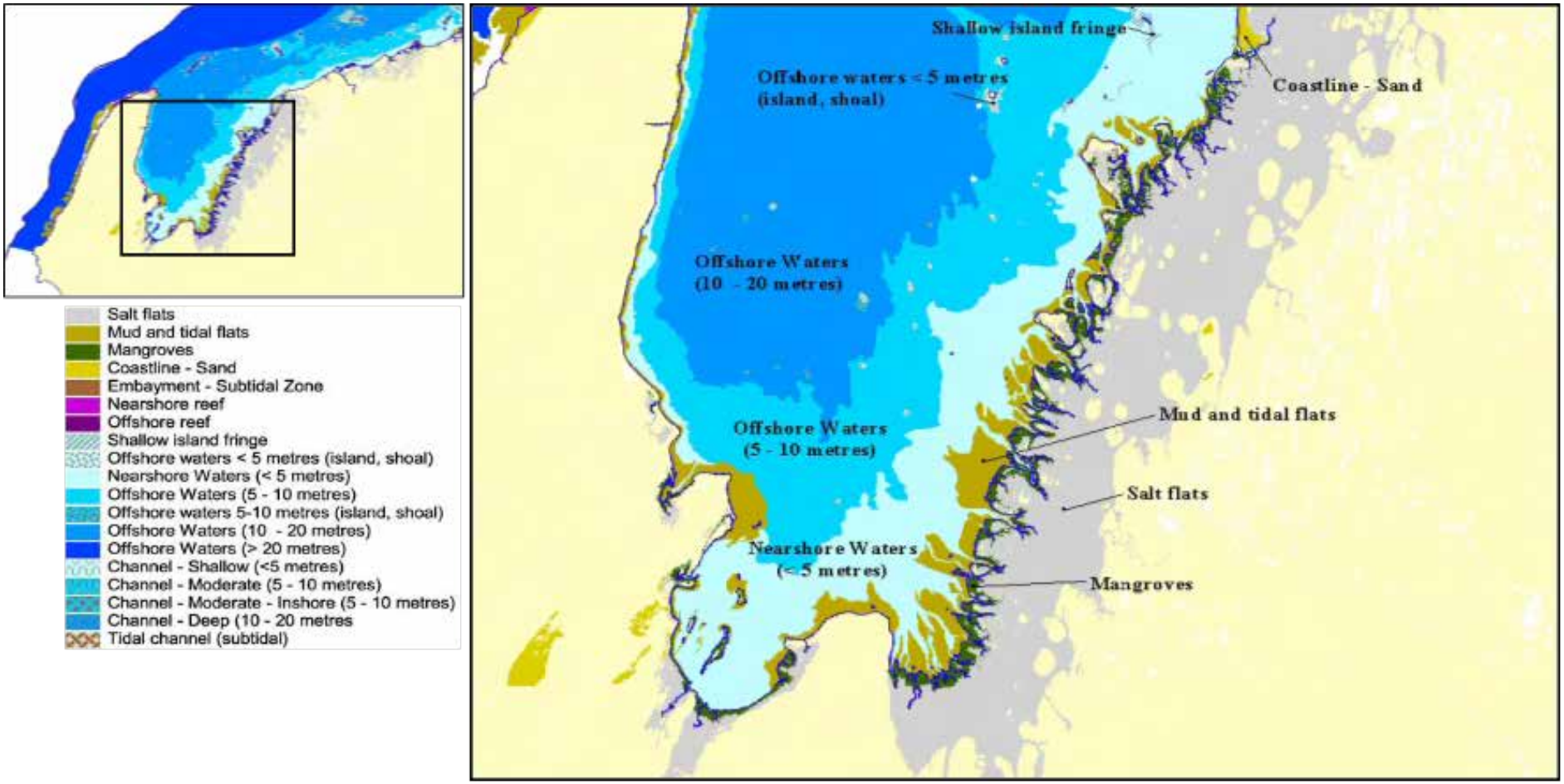

Figure 13.1. Biogeomorphic units of Exmouth Gulf (Source: Lyne et al. 2006)

Additional information was obtained on marine habitats in some areas, which allowed for the extension of the hierarchical classification to Level 4 (primary biotopes). This information was compiled from existing habitat mapping and inferred where data did not exist (Figure 13.2).

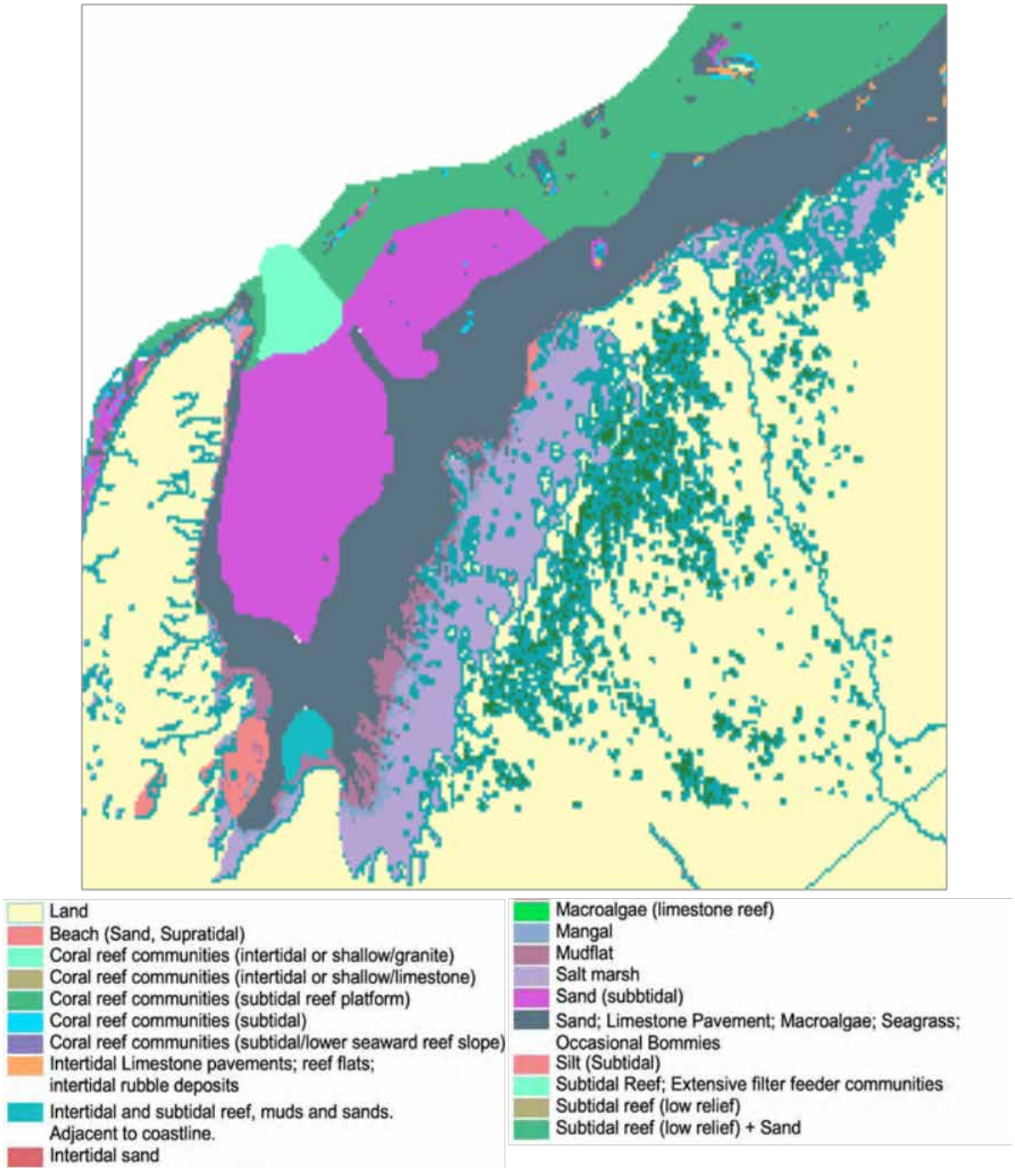

Figure 13.2. Primary biotopes of Exmouth Gulf region (Source: Lyne et al. 2006)

13.3 Habitat Assessment

13.3.1 Fishery Impacts

Approximately 30 % of Exmouth Gulf is trawled annually by the EGPMF (Table 13.2), with 21.7 % (247.1 nm^2) of the Gulf trawled in 2013 (see Figure 3.1 for spatial extent of trawling activities). There is a large permanent spatial closure in the southern and eastern areas of the Gulf covering a designated prawn nursery area. This nursery area covers 344 nm^2, approximately 28 % of the Gulf (Morrison et al. 2003).

Historical fishing activities have occurred in shallow water areas containing sponge habitats, but since the early 1980s, the fishery has focused activities to deeper waters to take larger prawns, reducing this interaction. Trawl effort is now focused in the deeper central and north-western areas of the Gulf (see Figure 3.1), over predominantly sand and mud habitats.

Table 13.2. Annual area (nm^2) and per cent of permitted trawl area and whole fishery area trawled by the Exmouth Gulf Prawn Managed Fishery for 2006 – 2013

Year	nm^2	Percent of Permitted Trawl Area	Percent of Whole Fishery
2006	354	43.8	31.1
2007	307.3	38.1	27
2008	368.8	45.7	32.4
2009	311.3	38.6	27.3
2010	340.3	42.1	29.9
2011	334.8	41.5	29.4
2012	172.7	33.9	24
2013	247.1	30.6	21.7

Macroalgal beds are a significant feature of Exmouth Gulf and are considered responsible for the comparatively high levels of productivity despite an apparent lack of nutrient input. Macroalgal beds are predominantly located in the southern reaches and on the periphery of the Gulf in the shallow subtidal and low intertidal limestone pavement regions. The majority of these areas, as well as large areas of seagrass beds, are protected from trawling in the permanent nursery closure. Some areas of high biodiversity such as marginal reefs and sponge gardens can be found within trawlable areas but these may not be permanent structures given the high natural environmental disturbance regime (e.g. storm surges, tides, flooding and cyclones); however, experiments in the NPF have indicated that sessile or slow-moving taxa recover from the effects of intensive trawling within 6 – 12 months (Haywood et al. 2005), and it is likely that benthic habitats in Exmouth Gulf would recover in a similar time frame.

Benthic habitats in the trawl grounds are predominantly mud and sand bottom, which are naturally dynamic as a result of environmental influences. Sediment samples from Exmouth Gulf taken in 2004 suggest that most of trawling activity takes place over coarser sands (Kangas et al. 2007). Research results from a study done over six years in the North Sea, found no effect of trawling activity on abundance and species richness on coarse sands, while

the communities of fine sediments were affected (Queirós, et al. 2006, Van Denderen et al. 2015). The gear is considered to have relatively little impact on these habitats due to the gear restrictions, effort limits and the restricted season, which minimises the impact of the trawl gear and allows for recovery between years.

A number of studies have shown that no significant effects are caused to infaunal communities in areas of similar habitat (sand / mud) where trawling occurs (e.g. Van Dolah et al. 1991; Kaiser & Spencer 1996; Jennings and Kaiser 1998). In southwest WA, Laurenson et al. (1993) compared trawled and untrawled areas using trawl samples and underwater video. Underwater video observation of both areas before and after the completion of a depletion experiment failed to detect any visual impact on the substrate or habitat. Within the Gascoyne Coast Bioregion, Kangas et al. (2007) measured the biodiversity on trawled and untrawled areas and found no significant differences for pooled data between trawled and untrawled sites in Shark Bay, Exmouth Gulf and Onslow (Area 1), with respect to fish and invertebrate abundance, species richness, evenness or diversity. Results from these studies indicate that trawling causes only minor and short-lived impacts to sand / mud habitats, and the restrictions in place within the EGPMF further limit any trawl impacts. The continuity of the fishery over the past 50 + years is also considered to be evidence that the fishery has not had any significant detrimental impacts on habitat structure or function within the Gulf.

13.3.1.1 Habitat Risk Assessment Outcomes

13.3.1.1.1 Sand / Mud

2008 Risk Rating: Impact to Habitat Ecology and Structure (C2 L2) **Low**

Prawn trawling in Exmouth Gulf occurs predominantly over mud and sand habitats. When trawling, ground chains and otter boards make contact with the sea bottom, disrupting organisms within the habitat. Evidence from video footage of trawled areas of Shark Bay suggests that trawling over sand has the effect of flattening this otherwise rippled and three-dimensional substrate, which indirectly affect the species that inhabit this area by changing the nature of their habitat. It should be noted, however, that the mud substrate in Exmouth Gulf is generally comprised of coarser and heavier sediments than Shark Bay and is therefore thought to be more 'resistant' to disturbance by trawling activities than sediments in Shark Bay. Moreover, such exposed seabeds are naturally dynamic as a result of environmental influences, such as cyclones (Kangas et al. 2006).

Thus, the potential impact on the mud and sand habitat on Exmouth Gulf as a result of the prawn trawling operations was considered unlikely to have even a minor consequence due to the following (Kangas et al. 2006):

- Of the area that is permitted to be trawled, only around 30 % of this is actually trawled (due to targeting of known favourable grounds);
- Furthermore, 28 % of the Gulf is permanently closed to trawling; and

- Studies of actual impacts from prawn trawling suggest only minimal impacts to infaunal communities (e.g. Kangas et al. 2007).

13.3.1.1.2 Sponges and Soft Corals

2008 Risk Rating: Impact to Habitat Ecology and Structure (C1 L5) **Low/Negligible**

By virtue of their shape and physical structure, coral and sponge habitats are vulnerable to physical damage from trawling activities. Furthermore, they are slow to recover due to generally slow growth rates.

Current estimates of the amount of soft coral and sponge habitat within Exmouth Gulf suggest that there are only relatively small amounts, particularly in the trawlable areas (Kangas et al. 2006). While sponges may be taken within the trawl nets, the grids is place have been shown to exclude sponges from the trawl nets prior to being landed on the trawl boats.

13.3.1.1.3 Macroalgae and Seagrass

2008 Risk Rating: Impact to Habitat Ecology and Structure (C0 L5) **Negligible**

Macroalgae and seagrass beds in Exmouth Gulf are geographically separated from the actual trawl grounds and are predominantly located in the southern reaches and on the periphery of the Gulf in the shallow subtidal and low intertidal limestone pavement areas.

The majority of these areas are a permanent nursery closure where trawling does not occur. Therefore, it is considered highly likely that the trawling activities of the EGPMF would pose a negligible risk to macroalgal and seagrass habitats (Kangas et al. 2006).

13.3.2 Habitat Management

There is a strategy in place for managing the impact of the EGPMF on benthic habitats. This strategy utilises a number of measures in place under the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* and operational activities (as per the *EGPMF Harvest Strategy 2014 – 2019*) including:

- Limited entry;
- Gear controls;
- Seasonal closures;
- Spatial closures;
- Temporal closures; and
- Reporting.

The EGPMF uses a number of measures to reduce physical impacts of the trawl gear. Otter trawl systems, similar to those used in the EGPMF, have been demonstrated to have the least impact of all forms of trawling (Collie et al. 2000). The trawl gear is also configured in a manner that largely precludes the capture of invertebrate species living on or in the substrate.

The ground chain attached to the net is designed to skim over the sand instead of digging into the seafloor, and immobile and slow-moving benthic organisms are able to avoid capture through a gap (~ 150 mm) between the ground chain and footrope. Some large immobile organisms, i.e. sponges, may be flicked up into the water column by the ground chain and subsequently captured in the net; however, the grids in place have been shown to reduce the capture of sponges in the nets by 95 % (Kangas & Thomson 2004).

Sensitive habitats, such as macroalgae and seagrass, are protected in permanently closed nursery areas along the southern and eastern section of the Gulf. These closed areas also provide protection for a portion of other habitats, such as sand / mud and sponge gardens, that are widespread throughout the Gulf. The input controls in place, such as limited entry, total headrope capacity, seasonal closures and the temporal restrictions of the TPSA further limit any impacts of trawling activities on the various habitats throughout the Gulf.

The harvest strategy includes the long-term management objective: *to ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function*. As such, appropriate performance indicators, reference levels and control rules have been developed for habitats in the EGPMF (DoF 2014a). The habitat performance indicators relate to the extent of the area trawled within the entire fishery area. Exmouth Gulf includes a number of sensitive habitats, which are permanently closed to trawling as part of the nursery area. The limit reference level relates to the extent of fishing within the entire fishery area to account for potential changes in fishing patterns. Fishing effort and distribution is monitored to ensure that no more than 40 % of the total available mud / sand habitats are trawled each year. If a larger area is trawled, then legal trawl boundaries will be amended to regulate for 60 % of mud / sand refuge area. Fishing distribution within the Gulf has continually met this requirement, with only 28 % of the Gulf trawled in 2013 (Sporer et al. 2014).

Significant effort is put into ensuring adequate compliance with management regulations to ensure proper implementation. This includes at-sea and aerial patrols to ensure closed seasons, closed areas and operational rules are being adhered to. The use of the VMS on the vessels also helps the Department monitor vessel location and speed, thus increasing compliance with closures and allowing for an assessment of the total area trawled and intensity of trawling activities throughout the Gulf.

13.3.3 Habitat Information and Monitoring

The spatial extent and intensity of fishing activities throughout the fishery are monitored by the Department using VMS and daily logbooks. This information allows managers to monitor fishing activities in relation to sensitive habitats and track changes in fishing location and intensity over time and is considered sufficient to detect any increase in risk to habitat.

The results from Kangas et al. (2007; biodiversity study) and Lyne et al. (2006; habitat mapping) have provided baseline data for future monitoring and management. A project to increase habitat monitoring in Exmouth Gulf has recently been submitted to the FRDC for funding consideration (see Section 5.3). If granted, the outcomes of the project will include the development of a comprehensive GIS environment, with all available historical habitat

and environmental data for Exmouth Gulf and Shark Bay ecosystems, and the development of new habitat maps for these regions.

13.4 Ecosystem Assessment

13.4.1 Fishery Impacts

Fisheries pose the risk of altering the benthic or demersal communities or changing prey availability through discards, such that food web dynamics shift. The main ecosystem impacts from fishing activities in the EGPMF would be due to the removal of the target species, brown tiger and western king prawns, as these species make up the majority of the catch. The fishing mortality rate of prawns in Exmouth Gulf is relatively low compared to the natural seasonal variability of prawn populations as a consequence of environmental conditions, such as water temperature, currents and natural events, e.g. cyclones (Kangas et al. 2006). Retained non-target ('byproduct') species are taken in relatively small quantities (see Section 10.1) and generally have large distribution ranges (Kangas et al. 2007). Similar to the target prawn species, the fishing mortality rate for retained non-target species in Exmouth Gulf is relatively low compared to the natural seasonal variability of populations as a consequence of environmental conditions.

There are no known obligate predators that are likely to be directly impacted by the removal of adult size prawns or any of the retained non-target species. Most carnivorous predators in Exmouth Gulf are opportunistic and / or scavengers and are not considered dependent on any one species (Kangas et al. 2007). A variety of other small crustacean, invertebrate and fish species live in the Gulf; thus, it is not likely that the commercial take at of prawns or other species current levels will significantly impact on the trophic system within the Gulf.

Bycatch discards result in fish and invertebrates being made available to other organisms that would not normally have access to such a food source. This has the potential to affect the feeding behaviour of some species, particularly predators, and alter the distribution of other species through the water column and at the surface. Given the seasonal duration of the fishery (7 – 8 months), the amount of discards is very minor in terms of the overall productivity of Exmouth Gulf. Also, a considerable proportion of the bycatch is crustaceans and elasmobranchs, which have a high survival rate and do not contribute to provisioning (Kangas et al. 2006). Although many studies have shown that various trophic groups feed on bycatch (e.g. Britton & Morton 1994; Poiner et al. 1999; Wassenberg & Hill 1990), few studies have found direct conclusive evidence of a resultant change in trophic structure. In Exmouth Gulf, there is neither direct scientific evidence nor anecdotal suggestion of changes to the food web from removal of particular species / groups or from food being cycled from the bottom of the sea floor to the surface.

The ecosystem impacts of trawling are well-studied in Australia, including numerous studies in tropical and sub-tropical environments, in particular in the Northern Prawn Fishery (NPF), where research has found no evidence that the fishery affects this ecosystem in a significant way. NPF studies have suggested that the effects of trawling at the current scale of the fishery do not affect overall biodiversity and cannot be distinguished from other sources of variation

in community structure (MRAG Americas Inc. 2012). Similarly, the ecosystem impacts of the EGPMF have been assessed by Kangas et al. (2007). Results from this project indicated that the current level of trawling activities in Exmouth Gulf does not affect overall biodiversity and cannot be distinguished from other sources of variations in community structure (Kangas et al. 2007).

13.4.1.1 Ecosystem Risk Assessment Outcomes

13.4.1.1.1 Removal of all Species

2008 Risk Rating: Impact on trophic structure (C2 L2) **Low**

Exmouth Gulf is a highly productive system, and the impact on the environment by removing the sum of all retained and discarded species is considered to be unlikely to even cause a moderate change to the ecosystem due to:

- The high natural mortality rate of prawns, such that a large percentage of the yearly recruits would already be removed from the system by the end of the season regardless of fishing activities. As a result, the natural variation of prawns is very high, and the effect of removing prawns through fishing would be masked.
- Additionally, there are no known obligate predators of prawns or other retained species that are likely to be directly impacted upon by the removal of these species. A variety of other small crustacean, invertebrate and fish species live within Exmouth Gulf and would be able to fulfil the roles of the removed species.
- Management arrangements ensure that an adequate spawning stock of all prawn species survive to reproduce recruits for the subsequent season through the use of closed areas and seasons.
- Research in this (i.e. Kangas et al. 2007) and similar fisheries that has indicated similar species diversity and abundance in both trawled and untrawled areas (Kangas et al. 2006).

13.4.1.1.2 Discarding Bycatch

2008 Risk Rating: Impact on environment (C2 L3) **Low**

Bycatch results in fish and, to a lesser extent, crustaceans being made available to other organisms that would normally not have access to such a food source. This has the potential to affect the feeding behaviour of some species, particularly predators, and alter the distribution of other species throughout the water column and at the surface. For example, dead fish that sink to the seafloor become available to benthic scavengers, such as crabs. These fish would normally be only available, in that level of abundance, to pelagic predators (Kangas et al. 2006).

Studies on the fate of discards through trophic structure have been examined in other similar fisheries but not in the EGPMF specifically. A number of studies have shown that various trophic groups feed on bycatch:

- In the Great Barrier Reef Trawl Fishery, a study showed that the majority of discards were fish and about 40 % of the fish floated on return to the water. Most of these fish were taken by birds, dolphins and sharks. The discards that sank were considered to be dispersed over the seabed, without causing a measurable impact (Poiner et al. 1999).
- In Moreton Bay, Queensland, Wassenberg and Hill (1987) found that crabs were a dominant scavenger of bycatch from the local prawn trawl fishery, with 30 % of their diet coming from this source. A further study in Moreton Bay also found that trawl discards became the principle food source for three species of seabirds (Wassenberg & Hill 1990).
- In South Australia, the most common scavengers on prawn trawl bycatch were dolphins and sea birds (Svane 2005). Four surveys were undertaken in which skippers recorded the numbers of seabirds and dolphins feeding on discarded bycatch. The mean number of dolphins per boat and observation varied between seasons, with 0.5 – 1.3 dolphins per boat per observation. The occurrence of seabirds varied between sites but not between season and time of night. The largest mean number of seabirds observed on one site was 2.8 seabirds per observation. It was concluded that an estimated 18 – 183 t of discards were consumed per year by dolphins, constituting 0.3 – 2.6 % of the discarded bycatch, while seabirds potentially consumed less than 0.3 % of the discarded bycatch (Svane 2005).

Based on results from the observer program during BRD trials, the ratio of discards to retained species in the EGPMF is about 2 – 5:1. Of this, about 50 % of the fish are dead and sink, therefore becoming available to bottom feeders (Kangas & Thomson 2004). Most of the crustaceans sink but have a relatively high survival rate. The impact of provisioning as a result of discarding bycatch in the EGPMF was considered be a 'moderate' risk as a result of the following factors:

- Although many studies have shown that various trophic groups prey upon bycatch species, few studies have found direct conclusive evidence of a resultant change in trophic structure (see above).
- In Exmouth Gulf, there is neither direct scientific evidence nor any anecdotal suggestion of changes to the food web from the removal of particular groups or species, or from food being cycled from the bottom of the sea floor to the surface.
- The area over which organisms are discarded is large, and therefore any impacts would be diffused. Additionally, a considerable proportion of the bycatch is crustaceans and elasmobranchs, which have a high survival rate and therefore do not contribute to the provisioning. Furthermore, the discards from this fishery are seasonal, as the fishery only operates for eight months of the year.
- While dolphins have been known to follow the prawn vessels for discards, the amount of discards that result in this fishery is not significant. Due to the seasonality of the

fishery, dolphins are still reliant on their normal feeding habits to sustain them throughout the year.

13.4.1.1.3 Creation of Turbidity

2008 Risk Rating: Impact on environment (C0 L5) **Negligible**

The interaction between trawl gear and the sea bottom has the potential to raise sediments into the water column, resulting in increased turbidity. If turbidity resulting from trawling activities was above the natural turbidity range (in terms of either intensity or duration) then there could be implications for the local communities through reduction of light availability for seagrass productivity and / or smothering of benthic organisms, such as corals and sponges (Kangas et al. 2006).

The prawn trawling activities undertaken in Exmouth Gulf are considered 'negligible' in terms of creating a more turbid environment that has the potential to increase the nutrient loading of the ecosystem and cause habitat siltation (Kangas et al. 2006).

This conclusion is made on the basis that the trawl gear design is such that it is not in direct and consistent contact with the substrate and therefore does not disturb the substrate to any significant degree and that the ground trawled in Exmouth Gulf is typically comprised of coarse sediments that do not readily 'silt'. Furthermore, it should be noted that Exmouth Gulf is a cyclone hotspot and is influenced on a regular basis by either direct cyclonic hits or indirectly through swell and wind emanating from other cyclone centres. Consequently, while prawn trawling is not thought to contribute significantly to the level of turbidity in Exmouth Gulf, the Gulf itself is regularly clouded as a result of acute environmental events. The recovery time of Exmouth Gulf following such a cyclonic event is generally dependent on the intensity, duration and rainfall associated with that event (Kangas et al. 2006).

13.4.2 Ecosystem Management

There is a strategy in place that contains measures to address all main impacts of the fishery on the ecosystem. This strategy utilises management measures in place under the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* and operational activities (as per the *EGPMF Harvest Strategy 2014 – 2019*) including:

- Limited entry;
- Gear controls;
- Seasonal closures;
- Spatial closures;
- Temporal closures; and
- Reporting and the use of VMS.

This strategy focuses on minimising impacts on ecosystem through maintaining significant biomass levels of prawns and other retained species in order to minimise the potential for trophic perturbations. Other arrangements, such as gear restrictions, spatial and seasonal closures, a limited number of vessels and continuing monitoring and research also further minimise the potential for ecosystem impacts through reducing potential impacts on the ecosystem components (i.e. retained non-target species, bycatch, ETP species and habitats).

The harvest strategy includes the long-term management objective: *to ensure the effects of fishing do not result in serious or irreversible harm to ecological processes*. As such, appropriate performance indicators, reference levels and control rules have been developed for the Exmouth Gulf ecosystem (DoF 2014a). The ecosystem performance indicators relate to risk assessment outcomes for each ecosystem component and the ecosystem as a whole, the extent of the area trawled in Exmouth Gulf and the annual catch of all retained species.

Within Exmouth Gulf, there is direct information from Kangas et al. (2007) that the fish and invertebrate species on trawl grounds have not been significantly affected compared to the non-trawl grounds. This is clear evidence that the ecosystem has not been affected to any measurable degree, with the closed areas providing protection to those species more vulnerable to trawling. Furthermore, the continuity of the fishery over the past 50 + years is also considered to be evidence that the strategy works, is being implemented successfully and is achieving its objective.

Compliance with the management arrangements is monitored by the Department using at-sea and aerial patrols to ensure closed seasons, closed areas and operational rules are being adhered to. Further evidence that this strategy is being implemented successfully is available in the form of species and VMS monitoring data, as well as changes to monitoring procedures as necessary based on annual performance evaluations. If future studies or monitoring indicate that further management is required, this may be achieved through extending the use of current management tools, such as spatial and temporal closures, targeted harvesting

strategies to optimise expenditure of effort, a reduction in overall fishing effort and the use of mechanical or other devices, such as BRDs and hoppers / handling techniques.

13.4.3 Ecosystem Information and Monitoring

Information continues to be collected on the impacts of the fishery on each of the key ecosystem components at a sufficient level to detect any increased risk. Fishers are required to report all retained species catches, effort, any ETP species interactions and fishing location in daily logbooks. Fishing activities (location and intensity) are also monitored by the Department via VMS.

The long time series of data available for the fishery, along with biodiversity research (i.e. Kangas et al. 2007) in Exmouth Gulf, supports the conclusion that the ecosystem has not been unacceptably impacted by the fishery during the 50 + years of its operation.

Further monitoring activities are provided in the *Exmouth Gulf Prawn Managed Fishery Bycatch Action Plan 2014 - 2019* (DoF 2014b).

MSC Principle 3

MSC Principle 3 relates to the effective management of the fishery under assessment. Within this context, the fishery must demonstrate that it meets all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability (MSC 2013).

14. Governance and Policy

The governance and policy section captures the broad, high-level context of the fishery management system within which the EGPMF is found. This section therefore includes information on:

- The legal and/or customary framework that overarches the fishery, including relevant international treaties, national environmental legislation, national cooperative arrangements, jurisdictional arrangements between the WA State and Commonwealth Governments and the system of governance in WA, including relevant fisheries legislation;
- Consultation processes and policies, as well as the roles and responsibilities of people and organisations within the overarching fishery management system;
- The long-term fishery management objectives; and
- A description of the incentives in place for sustainable fishing within the EGPMF.

14.1 Legal and / or Customary Framework

The management system for the EGPMF exists within an appropriate legal and/or customary framework which ensures that it (1) is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2; (2) observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; and (3) incorporates an appropriate dispute resolution framework.

14.1.1 Compatibility of Laws or Standards with Effective Management

The governance system in place for all WA commercial fisheries, including the EGPMF, is subject to a number of international, national and local (state-level) treaties, policies and pieces of legislation.

14.1.1.1 International Fisheries Jurisdiction and Treaties

On 1 August 1994, the Commonwealth of Australia declared an Exclusive Economic Zone (EEZ) extending from 12 nm to 200 nm from its coastline[19]. Within its EEZ, Australia has sovereign rights to explore and exploit, conserve and manage the natural resources — both living (such as fisheries and genetic material) and non-living (such as oil, gas, minerals).

[19] http://www.daff.gov.au/fisheries/domestic/zone

Australia is a signatory to a number of international agreements and conventions (which it applied within its EEZ), such as:

- *United Nations Convention on the Law of the Sea* (regulation of ocean space);
- *Convention on Biological Diversity and Agenda 21* (sustainable development and ecosystem based fisheries management);
- *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES; protection of threatened, endangered and protected species);
- *Code of Conduct for Responsible Fisheries* (standards of behaviour for responsible practices regarding sustainable development);
- United Nations *Fish Stocks Agreement*; and
- State Member of the *International Union for Conservation of Nature* (marine protected areas).

14.1.1.2 National Environmental Legislation

The EPBC Act[20] is the Australian Government's (hereafter referred to as the 'Commonwealth Government') central piece of environmental legislation. The EPBC Act is administered by the Commonwealth Government's Department of the Environment (DotE) and provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as matters of national environmental significance. The DotE is responsible for acting on international obligations on a national level, by enacting policy and / or legislation to implement strategies to address those obligations.

The Commonwealth DotE, through the Commonwealth Minister, has a legislative responsibility to ensure that:

- All Commonwealth-managed fisheries undergo strategic environmental impact assessment before new management arrangements are brought into effect; and
- All fisheries in Australia from which product is exported undergo assessment to determine the extent to which management arrangements will ensure the fishery is managed in an ecologically sustainable way in the long term.

WA fisheries legislation and policy conforms to overarching Commonwealth Government fisheries and environmental law, including the EPBC Act. WA's commercial export fisheries, including the EGPMF, have been assessed using the Australian National ESD Framework for Fisheries[21], in particular, the *Guidelines for the Ecologically Sustainable Management of Fisheries* (the Guidelines; CoA 2007). Further detail on the Commonwealth Government's ESD policy and the ESD assessment process for the EGPMF is provided in Section 14.3.3.1.

[20] http://www.austlii.edu.au/au/legis/cth/consol_act/epabca1999588/
[21] http://www.fisheries-esd.com

14.1.1.3 State and Commonwealth Fisheries Jurisdictional Arrangements

There are three different statutory entities responsible for the control and management of fisheries off the coast of WA —

- the WA State Government;
- the WA Fisheries Joint Authority; and
- the Commonwealth Australian Fisheries Management Authority[22] (AFMA).

The WA State Government and WA Fisheries Joint Authority-managed fish resources that fall under the jurisdiction of the FRMA are described in a formal agreement between the Commonwealth and State Governments known as the *Offshore Constitutional Settlement 1995* (Brayford & Lyon 1995; OCS 1995). Commonwealth fisheries are managed by AFMA under the Commonwealth *Fisheries Management Act 1991*[23].

The OCS 1995 sets out that the State will manage all trawling on the landward side of the 200 m isobath in WA, and the Commonwealth will manage all deep-water trawling. The EGPMF is managed by the State of WA pursuant to the OCS 1995, as its western boundary is the 200 m isobath. There are no migratory or straddling stock management requirements associated with this fishery.

14.1.1.4 System of Government in WA and Relevant Fisheries Legislation

The Government of WA operates under the Westminster system, and an important tenant of this system is that the responsible Minister makes executive decisions. Insofar as the administration of fisheries in WA is concerned, the relevant executive decision maker is the Minister for Fisheries.

The Department of Fisheries WA (the Department) is established and governed under the State *Public Sector Management Act 1994*[24] (PSM Act) which is administered by the Western Australian Public Sector Commission[25] under the Department of Premier and Cabinet. Departmental staff must act in accordance with the PSM Act and any allegations of official corruption by Departmental staff are handled by the WA Corruption and Crime Commission[26]. The Department is required to report on its performance annually via its *Annual Report to State Parliament* (*Annual Report*).[27]

The Department is principally responsible for assisting the Minister for Fisheries in administering the following Acts and Regulations[28] that apply to the aquatic resources (excluding pearling) located in WA:

- FRMA;
- FRMR;

[22] http://www.afma.gov.au/
[23] http://www.austlii.edu.au/au/legis/cth/consol_act/fma1991193/
[24] http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_771_homepage.html.
[25] http://www.publicsector.wa.gov.au/
[26] http://www.ccc.wa.gov.au/Pages/default.aspx
[27] http://www.fish.wa.gov.au/Documents/annual_reports/annual_report_2012-13.pdf
[28] http://www.slp.wa.gov.au/statutes/subsiduary.nsf/fishlegis?OpenPage

- *Fisheries Adjustment Schemes Act 1987*; and
- *Fishing and Related Industries Compensation (Marine Reserves) Act 1997.*

The FRMA adheres to arrangements established under relevant Australian laws with reference to international agreements as set out in sections 3 and 4A —

Section 3 of the FRMA:

"The objects of this Act are

(a) to develop and manage fisheries and aquaculture in a sustainable way; and

(b) to share and conserve the State's fish and other aquatic resources and their habitats for the benefit of present and future generations."

Section 4A of the FRMA precautionary principle, effect of, states —

"In the performance or exercise of a function or power under this Act, lack of full scientific certainty must not be used as a reason for postponing cost-effective measures to ensure the sustainability of fish stocks or the aquatic environment."

The FRMA deals with broad principles, the provision of head powers and high-level overarching matters; the FRMR and other subsidiary legislation, such as commercial fishery management plans, deal with the details needed to put these matters into practice.

In many cases, the FRMA will specifically require some matters to be dealt with by subsidiary legislation. Subsidiary legislation cannot be inconsistent with the provisions of the FRMA, under which it was made, and must be permitted to be made by a head of power in the empowering Act.

14.1.1.4.1 New WA Aquatic Resources Management Act

In 2010, the (then) Minister for Fisheries directed the Department to investigate and scope the requirements for a new Western Australian Act of Parliament to ensure the sustainable development and conservation of the State's aquatic biological resources into the future.

This review recognised the need for the establishment of a clear statutory basis for commercial and recreational fishing access rights as a component in improving the overall robustness of sustainable fisheries management and improving security of resource access for all fisheries sectors.

A new *Aquatic Resources Management Act* (ARMA) has been drafted to replace the FRMA and is expected to be passed by Parliament during 2015. Importantly the ARMA's proposed framework includes provision for a rights-based management approach for all fishing sectors in the context of aquatic resource management strategies and sectoral harvest strategy plans.

An overview of the proposed new ARMA and the objectives of sustainable fisheries and aquatic management policy and how they relate to national and international fisheries law

and policy are published in DoF (2010). The guiding principles for the proposed ARMA are that it:

- Provides an integrated aquatic resource management framework which incorporates ESD and biodiversity conservation goals;
- Incorporates the precautionary principle more explicitly;
- Broadens the base of the Act to include aquatic ecosystem issues in the management prescriptions;
- Provides a basis for simplifying subsidiary legislation where possible;
- Provides for greater devolution of decision making and delegation where suitable;
- Provides flexibility for more cost-effective management based on more explicit risk assessment;
- Provides explicit head powers to achieve biological and allocation outcomes across all harvest sectors as required; and
- Provides improved security of access for all resource users.

Importantly, the proposed ARMA includes objects to: *"(a) ensure the ecological sustainability of the State's aquatic resources and aquatic ecosystems for the benefit of present and future generations; and (b) to ensure that the State's aquatic resources are managed, developed and used having regard to the economic, social and other benefits that the aquatic resources may provide"*.

14.1.2 Resolution of Legal Disputes

There are well established mechanisms for administrative and legal appeals of decisions taken in respect of fisheries, which are prescribed in Part 14 of the FRMA. Most decisions made by the Chief Executive Officer[29] of the Department and disputes regarding the implementation and administration of fisheries legislation can be taken to the Western Australian State Administrative Tribunal (SAT)[30] for review or the WA (and Commonwealth) Court System[31].

These mechanisms have been used and tested across several fisheries. The decisions of the SAT and the Courts are binding on the Department (for details of decisions see http://decisions.justice.wa.gov.au/SAT/SATdcsn.nsf). All SAT decisions must be carried out by the Department (section 29(5) of the *State Administrative Tribunal Act 2004*[32]).

[29] Note that when exercising his powers pursuant to the FRMA, the Director General of the Department of Fisheries is referred to as the 'Chief Executive Officer'.
[30] http://www.sat.justice.wa.gov.au
[31] http://www.courts.dotag.wa.gov.au/C/courts_history.aspx
[32] http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_918_homepage.html

Criminal offences against the FRMA are dealt with by the Magistrates Courts and a commercial operator or recreational fisher is either found guilty or not guilty.

All changes to, or new, fisheries legislation, including subsidiary legislation such as management plans and orders, are potentially subject to review through the disallowance process of State Parliament.

All subsidiary legislation is also reviewed by the Joint Standing Committee on Delegated Legislation who may seek further advice on the reasons for the legislation, and potentially, move to disallow. In this way, there is Parliamentary and public scrutiny of fisheries legislation. Fisheries legislation is "passed and enacted" when it is gazetted.

This framework applies to the EGPMF. It should be noted that the consultative, educative and partnership approach to management, which is inclusive of all stakeholders, provides informal but effective mechanisms to minimise opportunities for disputes.

14.1.3 Respect for Rights

14.1.3.1 Commonwealth Statutory Native Title Rights

Statutory aboriginal native title rights are managed under the Commonwealth *Native Title Act 1993* (NTA)[33]. A registered native title claim is an application where a decision about native title is yet to be made. A determination of native title is a decision that native title does or does not exist in a particular area of land and / or waters (the determination area). The National Native Title Tribunal[34] facilitates the negotiation of indigenous land use agreements following a claim or determination and is required to keep registers of approved native title determination and native title claims.

A key aspect of the legislation is that proposed developments or activities (including fisheries where a registered claim or determination extends into State waters) that may affect native title are classed as 'future acts'[35]. This requirement has been in place since 1993. In 1999, the Department obtained a 'Report for Fisheries Western Australia' in respect of the interaction between fisheries / pearling legislation and the NTA. That Report advised that:

1. The very wide scope of what can be done under a management plan means that they do have the potential to affect native title. As a result, a new management plan would be considered a 'future act' for the purpose of the NTA.

2. Because a new management plan would be covered by *Native Title Act* s24HA, it can be validly made without the need for any specific native title notification or comment procedure.

3. While specific notification is not required, it would, however, be prudent for comment to be sought from any native title parties likely to be affected by the new management plan under the provisions of the FRMA section 64(2).

[33] http://www.comlaw.gov.au/Series/C2004A04665
[34] http://www.nntt.gov.au/au/Pages/default.aspx
[35] http://www.dpc.wa.gov.au/lantu/FutureActs/Pages/Default.aspx

4. The granting of licences and permits under management plans will not be future acts in their own right, and they can therefore be granted without the need for any native title procedure or notification requirement.

In accordance with point 3 above, the Department provides any native title party, or parties, with an opportunity to comment on the development of a proposed fishery.

There is a registered Native title claim that includes the waters of Exmouth Gulf (WAD161/98)[36] by the Gnulli people, who are represented by the Yamatji Marlpa Aboriginal Corporation.[37] There is no indigenous land use agreement in place at this time. While the management plan for the EGPMF was established before 1993, the native title claimants are recognised as stakeholders.

A recent Australian High Court decision related to the application of State fisheries law to native title holders fishing for abalone in their local area in South Australia.[38] The decision concluded that the State fisheries legislation did not extinguish native title rights to fish and that the defence under section 211 of the NTA was applicable. It is therefore unlikely that fisheries legislation in WA has the effect of extinguishing native title rights to fish and that the defence provided by section 211 of the NTA will apply to most cases where the right being exercised is for a traditional, non-commercial purpose and where the person is in fact, an Aboriginal person.

14.1.3.2 Customary Fishing in WA

There are relatively large Aboriginal communities within the Gascoyne Coast Bioregion, and fishing is a popular activity. People of Aboriginal descent do not need a recreational fishing licence if fishing using traditional methods.

The WA Government and the Department are committed to working with the customary fishing sector to recognise customary rights. Section 6 of the FRMA acknowledges the rights of Aboriginal persons fishing for a customary fishing purpose —

"Aboriginal persons, application of Act to

An Aboriginal person is not required to hold a recreational fishing licence to the extent that the person takes fish from any waters in accordance with continuing Aboriginal tradition if the fish are taken for the purposes of the person or his or her family and not for a commercial purpose."

The FRMA defines customary fishing as:

"fishing by an Aboriginal person that —

(a) is in accordance with the Aboriginal customary law and tradition of the area being fished; and

[36] http://www.dpc.wa.gov.au/lantu/Claims/Geraldton/Pages/Default.aspx
[37] http://ymac.org.au/
[38] http://www.hcourt.gov.au/assets/publications/judgment-summaries/2013/hca47-2013-11-06.pdf

(b) is for the purpose of satisfying personal, domestic, ceremonial, educational or non-commercial communal needs."

The FRMA also provides the power to make regulations to manage customary fishing.

The Department released a policy position statement in 2009 relating to customary fishing in WA (DoF 2009), which states that customary fishing applies, within a sustainable fisheries management framework, to persons of Aboriginal descent who are fishing in accordance with the traditional law and custom of the area being fished and fishing for the purpose of satisfying personal, domestic, ceremonial, educational or non-commercial communal needs.

Further details regarding social aspects of customary fishing in WA can be found in Fisheries Management Paper 168 (2003) *Aboriginal Fishing Strategy - Recognising the Past, Fishing for the Future*[39].

To date, the only survey designed to document the Indigenous catch was the National Recreational and Indigenous Fishing Survey carried out in 2000/01 (Henry and Lyle 2003). While this survey did not present data separately for regional WA, what is clear from this report is that the vast majority of the Indigenous catch is from inland and coastal waterways.

Under the proposed ARMA, a quantity of a specified aquatic resource[40] will be reserved for conservation and reproductive purposes, then setting a sustainable allowable harvest level for use by the fishing sectors. The quantity "reserved" also includes an allowance for Customary fishing and public benefit purposes, such as scientific research. This means that a specific share does not have to be allocated to the Customary sector, as that share is set aside prior to setting an allowable harvest level for the resource, and Customary fishing can continue in accordance with existing Customary fishing arrangements.

Integrated Fisheries Management (IFM) is a Government initiative adopted in 2004 aimed at making sure that WA's fish resources continue to be managed in a sustainable way in the future. IFM recognises the rights of customary fishers of Aboriginal descent who are fishing for cultural needs. Given there is no evidence of Indigenous (or recreational) fishing for prawns in Exmouth Gulf, there is no requirement to implement IFM to manage the catch share of prawns between sectors in Exmouth Gulf; however, the customary fishing framework still applies.

14.2 Consultation, Roles and Responsibilities

The management system for the EGPMF has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties.

[39] http://www.fish.wa.gov.au/Documents/management_papers/fmp168.pdf
[40] In this context "aquatic biological resource" may refer to a single species of fish, or a number of species or species groups. The resource may also be defined by area. Several "fisheries" and sectors may operate on a resource.

14.2.1 Department of Fisheries

There is explicit definition of the roles and responsibilities of the Commonwealth's DotE as discussed above. The role and responsibilities of the State of WA in fisheries management is explicitly outlined in the *Western Australian Government Fisheries Policy Statement March 2012* (DoF 2012a) and in the OCS 1995 arrangements, particularly in relation to the management of trawl fisheries.

The members of the Department's Corporate Executive and an organisational chart are published in the Department's *Annual Report*. With respect to the EGPMF, key personnel to whom the responsibility of ensuring management, research and compliance outcomes, including proper prioritization of Departmental funding, include:

- Gascoyne / Northern Bioregion Program Manager (Aquatic Management Division);
- Gascoyne / Northern Bioregion Principal Management Officers (Aquatic Management Division);
- Gascoyne / Northern Bioregion Fisheries Management Officers (Aquatic Management Division);
- Supervising Scientist – Invertebrates (Research Division);
- Senior Scientist – Invertebrates (Research Division);
- Gascoyne Bioregion Compliance Manager (Regional Services); and
- Gascoyne Bioregion Regional Manager (Regional Services).

Planning and prioritisation is done in conjunction with the Chief Executive Officers of the peak sector bodies for the commercial and recreational sectors (where relevant) in WA:

- the Chief Executive Officer of WAFIC[41]; and
- the Chief Executive Officer of Recfishwest[42].

The Department or Minister is responsible for advising licensees and WAFIC of Ministerial / Department decisions which are the subject of a consultation process. Responsibilities of the Department in formal consultation arrangements with WAFIC include that it

- Provides annual funding to WAFIC equivalent to 0.5 % of WA commercial fishing gross value of product (based on a three year average), plus a pro-rata amount equivalent to 10 % of water access fees paid by aquaculture and pearling operators. Payments to WAFIC are made by six monthly instalments each year (see Section 0 for further information about the funding model);
- Works with WAFIC in a manner consistent with WAFIC's role as the peak body representing commercial fishing interests in WA; and

[41] http://www.wafic.org.au/
[42] http://www.recfishwest.org.au/

- Engages with WAFIC, sector bodies and commercial fishing interests according to WAFIC Operational Principles contained in Table 14.1.

Table 14.1. WAFIC's Commercial Fisheries Consultation Operational Principles

Principle	Responsible Body	Example
On generic policy issues which could affect, as a whole, the commercial fishing, aquaculture, and pearling industries	WAFIC	Bioregional marine planning; safety, education and training; research and development policy and biosecurity
On policy issues which currently primarily affect one sector but which could have implications for the broader industry	WAFIC will nominate the relevant sector body and WAFIC and that body will jointly represent industry.	WAFIC would represent industry on marina and port access issues which may primarily initially impact on the fishing industry in regard to certain locations but have precedents for the rest of the industry for other locations; and on animal welfare.
On issues which affect only one specific industry group.	The relevant sector association would represent itself but WAFIC would be kept informed and may have a statutory consultation role.	Regulation of gear design or compliance (WAFIC and specific industry associations).

The Department or Minister is also responsible for ensuring that the recreational fishing sector, through Recfishwest, is formally consulted on proposed changes to recreational fisheries management and is advised of Ministerial / Department decisions which are the subject of a consultation process. The Minister is responsible for providing Recfishwest with a proportion of the income generated from annual recreational fishing licence fees to undertake it role as the peak body representing recreational fishing interests in WA.

The Department or Minister may seek and provide advice directly through peak bodies (WAFIC and Recfishwest) and / or sector associations. For example, WAFIC and Recfishwest, have direct input into the annual planning and priority setting process used to determine management, compliance, research and other priorities.

14.2.2 Peak Sector Bodies

The WA Government formally recognises WAFIC and Recfishwest as the key sources of coordinated industry advice for the commercial and recreational sectors, respectively (DoF 2012a).

14.2.2.1 WAFIC

WAFIC is an incorporated association and the peak industry body representing professional fishing, pearling and aquaculture enterprises, as well as processors and exporters in WA. It was created by the industry more than forty years ago to work in partnership with Government to set the directions for the management of commercial fisheries in WA.

WAFIC aims to secure a sustainable industry that is confident:

- of resource sustainability and security of access to a fair share of the resource;
- of cost-effective fisheries management;
- that its businesses can be operated in a safe, environmentally responsible and profitable way; and
- that investment in industry research and development is valued and promoted.

WAFIC provides a monthly newsletter[43] to subscribers and publishes annual reports and financial information[44].

WAFIC's responsibilities include coordinating Government funding for industry representation and taking on a leadership role for matters which involve or impact on or across a number of fisheries, or are of an industry-wide or generic nature. WAFIC also represents those commercial fishing sectors that do not have capability of self-representation.

WAFIC's responsibilities can be summarised as:

- Providing effective professional representation of commercial fishing interests and the commercial fishing sector to Government, industry, other relevant organisations and the community;
- Providing professional advice to the Government and industry members on issues affecting commercial fishing;
- Engaging, facilitating and consulting as necessary in order to deliver the above;
- Providing representation of commercial fishing interests on fisheries management and Ministerial committees, as required;
- Documenting priority issues for commercial fishing interests by 30 March each year to the Department;
- Providing feedback to the Department on proposed deliverables and budget priorities for expenditure of the Fisheries Research and Development Account;
- Engaging with Recfishwest and other appropriate parties with a view to identifying joint priorities and solutions to issues of shared concern;
- Engaging in promotion, education and awareness of key sustainability messages consistent with best practice fisheries management and objects of the FRMA; and
- Conducting agreed activities that are consistent with the FRMA as it relates to the provision of assistance to, or promotion of, the fishing industry[45].

In carrying out the consultation functions on matters referred to it by the Minister or Department, WAFIC must:

[43] http://www.wafic.org.au/images/stories/WAFIC_Mar_2014_Newsletter.pdf
[44] http://www.wafic.org.au/about-wafic/publications/annual-reports
[45] Consistent with s. 238 (5) (l) of the *Fish Resources Management Act 1994*

- Distribute proposed changes to management arrangements including the Minister's / Department's reasoning for the proposal(s) and the information on which the proposal(s) is based to all licence holders in the relevant fishery;
- Describe the method by which licence holders may put their views;
- Ensure that licence holders have a reasonable period in which to consider their position and respond; and
- Ensure that the decision maker is fully aware of the views being put forward, so the decision maker gives proper and genuine consideration to the views being put forward.

14.2.2.2 Recfishwest

Similar roles and responsibilities exist with Recfishwest as the peak body for the recreational sector. Recfishwest is an incorporated association and receives 15 % of the revenue raised from recreational fishing licence fees to advocate for, and represent, the recreational fishing sector. Key roles undertaken by Recfishwest include consultation on management reforms, advocating for the sector on issues of significance, education, and oversee recreational fishing initiatives.

Recfishwest's monthly electronic newsletter reaches over 50 000 recreational fishers, keeping subscribers up to date with recreational fishing initiatives, research results and issues affecting the recreational fishing sector.

14.2.2.3 Licensees / Sector Associations

The licence holders in the fisheries have a responsibility to make themselves aware of the fisheries legislation that relates to their activities as it changes from time to time. In order to fulfil this responsibility, the Department assists licence holders by explicitly reminding them in writing of where they can access the latest legislation. This information can be found on every licence (e.g. MFLs, CFLs and FBLs).

14.2.2.4 Other interests

The prawn resources targeted by the EGPMF are not taken in any major numbers by recreational or customary fishers; however, other interested stakeholders are recognised on the basis that the fishery:

- has the potential to impact on ecosystem components, including ETP species and habitat;
- targets a species susceptible to changes in environmental conditions;
- currently has a Native Title claim within its boundaries;
- has the potential to interact with other marine users in Exmouth Gulf;
- may be impacted upon by mining activities; and

- provides an iconic seafood product to retailers and consumers both locally and overseas.

Based on these aspects of the fishery, other interested stakeholders relevant to the EGPMF include:

- Organisations / institutions undertaking research relevant to Exmouth Gulf and environmental factors (e.g. WAMSI[46], universities and CSIRO[47]);
- Local Government and State Government agencies (e.g. Department of Parks and Wildlife[48]);
- Conservation sector representatives (e.g. Conservation Council of WA[49]);
- Native Title claimant and their representatives (Gnulli people, represented by the Yamatji Marlpa Aboriginal Corporation);
- Local government (Shire of Exmouth);
- Investors, banking representatives, boat brokers, etc.;
- Retailers and consumers; and
- The wider community.

14.2.3 Consultation Processes

The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge, and the system demonstrates consideration of information and explains how it is used or not used.

The WA Government's commitment to consultation with stakeholders is set out in the *Western Australian Government's Fisheries Policy Statement* of 2012 (DoF 2012a). The broad consultation framework was developed following the outcome of a 2009 review of consultation arrangements between the fishing sector and Government that incorporated the following objectives:

1. Enhanced efficiency, cost effectiveness and flexibility;
2. Clarification with respect to
    a. fishing sector representation;
    b. expertise based advice to the Department; and
    c. the Department of Fisheries as the primary source of management advice to the Minister for Fisheries.
3. Enhancement of the Department's engagement with industry, stakeholders and the public.

[46] http://www.wamsi.org.au/
[47] http://www.csiro.au/
[48] http://www.dpaw.wa.gov.au/
[49] http://ccwa.org.au/

The review[50] process resulted in:

- The replacement of Management Advisory Committees (MACs) with two key sources of advice: the Department as the key source of Government advice on fisheries management and WAFIC and Recfishwest as the key sources of coordinated industry advice for the commercial and recreational sectors, respectively.

- Recognition of WAFIC as the peak body representing the commercial fishing sector (including pearling and aquaculture), with funding provided by Government to support WAFIC in this role.

- Recognition of Recfishwest as the peak body representing the recreational fishing sector, with funding provided by Government to support Recfishwest in this role.

- Establishment of an Aquatic Advisory Committee (AAC) to provide independent advice to the Minister or the Department on high-level strategic matters.

- The establishment by the Minister (or Department) of tasked working groups to provide advice on specific fisheries or operational matters. Tasked working groups differ to MACs in that they are expertise based and operate on the basis of a written referral on a specific matter. Tasked working groups have been established in the past to provide advice on matters such as water access (lease) fees, strengthening of access rights in the fisheries legislation, development of a Government fisheries policy statement, and determining catch shares among sectors.

- Capacity for peak bodies to perform consultation functions on behalf of the Minister. In this regard, the Department has entered into a Service Level Agreement (SLA) with WAFIC for the provision of specified consultation services with the commercial sector.

Figure 14.1 provides a diagrammatical representation of the broad consultation framework for fisheries management in WA that resulted from the review.

[50] See Report of the Consultation Working Group at- http://www.fish.wa.gov.au/Documents/occasional_publications/fop073.pdf

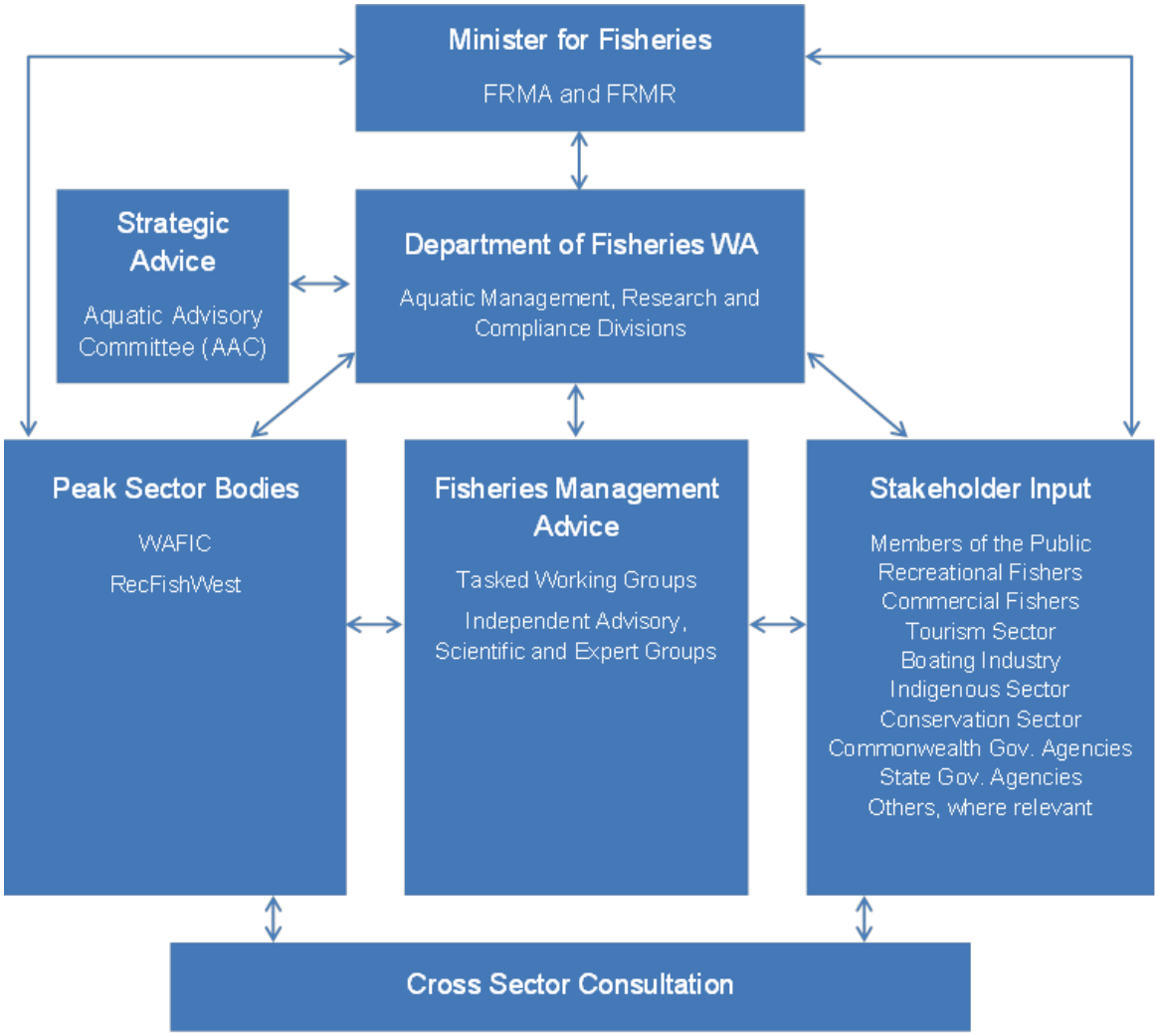

Figure 14.1. Department of Fisheries WA Consultation Framework

14.2.3.1 Statutory Consultation

Given the commercial aspects of fishing access rights and the potential for amendments to management arrangements to adversely affect these interests, it is fundamental that the interest holders are consulted, have the opportunity to respond to any proposed amendments by the Minister / Department and have these responses genuinely considered by the Minister prior to the final decision.

Most management changes and fishing arrangements in the EGPMF are facilitated through amendments to the fishery's management plan and by notices determined by the Department's Director General (DG; also referred to as the CEO under the FRMA); however, other arrangements can be implemented via section 43 orders, licence conditions and (section 7) exemptions, as required. The Minster is the final decision-maker in determining or amending legislation. The Department generally undertakes consultation work on the Minister's behalf; however, the statutory consultation function is presently conducted by WAFIC on behalf of the Department under an SLA.

Amendments to a fishery management plan cannot be undertaken without addressing statutory consultation requirements pursuant to section 65 of the FRMA[51], with each fishery management plan explicitly identifying the key stakeholders for the fishery that the Minster must consult with prior to making an amendment. It should be noted that, since there is no longer a Joint Trawl Management Advisory Committee as a result of the consultation review detailed in Consultation Processes section above, the key stakeholder in the EGPMF defaults to the licence holder.

The EGPMF is opened annually pursuant to clause 10 of the Management Plan. The Department consults with the licensee prior to providing advice to the Chief Executive Officer who must provide notice of his decision to the licensee in writing. For the implementation of other statutory fishing management tools, such as section 43 orders or section 7 exemptions, statutory provisions are silent as to procedural consultation requirements; nevertheless, the Minister must have regard for common law principles to afford natural justice to the licence holder. The Department has a series of formal decision-making delegations for licensing decisions and exemptions from legislation. Most Departmental decisions (excluding Ministerial decisions) are subject to review by the State Administrative Tribunal.

14.2.3.2 Obtaining Information

The Department / Minster may seek advice from a number of sources, including external expert advice and internal management advice, when considering policy or management changes. Collaborative research projects using expert advice on data and other information are often sought and underpin management changes.

The Department / Minister may also seek and provide advice directly through the peak sector bodies (WAFIC and Recfishwest) and / or other sector associations. For example, WAFIC and Recfishwest have direct input into the annual planning and priority-setting process used to determine management, compliance, research and other priorities for the Department.

14.2.3.2.1 Strategic Advice

An Aquatic Advisory Committee (AAC) provides independent advice to the Minster / Department on high-level strategic matters. This committee consists of members who have strong backgrounds in governance and policy.

14.2.3.2.2 Fisheries Management Advice

Fisheries management advice may be provided by tasked working groups and / or independent advisory, scientific and expert groups. Tasked working groups and panels can be established by the DG or the Minister to provide independent, expert advice relating to a range of fisheries management matters. Working groups are highly flexible and work to specific terms of reference within a particular timeframe. They are usually provided with a

[51] Note that section 65(4) of the FRMA provides for the Minister to amend a management plan without consultation if, in the Minister's opinion, the amendment is required urgently or is of a minor nature (but must provide advice following the amendment of the plan). This might include the need for amendments for emergency sustainability reasons.

specified task, such as addressing resource access (e.g. closures and compensation) and allocation (e.g. IFM) or reviewing research, management or Government policy.

14.2.3.2.3 Stakeholder Input

The Department / Minister is responsible for advising licensees and WAFIC of management decisions that are the subject of a consultation process. In carrying out the consultation functions on matters referred to the organisation by the Minister or the Department, WAFIC must:

- Distribute proposed changes to management arrangements that include the Minister's / Department's reasoning for the proposal(s) and the information on which the proposal(s) is based to all licence holders in the relevant fishery;
- Describe the method by which licence holders may provide their views; this may be by way of inviting written responses, or it may involve additional processes, such as the establishment of appropriate forums in which licence holders can discuss and deliberate on the merits of proposed changes prior to putting forward individual views as well as collective views, where appropriate;
- Ensure that licence holders have a reasonable period in which to consider their position and respond; and
- Ensure the decision maker is fully aware of the views being put forward, in order to ensure the decision maker gives proper and genuine consideration to the views being put forward.

The Department has a general practice of holding regular (often annual) management meetings with fishery licensees to discuss research, management, compliance and other specific issues affecting the fishery (e.g. marine park planning). These management meetings underpin the decision-making process at the fishery-specific level. These meetings are generally coordinated by WAFIC (under the SLA), with the location, timing and priority of the annual management meeting determined by the WAFIC Industry Consultation Unit (ICU) in liaison with relevant Departmental resource managers. The meeting can occur at any time of year but is usually held either before the start of a licencing year or at the end of a fishing year, in accordance with the schedule agreed upon by WAFIC and the Department.

The meetings are attended by Departmental personnel, WAFIC and licence holders, but can also be open to other stakeholder groups, e.g. Recfishwest, processors, universities, other Government departments, the conservation sector and the general public, following appropriate consultation with industry.

The annual management meetings are widely recognised by the commercial licence holders as a mechanism for receiving the most up-to-date scientific advice on the status of the fishery, facilitating information exchange between stakeholders and decision-makers and for discussing new and ongoing management issues. The invaluable information licensees provide to the Department at these forums is considered when making research, management and compliance decisions. Because there is only one company operating in the EGPMF,

formal management meetings are held on an "as needs" basis (but are generally held annually).

14.2.3.3 Other Consultation Processes

The Department may also hold meetings, workshops or consult in writing with stakeholders on an "as needs" basis on a range of fisheries management matters including:

- Updates on the implementation of the ARMA;
- Ministerial decisions regarding the EGPMF or wider commercial fisheries' policy and management;
- Risk assessment workshops;
- ESD accreditation, including conditions and reassessments;
- Intra and inter-sectoral access, allocation and conflict issues;
- Impacts of other State Department policies (e.g. marine park planning or mining activities);
- Implementation of new initiatives (e.g. MSC accreditation, new mobile applications);
- Expert review workshops;
- FRDC project steering committee representation[52];
- Published research results;
- Release of discussion papers that seek stakeholder input; and
- Implementation of IFM, where relevant.

When specific issues arise that involve particular stakeholder groups, there is consultation with them. The EGPMF is unique in that a co-operative real-time management framework exists which underpins some of the decision making. To ensure interested stakeholders understand this process both the annual and in-season consultation processes for the EGPMF have been documented in the fishery's Harvest Strategy, which is available on the Department's website (DoF 2014a).

14.2.4 Participation

The existing system for consultation includes both statutory and non-statutory opportunities for interested stakeholders to be involved in the management system.

The consultation processes undertaken by the Department ensures that stakeholders and the broader community have an increased awareness of and access to relevant information regarding fisheries management decisions. The Department encourages input from stakeholders and the broader community in the management process and facilitates their involvement by making all relevant information available and providing for discussion and the exchange of ideas.

[52] http://www.fish.wa.gov.au/Documents/research_reports/frr160.pdf

WAFIC and Recfishwest are also responsible for seeking advice from their sector members during consultation periods and providing consolidated advice to the Department. Both organisations provide a monthly newsletter to subscribers, keeping them up-to-date with new initiatives, research results and issues. News and other relevant information is also publically-available on their WAFIC and Recfishwest websites (www.wafic.org.au and www.recfishwest.org.au, respectively).

Before making a decision around aquatic resource policy, the Minister for Fisheries must demonstrate that they have asked for, and taken into account, interested and affected parties' submissions on policy proposals.

The release of Fisheries Management Papers (FMPs; discussion papers) for public comment are the most common way the Department undertakes wider consultation and invites stakeholder engagement on fisheries management proposals. Published FMPs detail the recommended management approach arising out of the expert review process and seeks public comment on those recommendations. The Minster is required to take these comments into account before a decision is made in respect to future management.

The Department encourages stakeholder comment in regard to any proposed management recommendations and publicises the release of Fisheries Management Papers. To ensure coverage and engagement during the consultation period with stakeholders and the wider community, the Department uses a variety of processes including:

- Direct consultation in writing;
- Press releases;
- Newspaper, radio and television interviews;
- Information posted on the Department's website information;
- Inviting stakeholders to sit on tasked working groups, scientific reviews / workshops, risk assessments and management reviews.

These processes ensure that stakeholders and the community more generally have an increased awareness and access to relevant information. Making information available and providing for a discussion and exchange of ideas encourages input from stakeholders and the community in the management process.

14.3 Long-Term Objectives

The fisheries management legislation and policy in WA has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria and incorporate the precautionary approach.

The WA Government has set a long-term overarching objective that is underpinned by the principle of social and environmental responsibility *to ensure that economic activity associated with aquatic resources is managed in a socially and environmentally responsible*

manner for the long-term benefit of the State. This objective is explicit in both fisheries legislation and management policy, as described below.

14.3.1 WA Fisheries Legislation

Sections 3 and 4 of the FRMA set out the overarching long-term sustainability strategy (including a precautionary approach) for fisheries and the aquatic environment in WA. The broad scope of the legislation ensures that it —

- Manages all factors associated with fishing (incorporating ESD and EBFM);
- Provides a clear basis for management of a whole biological resource (as opposed to just one sector);
- Gives effect to IFM by
    - Creating head powers that can establish management strategies with clear biological outcomes for all sectors, as required;
    - Establishing formal harvest allocations where these have been made; or
    - Describes the basis of informal allocations where these operate.
- Clearly distinguishes between managed aquatic resources and fisheries with biological targets and socially-regulated fisheries.

As set out in section 3, the objects of the FMRA are to:

"(a) to develop and manage fisheries and aquaculture in a sustainable way and (b) to share and conserve the State's fish and other aquatic resources and their habitats for the benefit of present and future generations."

The FRMA outlines the following means to achieve these objectives, including:

- *"Conserving fish and protecting their environment;*
- *Ensuring that the impact of fishing and aquaculture on aquatic fauna and their habitats is ecologically-sustainable and that the use of all aquatic resources is carried out in a sustainable manner;*
- *Enabling the management of fishing, aquaculture, tourism that is reliant on fishing, aquatic eco-tourism and associated non-extractive activities that are reliant of fish and the aquatic environment;*
- *Fostering the sustainable development of commercial and recreational fishing and aquaculture, including the establishment and management of aquaculture facilities for community or commercial purposes;*
- *Achieving the optimum economic, social and other benefits from the use of the fish resources;*

- *Enabling the allocation of fish resources between users of those resources, their reallocation between users from time to time and the management of users in relation to their respective allocations;*
- *Providing for the control of foreign interests in fishing, aquaculture and associated industries; and*
- *Enabling the management of fish habitat protection areas and the Abrolhos Islands reserve."*

Additionally, section 4a of the FRMA outlines the use of the precautionary principle in fisheries management:

"*In the performance or exercise of a function or power under this Act, lack of full scientific certainty must not be used as a reason for postponing cost-effective measure to ensure the sustainability of fish stocks or the aquatic environment.*"

The proposed ARMA more-explicitly incorporates broader ESD and biodiversity conservation goals, with objects to:

"(a) ensure the ecological sustainability of the State's aquatic resources and aquatic ecosystems for the benefit of present and future generations; and (b) to ensure that the State's aquatic resources are managed, developed and used having regard to the economic, social and other benefits that the aquatic resources may provide."

In order to effectively deal with community expectations for aquatic resource management, these legislative objectives have been translated into clearly-defined operational arrangements and procedures for each resource / fishery in the form of a fishery- or resource-specific harvest strategy. The harvest strategy is used to implement adaptive and precautionary approaches to fisheries management and includes the identification of harvesting approaches, the establishment of precautionary reference points and harvest decision and control rules that describe how fishing exploitation should be adjusted as a function of changes in spawning potential or stock size (DoF in press).

The *EGPMF Harvest Strategy* (DoF 2014a) includes fishery-specific objectives that align with those prescribed under the FRMA (and proposed ARMA), as well as clear and specifically-articulated performance levels and the associated management actions designed to achieve these objectives.

Performance against social and economic objectives is measured regularly. Commercial fisheries' gross value of production and rates of employment are reported annually in the *Status Reports of the Fisheries and Aquatic Resources of WA: the State of the Fisheries* (e.g. Fletcher & Santoro 2013). Other indicators of acceptable performance for social and economic objectives include maximising the opportunity for commercial fisheries to operate viably within a sustainable framework, high levels of licensee satisfaction, low levels of inter-sectoral conflict, appropriate areas put aside for aquatic conservation and appreciation, stakeholder satisfaction surveys, initiatives to benefit recreational fishers and the availability of fresh, locally sourced fish to the retail sector and community.

14.3.1.1 Efficiency Indicators

Government's desired outcome for the Department is the conservation and sustainable development of the State's fish resources. The Department has developed effectiveness and efficiency indicators to show the extent to which the Department achieved its goal of conserving and sustainably developing the State's aquatic resources. Performance against these indicators is reported annually in the Department's *Annual Report*.[53]

The Internal Audit Committee maintains and manages the Department's internal audit function on behalf of the Director General. The committee assists the Director General to identify and quantify risks that have the potential to impede the Department in achieving its goals, and to guide the development and implementation of risk-mitigation strategies.

14.3.1.2 Strategic Plan 2009 – 2018

The Department's *Strategic Plan 2009 - 2018* (Phase 3 2013 – 2015)[54] sets out clear and explicit long-term biological, ecological, social and economic objectives. These include:

- Sustainability — to ensure WA's fisheries and aquatic resources are sustainable and to provide services based on risk to ensure fish for the future and support the maintenance of healthy aquatic ecosystems;
- Community Outcomes — to achieve an optimum balance between economic development and social amenity in accordance with a framework to achieve sustainability;
- Partnerships — to promote effective strategic alliances and community stewardship; and
- Agency Management — deliver services on behalf of Government in accordance with the Department's statutory requirements to achieve effective and efficient use of resources to support the delivery of our strategy.

The *Strategic Plan 2009 - 2018* also sets out the strategies and key deliverables and Divisions of the Department that are responsible for delivery and is reviewed on a regular basis.

The Research Division of the Department has established a Research Strategic Plan that is focused on achieving research outcomes against the objectives listed above. Further information on the integration of the Research Strategic Plan into the fishery-specific management system is provided in Sections 15.4 and 15.5.

14.3.1.3 Fisheries Policy Statement 2012

The Government's fisheries and aquatic resource policy is set out in broad terms in *Western Australian Government Fisheries Policy Statement March 2012* (DoF 2012a). The Policy Statement focuses on the Government's approach to sustainable resource management, fisheries and aquaculture development and growth, and appropriate structures and processes to ensure good governance is achieved in:

[53] http://www.fish.wa.gov.au/Documents/annual_reports/annual_report_2012-13.pdf
[54] http://www.fish.wa.gov.au/Documents/corporate_publications/strategic_plan_2009-2018_phase3.pdf

- aquatic resource management;
- aquatic resource access and allocation;
- aquatic environmental management
- marine planning;
- development and growth; and
- structures and processes (e.g. administration).

14.3.1.4 Improving Access Rights

In June 2010, the Minister for Fisheries announced that he would be establishing a working group to provide him with advice on elements of policy that related to the improvement of commercial fishing access rights. The Access Rights Working Group's report to the Minister is published in Fisheries Occasional Publication 102 (November 2011): *Improving Commercial Fishing Access Rights in Western Australia - Access Rights Working Group Report to the Hon Norman Moore, MLC Minister for Fisheries*[55].

The Access Rights Working Group proposed that the ARMA should be structured around the concept of rights-based fisheries management, and make specific provision for establishing and managing these rights in a robust and integrated manner. It also recommended that a new system for the creation, trading and administration of fishing access rights (fishery shares) discrete from fishing activity (fishing permits) should be created.

The FRMA was amended in 2011 to incorporate some short term changes to existing legislation and administrative practice which provided some immediate improvements to the trading aspects of fishing rights created under Part 6 (Management Plans) of the FRMA. Specifically, the amendments improved the transferability, security and duration characteristics of fishing access rights created under the FRMA within the existing rights management approach.

14.3.2 Resourcing the Ability to Meet Long-Term Objectives

The costs of managing the aquatic resources, including conducting research, are met from a variety of sources. In particular, significant contributions can come from:

- Commercial fishing licence fees;
- State Government Consolidated Revenue;
- the Fisheries Research and Development Corporation;
- the Recreational Fishing Account (from recreational fishing licence fees);
- the National Heritage Trust;
- the Western Australian Marine Science Institution;

[55] http://www.fish.wa.gov.au/Documents/occasional_publications/fop102.pdf

- Australian Research Council linkage grants;
- the Natural Resource Management Rangelands Catchment Coordinating Group;
- the Commonwealth Scientific and Industrial Research Organisation; and
- Commonwealth World Heritage Funding.

There is a commitment from the Department to meet the cost of development and implementation of management outcomes and ensuring adequate compliance by fishers with new and existing management initiatives. Government consolidated revenue provided $ 48.4 million of the Department's income in 2012/13 (*Annual Report*[56]).

From 1 July 2010, managed commercial fisheries were subject to a new funding model[57] which replaced a cost recovery system. The new funding model aimed at improving flexibility for resourcing priority management needs, equity in how much licensees pay in access fees and greater certainty of funding and access rights. This involves managed commercial fisheries in WA paying an access fee equivalent to 5.75% of the gross value of production (GVP) of the respective fishery. Commercial fishery access fees contributed $ 16.2 million to the Department's income in 2012/13.

As part of these arrangements, Government also agreed to contribute the equivalent of 0.5 % of managed commercial fishery GVP to WAFIC, to support its role as the peak body, and the equivalent of 0.25 % of GVP to the Fisheries Research and Development Corporation (FRDC)[58].

The recreational fishing sector also contributes to the cost of managing recreational fishing through recreational fishing licence fees (via a Recreational Fishing Account established under the FRMA)[59]. The Recreational Fishing Account is used to address management, compliance and research relevant to recreational fishing, and where appropriate, co-funds programs that deal broadly with issues that can cross sectors. Recreational fishing licence fees contributed over $ 6 million in 2012/13.

The Department also receives revenue from sources other than access fees that can be used to meet the cost of fisheries or more general ecosystem research. In particular, the FRDC is a significant source of funds for many research projects in WA. Other sources of funding are the Western Australian Marine Science Institution (WAMSI), Australian Research Council linkage grants with a university partner (University of Western Australia, Murdoch University, Edith Cowan University or Curtin University) and the National Heritage Trust. Where funding is sought from outside sources, such as FRDC, the Department cannot ensure that applications will be accepted and that funding will be secured. Grants and other income from outside sources contributed $ 6.4 million of the Department's income in 2012/13.

[56] http://www.fish.wa.gov.au/About-Us/Publications/Pages/Annual-Report.aspx
[57] For further information on the new access fees see http://www.fish.wa.gov.au/sec/com/lic/index.php?0205.
[58] http://www.fish.wa.gov.au/sec/com/lic/index.php?0205
[59] http://www.fish.wa.gov.au/docs/media/index.php?0000&mr=793 for media update and http://www.fish.wa.gov.au/docs/pub/rfl/index.php?00 for details of licensing arrangements.

As part of the Department's Ecosystem Based Fisheries Management framework, the Department monitors the environmental system (ecosystems and aquatic resources) of the Gascoyne Coast Bioregion, including Exmouth Gulf. Actions to be undertaken to achieve outcomes (e.g. key target species' stock assessment and modelling, observer programs, managing ETP species interactions, habitat mapping, understanding environmental and external factors etc.) are funded through the prioritised spending of the 5 % GVP commercial fisheries access fee and by accessing funds from FRDC and other outside funding sources.

14.3.3 Key Policies for Meeting Long-Term Objectives

14.3.3.1 Ecologically Sustainable Development (ESD)

The WA Government is committed to the concept of ESD, which seeks to integrate short- and long-term economic, social and environmental effects in to all decision-making. The key principles of ESD are implicitly contained in the objectives of the FRMA, and the Department's ESD Policy (Fletcher 2002).

The Department was one of the first fisheries agencies in the world to articulate how to demonstrate, in a practical manner, whether ESD requirements were being achieved. Each of WA's main commercial fisheries has now been assessed using the *Australian National ESD Framework for Fisheries*[60], as developed by the FRDC ESD Subprogram, and it is now an integral part of the stock sustainability assessment process for all fisheries in WA.

For the purposes of the wildlife trade provisions of Part 13A of the EPBC Act (i.e. to be exempt from export controls for native species harvested in a fishery), management agencies must demonstrate that fisheries management regimes comply with the objectives of ESD. The DotE has prepared publicly-available guidelines (CoA 2007), on which management agencies are required to base their submissions for export approval. The submissions are released for public comment, which ensures rigorous and transparent assessments are conducted with input from Commonwealth and State fisheries agencies, the fishing industry and the wider community. All documents pertaining to the submissions and assessments, including the Commonwealth Minister's decisions and any conditions that are set on the fishery, are publicly available on the Commonwealth DotE's website.

WA fisheries assessments are conducted against the Commonwealth Guidelines which outline specific principles and objectives designed to ensure a strategic and transparent way of evaluating the ecological sustainability of fishery management arrangements. Adequate performance of fishing in relation to the Commonwealth Guidelines will see that the management arrangements demonstrate a precautionary approach, particularly in the absence of information.

A precautionary approach should be used in all stages of fishery management, from planning through to assessment, enforcement and then re-evaluation. A precautionary approach requires managers to utilise the best scientific evidence available when designing a management regime. It also requires that a minimum level of information be available before

[60] http://www.environment.gov.au/marine/fisheries/wa-managed-fisheries

a fishery is established. Thus, information collection and ongoing research is of significant importance and may be inversely proportional to the level of precaution that is taken in setting management measures for a fishery. Sources of uncertainty within the data should be identified and where possible, quantified. Until research on the specific stock provides information, a precautionary approach should set conservative limits to account for the unknown level of uncertainty.

To satisfy the Commonwealth Government requirements for a demonstrably ecologically sustainable fishery, the fishery (or fisheries if a species is caught in more than one fishery), must operate under a management regime that meets Principles 1 and 2 of the Commonwealth Guidelines. The management regime must take into account arrangements in other jurisdictions, and adhere to arrangements established under Australian laws and international agreements.

Under the Commonwealth Guidelines, the management regime does not have to be a formal statutory fishery management plan as such, and may include non-statutory management arrangements or management policies and programs. The management regime should:

- be documented, publicly available and transparent;
- be developed through a consultative process providing opportunity to all interested and affected parties, including the general public;
- ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process;
- be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements are measured;
- be capable of controlling the level of harvest in the fishery using input and/or output controls;
- contain the means of enforcing critical aspects of the management arrangements;
- provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria;
- be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates; and
- require compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under that policy.

The steps to apply this 'ecosystem type of approach' to individual fisheries are based on the adoption of international standards for risk management (Australian Standards/New Zealand Standards 4360 2009)[61], reflecting that fisheries management is a specific form of risk

[61] http://www.standards.org.au/Pages/default.aspx

management. These steps have also now been routinely applied elsewhere in Australia and internationally.

The *Australian National ESD Framework for Fisheries* includes an ESD reporting framework for fisheries outlined within a series of reports, making the completion of ESD reports as efficient and effective as possible. There are four main processes needed to complete an ESD report: identifying issues; determining the importance of each of these issues using risk assessment; completing suitably detailed reports; and compiling sufficient background material to put these reports into context (Figure 14.2).

Further information regarding the EGPMF export approval under the EPBC Act is provided in Section 15.1.

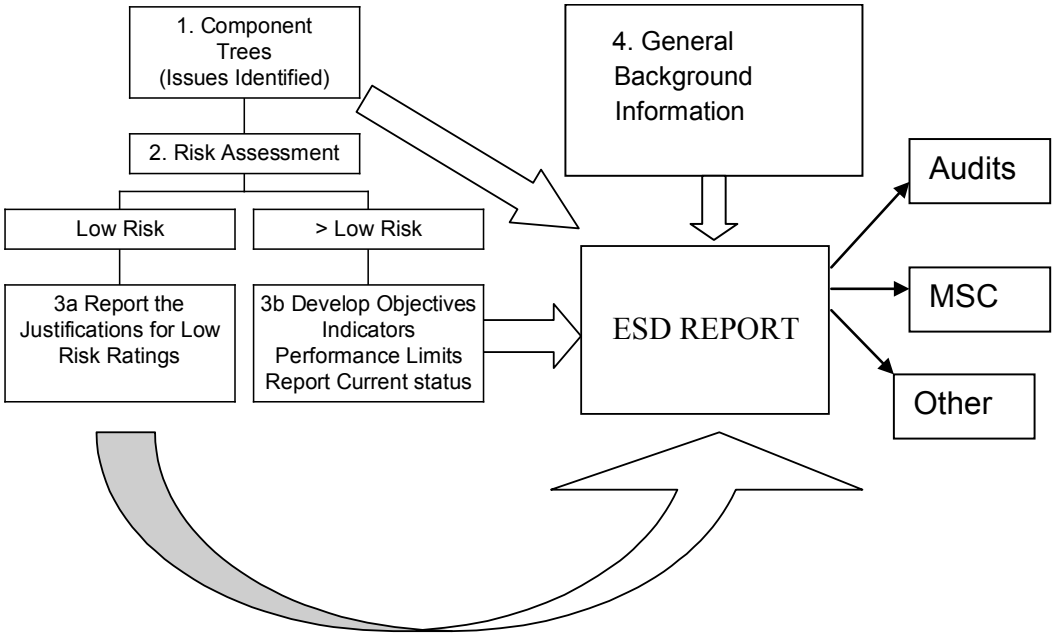

Figure 14.2. General process for completing an ESD report for a fishery

14.3.3.2 Ecosystem-Based Fisheries Management

Following the success of the ESD framework for individual fisheries, a practical, risk-based framework for use with regional-level management of marine resources was developed by the Department to enable cross / multiple fishery management at the bioregional level to fully implement Ecosystem Based Fisheries Management (EBFM). This was designed to replace the previous, disjointed fishery-level, planning systems, with a single, coordinated risk-based system to generate efficiencies for the use of Departmental (government) resources. The simple set of steps developed has enabled adoption of a fully regional, 'ecosystem-based' approach in WA without material increases in funding.

The Department has met 'best practice' international sustainability benchmarks by being one of the first fisheries agencies in the world to introduce EBFM across all aquatic resources. EBFM recognises that ecosystems work at a regional level and fits better with the global shift towards holistic, regional-based natural resource management.

EBFM takes into account the impacts of all aquatic resource use on species targeted by fishing, as well as non-target species and the environment — all of which are regarded as ecological assets — and the social and economic impacts of the resource use. It recognises that while fishing activity affects ecosystems, providing the impacts are risk-assessed and managed, fishing can also create social and economic benefits.

EBFM is based on using the best global standard for risk assessment and risk management. The levels of risk are used as a key input to the Department's Risk Register which, combined with the assessment of the economic and social values and risks associated with these assets, is an integral component of the annual planning cycle for assigning activity priorities (e.g. management, research, compliance, education, etc.) across each Bioregion.

A summary of the Department's risk-based planning annual cycle that is delivering EBFM in the long-term is provided in Figure 14.3 below.

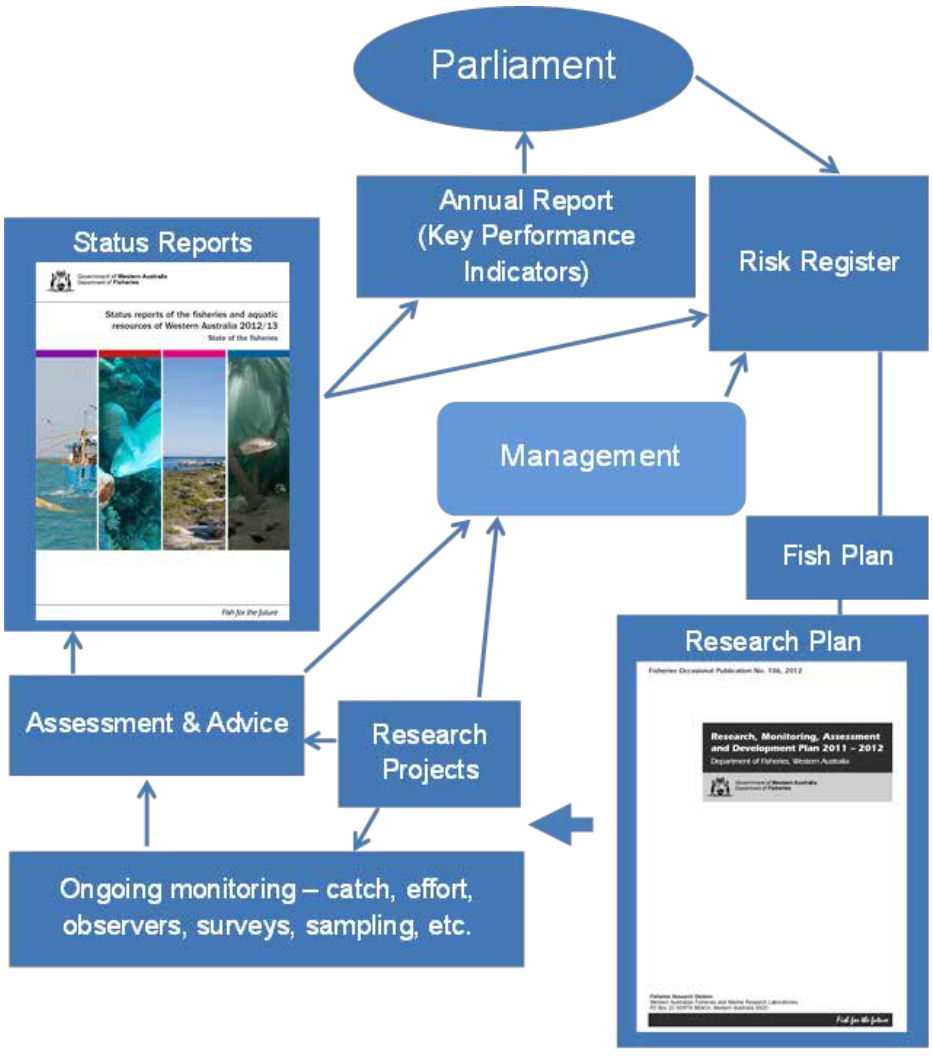

Figure 14.3. An outline of the risk based planning cycle used for determining Departmental priorities and activities

The Risk Register informs Fish Plan (current version 2011/12 – 2015/16), which sets out baseline management activities over a five year period. The extent to which the Department

is effective in achieving its Agency Level Outcome is measured by the Department's Key Performance Indicators (KPI's), which are published in the Department's *Annual Report* to Parliament.

Fish Plan assists the Department in achieving its desired Agency Level Outcome by providing a planned and structured approach to management of capture fishery resources (assets), including review of management arrangements for fish stocks, assessment and monitoring of fish stocks and compliance planning. This process provides the Department with a basis or framework for allocating resources to individual capture fishery assets and to provide greater certainty to peak bodies and industry participants on the timelines for management reviews, etc.

Fish Plan in turn informs the Research, Monitoring, Assessment and Development Plan 2011/12 – 2015/16 (RMAD Plan; DoF 2012b), which sets out the associated research projects over a five year period. The research projects and activities address ongoing monitoring requirements, as well as generating assessments and advice, which then drive reporting and management activities.

EBFM has been applied to the ecological assets recognised in each of the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0; CoA 2006) regions within each bioregion in WA. Those ecological assets include:

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

The EGPMF has been assessed pursuant to the EBFM framework, and strategies, partial strategies and measures have been implemented in the EGPMF based on the risk assessment outcomes.

It is important to note that the levels of knowledge needed for each of the issues only need to be appropriate to the risk and the level of precaution adopted by management. Implementing EBFM does not, therefore, automatically generate the need to collect more ecological, social or economic data or require the development of complex 'ecosystem' models, it only requires the consideration of each of these elements to determine which (if any) required direct management to achieve acceptable performance.

Further detailed information on the EBFM policy can be found at:

- Fisheries Research Report 194 - *Conceptual models for Ecosystem Based Fisheries Management (EBFM) in Western Australia*. Department of Fisheries (2009)[62]; and,

[62] http://www.fish.wa.gov.au/Documents/research_reports/frr194.pdf

- Fletcher, W.J., Shaw, J., Metcalf, S.J. and Gaughan, D.J. (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. *Marine Policy 34* (2010) 1226-1238[63].

As part of ensuring that it was implementing EBFM effectively, the Department undertook a study to:

1. Test the robustness of statistical procedures to identify impacts of multi-sector fishing on community composition using existing fishery data;
2. Assess the level of change in community composition in each bioregion of WA during the previous 30 years;
3. Identify key data to which ecosystem structure and management strategies are most sensitive and which should be collected in the future;
4. Identify critical changes in exploitation and/or environment that would impact marine ecosystems markedly; and
5. Identify areas where more detailed research and / or monitoring are needed.

The results from the study are published in Fisheries Research Report Number 215 (2011) *Development of an ecosystem management approach to the monitoring and management of Western Australian Fisheries*[64] and have influenced the monitoring and reporting of the management of the EGPMF against the principles of EBFM.

A description of how the general legislation integrates with the fisheries policy framework to achieve the long-term sustainability objectives of EBFM is published in DoF (2010).

14.3.3.3 Harvest Strategy Policy

A broad, high level *Harvest Strategy Policy* has been developed (DoF in press). The policy articulates all performance levels and the management actions designed to achieve agreed objectives. These objectives articulate what is to be achieved, and why, both for the resource and the relevant fisheries. This policy is aimed at ensuring target species' sustainability in the long term. Where a harvest strategy is required, the core elements are:

- Articulation, at an operational level, of what is to be achieved, and why, both for the resource and the relevant fisheries (operational objectives);
- Determination of performance indicators to be used to measure performance against operational objectives;
- Based on achieving acceptable risk levels, establishment of appropriate reference points/levels for each performance indicator;
- The selection of:

[63] http://ac.els-cdn.com/S0308597X10000849/1-s2.0-S0308597X10000849-main.pdf?_tid=bf282dea-7c03-11e3-b1dc-00000aab0f01&acdnat=1389584308_7fe8a2af9082316b5a6cb7c4ea86af47

[64] http://www.fish.wa.gov.au/Documents/research_reports/frr215.pdf

- the most appropriate Harvesting Approach (e.g. constant harvest/exploitation, constant escapement/stock size, constant catch);
- the associated Harvest Control Rules which articulate pre-defined, specific management actions based on current status designed to maintain target levels and avoid breaching thresholds or limits; and
- the Acceptable Catch/Effort Tolerance which is used to evaluate the effectiveness of the management actions in delivering the specific catch/effort as determined by the Harvest Control Rules and IFM allocation decisions;

- Monitoring and assessment procedures for the collection and analysis of all the data needed to underpin the harvest strategy and determine stock status and fishery performance against operational objectives; and
- The timetable and frequency for review of the harvest strategy elements.

The EGPMF is subject to an industry-agreed and published harvest strategy (DoF 2014a) under this framework.

14.3.4 Aquatic Biodiversity Policy

The Department is currently drafting an overarching *Aquatic Biodiversity Policy* that describes the Department's role, responsibilities and jurisdiction in the management of the State's aquatic biodiversity assets, and the key principles applicable in this management area. By focusing on five key asset areas (retained fish species, non-retained fish species, ETP species, fish habitats and ecosystem processes) and seven key threats imposed upon these asset areas (habitat loss, invasive pests, unsustainable harvest, external drivers, lack of information, governance and cumulative impacts), a practical framework for the management of aquatic biodiversity will be described.

14.4 Incentives for Sustainable Fishing

WA fisheries legislation, including that governing the EGPMF, has policies and principles that provide social and economic incentives to fishers to fish sustainably and encourage a sense of stewardship towards the resource. These incentives include policies that provide stability and / or security for fishers by:

- Providing strategic or statutory management planning to give certainty about rules and goals of management; for example, the Department has a general practice of holding regular (often annual) management meetings with fishery licencees to discuss fishery research, management, compliance and other fishery-specific issues as they arise. These meetings are attended by Department officers, WAFIC and licence holders and are recognised by licence holders as a mechanism for receiving the most up-to-date scientific advice on the status of the fishery, facilitating information exchange and discussing new and ongoing management issues;
- Providing for the clarification of roles, rights and responsibilities of the various stakeholders; for example, WAFIC is recognised by the WA Government as the key

source of coordinated industry advice for the commercial fishing sector. WAFIC's responsibilities include coordinating Government funding for industry representation and taking a leadership role for matters that involve or impact on a number of fisheries or are of an industry-wide or generic nature;

- Providing for a participatory approach to management, research and other relevant processes. The EGPMF has well-defined management processes, which are enshrined in legislation, policy and practice; for example, the recently-published *Harvest Strategy 2014 – 2019* and the *Bycatch Action Plan 2014 – 2019* were developed following multiple internal workshops, correspondence and face-to-face consultation with the licensee;
- Providing rights of exclusion (limited entry); the number of managed fishery licences (MFLs) in the EGPMF is limited to 15. All 15 MFLs in the EGPMF are held in the name of a single company — MG Kailis Pty. Ltd. These access rights engender a sense of ownership of the resource and a commitment to long-term sustainability to protect their investment;
- Providing industry the opportunity to optimise economic returns within a sustainable fishery framework. Fishing effort controls work towards maximum economic yield, which evens out inter-annual and intra-annual catch variations, thereby making the fisheries more economically-stable and viable. This provides industry with a more-secure investment environment (e.g. when borrowing from financial institutions); and
- Including features that encourage collective action while allowing for individual choice, such that individual decisions are steered towards the public good; for example, non-statutory rolling spatial closures occur throughout the fishing season to contain and direct overall fleet effort and protect small (pre-spawning) prawns. These closures occur through a co-operative arrangement[65] with the licensees, with skippers voluntarily complying with boundaries in order to maximise economic returns.

There is high acceptance by the commercial fishing sector that well-managed and sustainable fisheries result in positive social and economic outcomes for individual fishers, the sector as a whole and the broader community. This acceptance also drives sustainable and compliant fishing behaviour. Positive social and economic incentives that drive sustainable fishing practices in the commercial fishing industry include:

- An opportunity to support regional communities through the provision of employment and demand for services and supplies;
- The operation of commercially-viable fisheries that result in both profit and lifestyle benefits; and
- A general understanding by the WA community that the commercial fishing industry acts with integrity and respect.

[65] Note, however, if VMS or compliance monitoring indicated that there were repeated incursions into in-season voluntary closed areas, the Director General may close specific areas to fishing pursuant to clause 10 of the Management Plan.

14.4.1 Review Process

There are no incentives for the fishers to fish unsustainably in the EGPMF. Commercial fishers understand that management measures are in place to minimise fishery impacts in order to ensure the stock and environment continue to be managed sustainably and thus, fished profitably. Research, management and compliance monitor adherence to sustainable fishing arrangements and make adjustments to them if necessary.

15. Fishery-Specific Management System

The fishery-specific management system section focuses on the management system directly applied to the EGPMF, including:

- Fishery-specific management objectives;
- The decision-making process in the EGPMF;
- The compliance and enforcement system and implementation;
- Research planning and monitoring; and
- An evaluation of the performance of the management system in meeting the fishery's objectives.

15.1 Fishery-Specific Objectives

The EGPMF has clear, specific objectives designed to achieve the outcomes expressed by MSC's Principles 1 and 2.

Explicit, well-defined and measurable long- and short-term specific objectives have been applied to the management of prawn resources and associated ecosystem impacts of commercially fishing for prawns in Exmouth Gulf, and the fishery-specific management system contains a range of strategies that are monitored to ensure these objectives are being met in the long term. The management objectives are contained in the *EGPMF Harvest Strategy 2014 – 2019* (DoF 2014a), which is codified by industry and publically-available on the Department's website.

The annual performance of the fishery is measured by undertaking a post-season evaluation of each performance indicator against the reference levels set out in the Harvest Strategy. Along with the long-term management objectives, as described below, there is a short-term operational objective to maintain annual performance above the threshold reference level (and as close to the target reference level as possible) for each component of the fishery.

15.1.1 Target Species Stock (P1) Objectives

The EGPMF has a long-term management objective, which is demonstrably consistent with achieving outcomes expressed by MSC Principle 1, *to maintain spawning stock biomass of each target species (brown tiger and western king prawns) at a level where the main factor affecting recruitment is the environment.*

There is strong evidence to suggest that this management objective is being met in the long-term (see Section 6). As part of the EGPMF harvest strategy, a review of management arrangements is triggered if the annual performance measure (spawning stock index) is below the target level. This ensures that potential issues are recognised and addressed prior to the following fishing season and that the long-term management objective relevant to MSC Principle 1 continues to be met.

15.1.2 Ecosystem (P2) Objectives

The long-term management objectives for the EGPMF, which are demonstrably consistent with achieving the outcomes expressed by MSC Principle 2, are:

- *To maintain spawning stock biomass of each retained species at a level where the main factor affecting recruitment is the environment;*
- *To ensure fishery impacts do not result in serious or irreversible harm to bycatch species populations;*
- *To ensure fishery impacts do not result in serious or irreversible harm to ETP species populations;*
- *To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function; and*
- *To ensure the effects of fishing do not result in serious or irreversible harm to ecosystem processes.*

There is strong evidence to suggest that each of the long-term management objectives listed above are being met over the long term. More detailed information about the fishery's impacts, management of those impacts, information and monitoring and risk assessment outcomes is provided in the Principle 2 section of this document in Sections 9 – 13.

15.1.3 Economic Objective

The economic objective for the EGPMF is *to provide industry the opportunity to optimise the economic returns generated by the EGPMF within a sustainable fishery framework.*

There is strong evidence to suggest that the economic management objective to provide industry with the opportunity to optimise the economic returns generated by the EGPMF within a sustainable fishery framework is being met over the long term.

By implementing an effective harvesting approach that achieves EBFM outcomes, the sustainable exploitation of prawn resources and the management of ecosystem impacts results in positive economic consequences for both key stakeholders (e.g. the licensee) and indirect stakeholders, including the local community of Exmouth, the restaurants and retail sector in WA, consumers and the wider WA community.

The Department has implemented a flexible management framework for the EGPMF that is not overly regulated and provides the ability for the fishery to achieve optimum economic efficiency. The Department is prepared to consider proposals to improve economic efficiency

that do not adversely affect meeting the ecological objectives provided above. The co-operative management framework for the EGPMF allows the Department and the licensee to collaborate the timing and extent of in-season openings and closing of areas (other than those implemented for sustainability purposes) to optimise catch rates, as well as prawn size and condition. The licensee and skippers continue to work with the Department under this co-operative management framework, and there are no indications that the licensee is dissatisfied with the current arrangements.

While not directly used as a measure of performance against the economic management objective, there are ways that the economic efficiency of the fishery can measured. This includes the evaluation of:

- commercial catch rates;
- target prawn price per kg;
- gross annual returns; and
- employment levels.

This information is reported annually in *Status Report of the Fisheries and Aquatic Resources of Western Australia: the state of the fisheries*. The long-term trend from these data indicates that the management framework is providing the fishery with the opportunity to operate efficiently and viably within a sustainable fishery framework.

15.2 Decision-Making Processes

The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives, and has an appropriate approach to actual disputes in the fishery under assessment.

15.2.1 Established Processes

There are established decision-making processes in the EGPMF management system that are fully understood by all stakeholders and underpinned by explicit and transparent consultation. The fishery specific decision-making processes for the EGPMF consist of three components:

1. Annual and in-season consultation and decision-making that may result in measures to meet short-term (operational) objectives (driven by the control rules contained in the current Harvest Strategy);
2. In-season consultation and decision-making that is designed to meet the economic objective to provide the fishery with the opportunity to optimise economic returns (cooperative framework); and
3. Longer-term consultation and decision-making that results in new measures and strategies to achieve the long term fishery-specific management objectives (i.e. changes to the management framework).

15.2.1.1 Harvest Strategy Consultation and Decision-Making

The Harvest Strategy control rules guide the management response in the event that the operational objective (i.e. to maintain the performance indicator above the threshold reference level) is not met. In these cases, the decision-making processes may result in measures to achieve fishery-specific objectives.

An overview of the annual and in-season consultation and decision-making processes to achieve short-term operational objectives under the current management framework are described below.

15.2.1.1.1 Annual Processes

Post-season Report / Pre-season Briefing to the Licensee

The Department's research staff undertake a post-season evaluation of the fishing season outcomes and develop a written report for the licensee (see Appendix F). This report, together with a summary presentation, is provided to the licensee each year in February / March.

It is at this stage that any issues arising from the annual evaluation of the operational objectives in the Harvest Strategy are discussed. These discussions can include preliminary investigation of reasons why target reference levels were not met (if this was the case); such reasons can be stock-related or effort-related and may include environmental influences, low effort due to changes in fishing behaviour, market forces, etc. If sustainability is considered to be at risk, changes to fishing arrangements are discussed with the licensee and are implemented for the following fishing season (e.g. a delay to the commencement of fishing to reduce effort).

Consultation between the Department and the licensee also occurs at this stage to decide on the statutory season opening date (usually after the full moon in April) and closing date, the in-season survey schedule and the extent of moon closures.

Advice to Management and the Director General regarding the Opening / Closing of the Fishing Season

Following consultation with the licensee, a written briefing is provided to the Director General recommending the statutory opening and closing dates for the coming fishing season. The Director General (as the Chief Executive Officer[66]) determines the opening and closing dates for the fishery by signing a notice pursuant to clause 10 of the Management Plan, a copy of which is provided to the licensee in writing. The notice is then made publically available on the State Law Publisher's website[67]. This notice statutorily caps the overall fishing effort (fishing days) for the season at an acceptable level (i.e. no more than 200 fishing days). Clause 10 of the Management Plan provides the power for the Director General

[66] Note that annual notices made pursuant to clause 10 of the Management Plan are signed by the Director General as 'Chief Executive Officer' transitioned from the 'Executive Director' pursuant to section 242 of the *Machinery of Government (Miscellaneous Amendments) Act 2006*

[67] http://www.slp.wa.gov.au/statutes/subsidiary.nsf/0/D36C2D29CE34209248257CF30025401B/$file/10.06.14.+egp+notice+no+2+2014.pdf

to statutorily set the annual fishing season without the need for an amendment to the Management Plan. The Director General also approves the boundaries of the management areas in the notice.

Pre-season Skippers Briefing

The Department's research staff develop an information package (see Appendix G) and provide a briefing to the fleet skippers for the coming season. Skippers are also provided with a presentation of the outcomes of the previous fishing season. The skippers' briefing provides a feedback loop to the Department on the proposed seasonal arrangements for the coming season.

15.2.1.1.2 In-Season Processes

The key in-season decision-making process is undertaken pursuant to the control rules designed to achieve the in-season operational objectives in the Harvest Strategy (i.e. to achieve above the threshold reference levels).

Consultation is undertaken by the Department's Research staff directly with the licensee around the timing and extent of fishing in the management areas throughout the season. This decision-making processes is informed by a combination of the recruitment and spawning stock survey regime (catch rates and prawn size composition), knowledge of prawn biology (spawning and movement patterns of brown tiger and western king prawns) and daily monitoring of commercial catch rates. The resulting decisions are communicated to skippers, as well as to the Department's management and compliance (including VMS) staff.

The annual in-season fishing arrangements designed to achieve the in-season operational objectives in the Harvest Strategy are implemented on a non-statutory basis; however, they are monitored by VMS. If it is identified that an area of the fishery may need to be closed statutorily, this can be achieved quickly (within 24 hours) via a notice pursuant to clause 10 of the Management Plan. There has been no evidence arising from compliance monitoring that has required in-season closures to be legislated. This indicates a high level of trust and understanding by the licensee resulting from the established in-season decision-making process and the Harvest Strategy control rules.

15.2.1.2 Cooperative Framework

Once requirements have been addressed in line with the Harvest Strategy, an in-season cooperative consultation and decision-making process is used to provide the licensee with the opportunity to optimise economic returns from the target prawn species within the sustainable fishing framework.

Decisions around optimising economic returns are informed by prawn size composition information arising from both Department and industry surveys and real-time monitoring of daily commercial catch data. The consultation and decision-making process that is aimed at optimising economic returns is undertaken in person between the Department's Research staff and the licensee and is communicated to fleet skippers, compliance and VMS staff.

A description of the cooperative framework is provided in Kangas et al. (2008). Further to this, the EGPMF cooperative framework was used as a template to assess the feasibility of a local co-management governance model for other WA fisheries wishing to move to co-management. The results of the study were published in Rogers (2009). It is important to note that, while Rogers (2009) proposed a policy guideline for formal co-management in the EGPMF, the existing cooperative framework in the EGPMF has not been implemented via formal policy or explicit in legislation at this stage. Nevertheless, it has been in place for many years, is well understood by key stakeholders (the Department and the licensee) and has proved successful in delivering a long-term stable economic operating environment within a sustainable framework.

The fishing arrangements (i.e. timing and extent of fishing) resulting from the cooperative framework are non-statutory because they are not in place for stock sustainability reasons; however, they are monitored by VMS staff.

15.2.1.3 Management System

There is an established fishery-specific management system decision-making process in place that results in measures and strategies to ensure the management objectives continue to be met in the longer term.

This decision-making process is triggered primarily as a result of analysing longer-term patterns or trends in the annual monitoring of the success of the existing management regime. Variations in the operating environment caused by other factors (e.g. environmental conditions, market conditions, fishing behaviour, conflicts with other marine users, determination of native title, marine planning, etc.) can also trigger investigation and discussion that may lead to a change to the management system.

Changes to the management system as a result of implementing new measures and strategies tend to be more permanent (i.e. lasting for more than one season) and are often implemented in legislation. Depending on the issue and stakeholders affected (see below), consultation can occur through the following mechanisms:

- directly in writing;
- at licensee meetings and skipper's briefings;
- establishment of a tasked working group;
- external / expert workshops (e.g. ecological risk assessments); and / or
- internal workshops (e.g. harvest strategy development, ecological and compliance risk assessments).

These forums are used to work through options for addressing emerging issues, consider both key and other interested stakeholder advice and take into account the broader implications of those options. Following the consultation process, any new proposed management measures and strategies that require changes to legislation or publication must be provided to the statutory decision maker (usually the Director General or the Minister for Fisheries). The

Department must set out evidence of consultation and the results of the decision-making process during this process.

Recent examples of the fishery-specific management system decision-making process that resulted in new strategies include the development of the current Harvest Strategy and BAP for the EGPMF, both of which were developed following multiple internal workshops and face-to-face consultation with the licensee.

Figure 15.1 shows the consultation and decision-making process as it relates to the EGPMF management system.

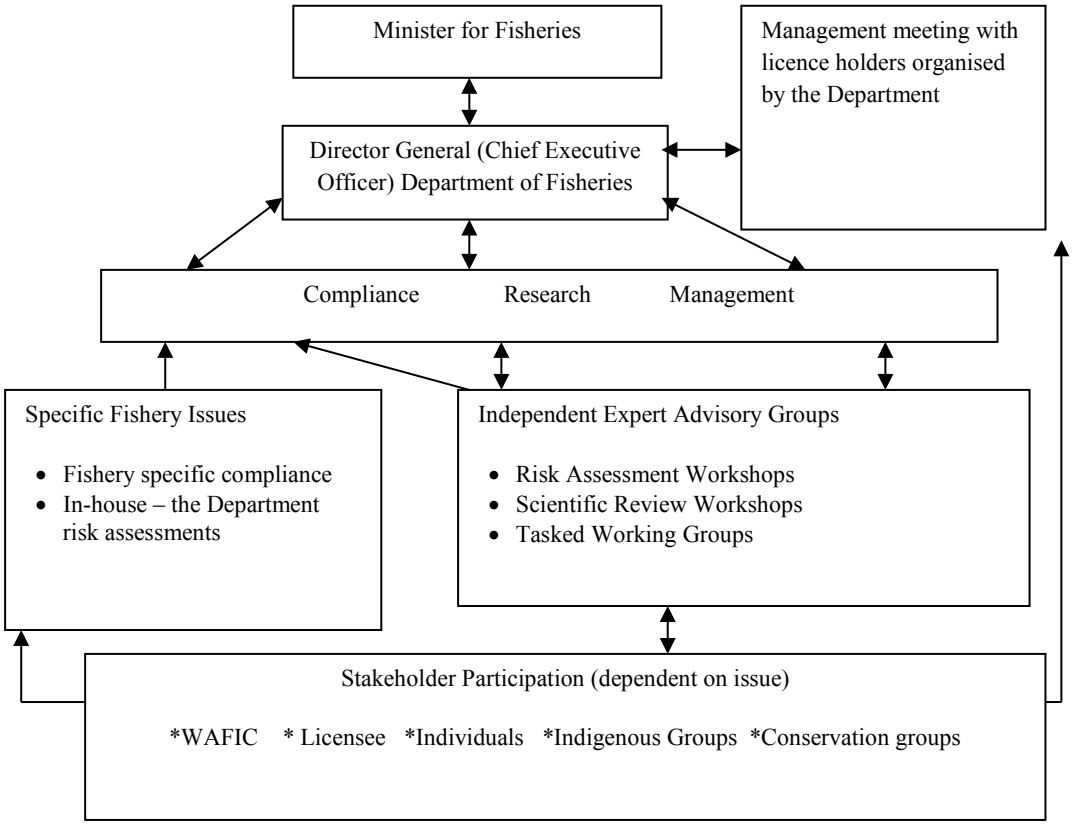

Figure 15.1. Fishery-specific consultation and decision-making framework for the EGPMF management system

15.2.2 Responsiveness of Decision-making Processes

The transparent decision-making processes described above allows for a timely response in instances where management changes need to be applied to alleviate unacceptable risks to stocks. The timing of provision of scientific advice on the status of prawn stocks is immediate given the real-time monitoring regime.

The annual and in-season control rules contained in the current Harvest Strategy are applied consistently and are informed by both real-time monitoring of fishery-independent and fishery-dependent catch rates (for decisions implemented in-season) and annual evaluation (for decisions implemented in the following fishing season).

For example, fishing did not commence in the Eastern Area in 2013 based on the catch rate of brown tiger prawns from the 2013 recruitment surveys, and the central TPSA did not re-open later in the season following the results of the 2013 brown tiger prawn spawning stock surveys. In addition, once the mean catch rate of brown tiger prawns fell below the threshold of 20 kg / hr to 17.3 kg / hr in 2012, management measures were reviewed in consultation with the licensee, and both temporal and spatial fishing effort on brown tiger prawns was managed more conservatively for the 2013 (and 2014) fishing season.

More permanent changes to the management system tend to result from internal and external reviews of the management / monitoring / stock assessment / compliance regime, an un-acceptable change in risk level detected by an updated risk assessment, results of research, requests from the licensee to optimise efficiency, fishery certification requirements, etc. (see Section 15.5).

The urgency of consultation and decision-making processes relevant to more permanent changes to the management system is based on risk. This can be a quick and streamlined process, given there is only one licensee in the EGPMF. Once approved, such management actions tend to be implemented by way of changes to legislative instruments. For example, actions to close areas of the fishery (or the entire fishery), reduce fishing days / hours (temporal effort management) or change management area boundaries (spatial effort management) can be implemented almost immediately by the Director General pursuant to clause 10 of the Management Plan.

Changes to other existing arrangements (such as headrope limits and gear specifications) can also be applied very quickly (within days or weeks), depending on urgency. Once a decision is made, the approval and implementation of such changes is undertaken by amendment to the relevant legislative instrument in a transparent and accountable way and in line with statutory requirements where necessary.

For example, the Minister for Fisheries must consult with the licensee before approving an amendment to the Management Plan (section 65 of the FRMA). While the Director General can impose, delete or vary an MFL condition, his decision is subject to a formal appeals process (section 147 of the FRMA). There are no statutory provisions as to the consultation requirements relating to section 7 instruments of exemption or section 43 orders (noting that section 43 orders can be disallowed in State Parliament); however, in the absence of any statute specifying consultative procedures, the Department has regard for common law principles to afford natural justice to the licensee. As such, the Department will formally consult with the licensee when making changes to management arrangements via an instrument of exemption or an order.

The outcomes of the decision-making process and implementation of statutory arrangements is always formally communicated to the licensee in writing and available publically on the State Law Publishers website.

Examples of the responsiveness of the decision-making process to implement longer-term management changes include:

- In line with the original ESD WTO certification in March 2003, the Department and the licensee worked to monitor ETP interactions and comparing faunal assemblages in trawled and untrawled areas within the fishery (2004) (see Section 15.4);

- The issue of the low abundance of brown tiger prawns in Exmouth Gulf in 2012 and 2013 triggered a review to investigate the reasons for the variation, which has led to the Department to seek funds from the FRDC to undertake research in 2015;

- The Department, in consultation with the licensee, has also worked rapidly to develop and implement the *EGPMF Harvest Strategy* and *EGPMF Bycatch Action Plan* following MSC pre-assessment in 2013 and prior to undergoing MSC full assessment in 2014.

The decision-making process also allows for the consideration of the wider implications of decisions, particularly where proposed longer-term management actions may result in adverse unintended consequences to other management components. It is important to note that all ecological objectives must be met prior to considering responses to achieve economic objectives. For example, the move to a quad-rigged net configuration by 2007 improved fishing efficiency for commercial purposes; however, a maximum headrope length for the fishery was imposed for sustainability purposes. Similarly, the removal of the 375 boat unit rule was also aimed at maximising economic efficiency and flexibility; however, an overall limit on boat length was also imposed.

15.2.3 Use of Precautionary Approach

The decision-making processes for the EGPMF (described above) uses the precautionary approach and are based on the best available information.

The EGPMF is managed based on a constant escapement harvesting approach. The management activities related to this approach have been developed over time based on a comprehensive understanding of the biology of brown tiger and western king prawns in Exmouth Gulf, together with a long-term annual and in-season monitoring and assessment regime. Based on this information, the decision-making processes have led to the implementation of a sustainable management framework over time. Furthermore, the reference levels are considered appropriate, as they are demonstrably achieving the fishery-specific management objectives.

The control rules incorporate a precautionary approach to the decision-making process by requiring a review when the target reference level is not met. This ensures that any warning signs are recognised and investigated / addressed in their early stages. The frequency of evaluation (both annually and in-season) and review means that management action to investigate and, where required, alleviate adverse impacts on stocks is always taken before the performance indicators reach the limit reference level. For example, recent decisions regarding the extent of fishing in 2013 and 2014 took into account the best available information and set the level of fishing more conservatively based on the previous seasons' outcomes.

The commercial catch rates of brown tiger and western king prawns for the 2014 fishing season are being closely monitored and the annual catch against the catch prediction arising from the recruitment surveys will be compared immediately following the close of the season. The brown tiger prawn spawning stock surveys undertaken in August, September and October 2014 and assessment of commercial catch rates of western king prawns will provide the most up to date information as to the current status of both stocks.

Sources of uncertainty within the data and data gaps have been identified, particularly where they relate to obtaining a more quantified and up-to-date assessment of the risk posed by the fishery to bycatch and ETP species' populations. This will be addressed in the current BAP and may result in management actions, should the existing management system prove to be posing an unacceptable risk.

The decision-making processes have resulted in the existing management regime being set at a precautionary level until further research on environmental changes and risk to bycatch and ETP species' populations provides further information.

15.2.4 Accountability and Transparency

15.2.4.1 Key Stakeholders

Formal and regular reporting to key stakeholders relating to information on fishery performance and management actions, how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity is primarily provided at the annual meeting between the Department and the licensee. This reporting consists of presentations and the provision of the annual season report for the fishery.

Key stakeholders are also formally briefed on the outcomes of research prior to publication. Such meetings and briefings are also used as a forum to discuss relevant recommendations and proposed management actions. Recommendations and final decisions that result in new measures or strategies are often published by the Department as fisheries management papers, research reports or in State of the Fisheries. For example, the current Harvest Strategy and Bycatch Action Plan for the EGPMF were developed directly in consultation with the licensee. These strategies are published and available on the Department's website.

15.2.4.2 Other Interested Stakeholders

Other interested stakeholders relevant to the EGPMF are provided in Section 14.2.4.

Formal / direct reporting to other interested stakeholders to provide information on the performance and management of the EGPMF, how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity is undertaken on a case-by-case basis. For example, formal / direct reporting is provided to other interested stakeholders that are involved in consultation and decision-making processes, such as tasked working groups, external risk assessments or external reviews of the EGPMF management system.

Notwithstanding this, comprehensive information on fishery performance and management actions, how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity is compiled on a regular basis and is publically available in documents published on the Department's website including

- *The Annual Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries* (e.g. Fletcher & Santoro 2013);
- The EGPMF Management Plan[68] (available on the State Law Publisher's website via a link from the Department's website);
- CEO notices regarding opening and closing the fishery[69];
- The *EGPMF Harvest Strategy 2014 – 2019* (DoF 2014a);
- The *Research, Monitoring, Assessment and Development Plan 2011 – 12*[70], which provides information on all completed and proposed research relating to the EGPMF and the associated ecosystem;
- The *EGPMF Bycatch Action Plan 2014 – 2019* (DoF 2014b); and
- Outcomes of management decisions, research and studies (e.g. Fisheries Management Papers, Fisheries Research Reports and Occasional Papers).

Other mediums for communication with other interested stakeholders can include media releases[71] and the MG Kailis website[72] also provides information targeted at consumers.

15.2.5 Approach to Disputes

The EGPMF consultation and decision-making processes proactively avoid legal disputes through the inclusion of stakeholders during consultation on key management matters. This allows for all impacts of proposed management actions to be considered, conflicts to be addressed and negotiation and compromise to be reached. In addition, the close collaboration and regular communication between the Department, the licensee and skippers has resulted in a mutual and in-depth understanding of industry operations and the fishery management system. Given this, there have been no actual legal disputes or requirement to implement judicial decisions in the EGPMF.

As described in Section 14.1, there are well-established mechanisms for administrative and legal appeals of decisions, which are prescribed in Part 14 of the FRMA. Should they arise, disputes regarding statutory validity are dealt with by the Courts. These decisions are publically available. Examples of these cases include:

[68] http://www.slp.wa.gov.au/statutes/subsiduary.nsf/FisheriesT?openpage
[69] http://www.slp.wa.gov.au/statutes/subsiduary.nsf/Fisheriesexec?openpage
[70] http://www.fish.wa.gov.au/Documents/occasional_publications/fop106.pdf
[71] http://www.fish.wa.gov.au/About-Us/Media-releases/Pages/Prawn-fisheries-seek-sustainability-certification.aspx
[72] http://www.mgkailisseafood.com.au/ExmouthFishingOperations.aspx

- Shine Fisheries Pty Ltd vs Minister for Fisheries (2002) at

  http://decisions.justice.wa.gov.au/supreme/supdcsn.nsf/judgment.xsp?documentId=89CBEA251EC082BB48256B5A000C1635&action=openDocument.

  This judgement has been put into effect in practice, by allowing the nominated operator of a vessel to be changed.

- Edgemere Pty Ltd vs Minister for Fisheries & Anor (1997) at

  http://decisions.justice.wa.gov.au/supreme/supdcsn.nsf/judgment.xsp?documentId=E2B71DECD36F4C1B48256497004CD3F9&action=openDocument.

The decisions of the SAT and the Courts are binding on the Department (for details of decisions see http://decisions.justice.wa.gov.au/SAT/SATdcsn.nsf). All SAT decisions must be carried out by the Department (section 29(5), page 20 of the *State Administrative Tribunal Act 2004*[73]).

15.3 Compliance and Enforcement

In order to optimally utilise compliance resources, enforcement effort is designed to maximise the potential for fishers to voluntarily comply with fishery rules, while at the same time provide a reasonable threat of detection, successful prosecution and significant penalties for those who do not comply. This is achieved through a range of strategies, including effective monitoring and surveillance, appropriately trained staff, suitable deterrents in the forms of fines and administrative penalties and targeted educative campaigns.

The Department's Regional Services Division (RSD) delivers the Department's compliance and educational services, with the support of the Communications and Education Branch, and the RSD also provides licensing facilities at the regional offices, as well as online renewal and payment. There is approximately 170 RSD staff across the State, spread throughout regional and district offices. Regional operational areas are supported by the Regional Services Branch's Perth-based Central Support Services and Strategic Policy sections.

Key compliance programs in place throughout the State include:

- Recreational fishing;
- Commercial fishing;
- Biosecurity;
- Pearling and Aquaculture;
- Marine parks (State and Commonwealth);
- Fish Habitat Protection Areas (FHPAs);
- Marine Safety; and

[73] http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_918_homepage.html

- Organised, unlicensed fisheries crime.

Compliance and community education services in the Gascoyne Coast Bioregion (GCB), which includes Shark Bay and Exmouth Gulf, are delivered by Fisheries and Marine Officers (FMOs), Community Education Officers and associated management and administrative support staff based at the District Offices in Denham, Carnarvon and Exmouth. During 2012/13, the three district offices supported a total of ten FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine parks, pearling and aquaculture operations and FHPAs. Most Fisheries Officers are permanently located in the main population centres with access to appropriate platforms to allow them to undertake patrols up and down the entire WA coastline. A small number of Officers are also specifically employed to undertake mobile patrols to conduct 'surprise' inspections, an activity that is particularly important in smaller towns where fishers can quite easily learn the movement patterns of local Officers (Green and McKinley 2009).

A significant aspect of the region's compliance work is the provision of compliance services to the State's Marine Parks. The GCB has two of WA's most iconic and significant Marine Parks, Ningaloo Marine Park (and the associated Commonwealth Ningaloo Marine Park) and the Shark Bay Marine Park and associated World Heritage Area. These two Marine Parks occupy just over 70 % of the GCB. In partnership with the Department of Parks and Wildlife (DPaW), FMOs monitor and deliver compliance and education programs covering some 30 Sanctuary Zones, Marine Managed Areas and other protected areas.

FMOs undertake regular land, air and sea patrols using a compliance delivery model supported by a risk assessment process and associated operational planning framework. Throughout the bioregion, they employ specially equipped four-wheel-drive vehicles, quad bikes and small towable vessels. They also make use of sophisticated surveillance, mapping and GPS equipment to assist in evidence gathering. This includes high-powered telescopes and photographic mapping technology. A high-visibility Recreational Fishing Mobile Patrol has been added to the Gascoyne pool of resources. This dedicated education and enforcement unit patrols the coast from Onslow through to Kalbarri.

FMOs at Exmouth make extensive use of the 13-metre Patrol Vessel (PV) the PV *Edwards* to conduct compliance activities throughout the GCB, while 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 Ningaloo Marine Park. In all three Districts, FMOs spend approximately 90 days a year at sea on patrol duties. Historically, large patrol vessels (greater than 20 m in length) have assisted FMOs at various times of the year for offshore patrols. FMOs conduct patrols the length of the GCB and target offenders in all of the recreational and commercial fisheries based on intelligence gathered, as well as conduct aerial surveillance, at-sea and on-land licence, gear and marine safety inspections and attend community events and school education programs.

15.3.1 Monitoring, Control and Surveillance Systems

Monitoring, control and surveillance (MCS) mechanisms ensure a fishery's management measures are enforced and complied with. There is a comprehensive MCS system implemented in the EGPMF that has demonstrated a consistent ability to enforce relevant management measures, strategies and / or rules. The MCS system is administered by the Department's RSD through a fishery-specific Operational Compliance Plan (OCP).

A fishery's OCP provides clear and unambiguous direction and guidance to FMOs for the yearly delivery of compliance-related activities in the fishery. The development of fishery-specific OCPs and compliance strategies continues to provide the most effective and efficient method for a planned and measureable approach to compliance delivery.

15.3.1.1 Implementation

15.3.1.1.1 Compliance Risk Assessments

Fishers and other stakeholder groups may be directly involved in setting compliance priorities through compliance risk assessments. The Department conducts compliance risk assessments every 1 – 2 years in major fisheries (e.g. the EGPMF) or those perceived to be at high risk and every 3 – 5 years in minor fisheries. The risk assessment process can also be triggered by the introduction of new supporting legislation[74] in a fishery / resource or the identification of any new major issues that would require RSD managers to assess their compliance program including (but not limited to):

- A sectoral complaint;
- Ministerial or Parliamentary enquiry;
- Management framework issues;
- Public complaint or sustained media interest;
- Intelligence; or an
- Upward trend in non-compliance.

The risk assessment process involves the participation of managers, field-based FMOs, researchers, commercial and recreational fishers, fish processors and representatives from other interested stakeholder groups, where relevant. There are two tiers in the risk assessment process — the first tier is the formal transparent process involving industry and other stakeholders, and the second tier is internal, utilising researchers, fishery managers and compliance personnel. The second process feeds into the fishery's OCP[75], which provides the formal framework for the delivery of specific compliance services that remove or mitigate the identified risks.

The compliance risk assessment process identifies modes of offending, compliance countermeasures and risks and relies on a weight-of-evidence approach, considering

[74] 'Supporting legislation' refers to any legislation that would allow non-compliance with the management framework to be detected and prosecuted with a reasonable chance of securing a conviction.
[75] By their nature, OCPs contain sensitive information and are only made available to authorised compliance personnel.

information available from specialist units, trends and issues identified by local staff and Departmental priorities set by the Aquatic Management Division through Fish Plan.

15.3.1.1.2 Operational Compliance Plan

An OCP provides a formal and transparent process for staff to carry out defined compliance activities in order to monitor, inspect and regulate the compliance risks to each specific high-risk activity in a fishery, and in turn confirm they are at an acceptable and manageable level. This is supported by measurable reporting methods defined under the OCP to demonstrate compliance activities being undertaken are having a direct and significant impact on reducing identified risks.

The development of an OCP consists of identifying and applying tailored compliance strategies for each identified risk. In the case of the EGPMF, this includes strategies that may deal with higher identified risks related to seasonal considerations, spatial considerations, environmental considerations and identified persons or groups of interest.

OCPs have been operating for several years now in the EGPMF and other major commercial fisheries in the GCB and for the management of the Ningaloo Marine Park, Shark Bay Marine Park and Commonwealth Ningaloo Marine Park. Each OCP is reviewed following a compliance risk assessment. Additionally, by regularly reviewing the OCPs for all fisheries in a particular location, rational, accountable decisions can be made about deploying compliance resources and ensuring that resources are available to mitigate risks to an acceptable level.

Following a formal review of a fishery's OCP and associated compliance strategies, compliance activities are prioritized in accordance with risk, budget and resourcing considerations. All existing OCPs were reviewed and updated during the 2012/13 year using this model.

Annual planning meetings are held for OCPs, with regular specific planning of day-to-day targeted and non-targeted patrols linked to the OCP based on resources and competing priorities.

15.3.1.1.3 Resourcing Compliance Operations

Gascoyne regional staff co-ordinate the allocation and prioritisation of existing resources across all programs in the region based on the risk assessments and related OCPs. Compliance planning meetings are held regularly to ensure staffing requirements are adequate for scheduled compliance activities.

Available compliance resources are allocated based on the risk assessment outcomes and the contacts and compliance statistics which are captured, reported on and reviewed at the end of each year. The allocated resources and compliance strategies (i.e. monitoring, surveillance and education activities) are outlined in the OCP, which specifies planned hours and staff allocated to key compliance tasks and duties. This planning and delivery process allows for more-targeted, effective and relevant compliance service in terms of both cost and activities.

There is also flexibility within the region to allocate additional resources to respond to changes, such as the need for a planned tactical operation in response to fresh intelligence. This may be achieved by redirecting existing resources or seeking additional resources from other areas or units. Similarly, changing priorities and resourcing on a local level can involve reducing planned delivery of compliance services to ensure resources are directed to where they are most needed.

15.3.1.1.3.1 Key Compliance Personnel in the Gascoyne Coast Bioregion

The Regional Office of the Department relevant to the EGPMF is located in Carnarvon and supported by district offices located at Exmouth, Carnarvon and Denham. Staff located at these offices provide on-ground compliance and educative delivery for these fisheries. Key compliance and enforcement personnel located in the region and their responsibilities include:

1. Compliance Managers
    - Overall responsibility for OCPs and compliance strategies, including their development, review and ensuring outcomes are delivered;
    - Responsible for providing sufficient and appropriate resources to achieve compliance outcomes;
    - Ensuring FMO safety is considered at all times and the Region's occupational health and safety requirements are met;
    - Monitoring the progress of the OCPs and strategies during their execution;
    - Consulting with all key stakeholders when reviewing the OCPs and strategies; and
    - Reporting outcomes.
2. Supervising Fisheries and Marine Officers
    - Field responsibility for OCPs and strategies, including reporting any deficiencies and reporting the outcomes as they are delivered or achieved;
    - Supervision of staff performance;
    - Ensuring officer safety is considered at all times and the district's occupational health and safety requirements are met;
    - Provide briefings and de-briefings as required;
    - Ensuring all equipment required to execute the OCPs and strategies is serviced, operational and available; and
    - Liaising with staff from other agencies operating in a joint servicing arrangement.
3. Fisheries and Marine Officers (FMOs):

- Day-to-day responsibility for the execution of the OCPs and strategies in their interaction with users of the Fishery;
- Ensuring FMO safety is considered at all times and individual occupational health and safety requirements are met;
- Reporting any deficiencies and outcomes in a timely and accurate manner; and
- Complying with the *Standard Operating Procedures*, *Prosecution Guidelines*[76], the Department's *Code of Conduct* and promoting the vision and mission statement of the Department and its joint-servicing partners.

FMOs are formally appointed pursuant to the FRMA, which clearly sets out their powers to enforce fisheries legislation, enter and search premises, obtain information and inspect catches. FMOs are highly trained; they must have a thorough knowledge of the legislation they are responsible for enforcing and follow a strict protocol for undertaking their duties in accordance with the FRMA and in recording information relating to the number and type of contacts, offences detected and sanctions applied.

In addition to regional compliance staff there are a number of units within the Department that support the delivery of compliance outcomes, including:

1. Patrol Boat Business Unit
    - Provides large oceangoing patrol vessels for Statewide offshore compliance operations and education activities.
2. Vessel Monitoring System Unit
    - Operates the Department's vessel monitoring system (VMS) to help manage the State's commercial fisheries.
3. Serious Offences Unit
    - Undertakes covert operations and deals with connections to organised crime;
    - Conducts major investigations and initiates proactive intelligence-driven operations;
    - Targets any serious and organised criminal activity within the fishing sector;
    - Provides specialist investigative training; and
    - Provides technical assistance in relation to covert surveillance.
4. Fisheries Intelligence Unit
    - Responsible for providing intelligence reports to support strategic, operational and tactical needs of compliance programs; and
    - Collects and analyses compliance data.
5. Compliance Statistics Unit

[76] The *Prosecution Guidelines* is a confidential guide used by FMOs that provide a tiered framework for dealing with fishery offences, thus it is not a publically-available document.

- Develop monitoring and sampling programmes to support compliance delivery;
- Collects and analyses compliance data to identify trends; and
- Provides compliance statistics to help target enforcement activities.

6. Prosecutions Unit
    - Manage the electronic system used to issue infringement notices or commence prosecution processes when offences are detected; and
    - Custodians of information relating to detected offences which can be used for official reporting purposes.
7. Strategic Policy Section of the Regional Services Branch
    - Develops and implements strategic compliance policy and standards;
    - Provides compliance risk assessments for fisheries;
    - Provides review and implementation of fisheries management and compliance legislation;
    - Oversees collection and analysis of compliance data;
    - Oversees compliance research projects;
    - Develops occupational health and safety standards for FMOs; and
    - Provides recruitment and training of new and existing FMOs.

15.3.1.2 Formal MCS Systems

Compliance staff utilise a number of formal monitoring and surveillance activities and control mechanisms in the EGPMF.

15.3.1.2.1 Monitoring Activities

VMS is a mandatory requirement for real-time monitoring to ensure fishers are operating within the legislated permitted fishing areas. All vessels operating in the EGPMF are required to install an Automatic Location Communicator[77] (ALC) pursuant to the fishery's Management Plan. The ALC tracks the location of the boat and transmits information such as the geographical position, course and speed of the boat via a satellite link to a VMS database at the Department's Marine Operations Centre in Fremantle, with authorised Departmental officers able to access VMS data in real-time. This monitoring reduces incentives to break the law due to a high level of certainty that an offence would be detected.

The licensee and / or the master of every licenced fishing boat is required (under regulation 64 of the FRMR) to submit accurate and complete catch and effort returns on forms approved

[77] Statutory approved directions are gazetted and readily-available to regulate the installation, use, servicing and testing of approved ALCs.

by the Department. Daily[78] Trawl Logbook Sheets (see Appendices) have been completed by all skippers in the fisheries since 1962/63 and have been compulsory since 2008. On each logbook sheet, fishers are required to report the starting position (longitude and latitude), start time, duration, mean depth and catches of each retained species for each trawl shot, as well as daily records of all ETP species interactions and environmental data (i.e. water temperature and moon phase).

This fishery operates using a constant escapement approach, with catch and effort monitored by the research branch and used to inform in-season control rules related to the rolling opening/closure of management areas throughout the Fishery. As part of the control rules, once the catch rates in an area fall below the limit reference levels, the area is closed to fishing activity (for a specified period of time or for the remainder of the season depending on the area). Thus, there is an incentive for fishers not to under-report catches, as this will generate a lower catch rate and thus, the potential closure of an area to fishing activity.

15.3.1.2.2 Control Mechanisms

Fisheries legislation forms the main component of the control system for commercial fisheries in WA, along with conditions applied on an MFL. The EGPMF is subject to controls under:

- The EPBC Act (export exemptions);
- The FRMA;
- The FRMR;
- The *EGPMF Management Plan*; and
- MFL conditions.

A description of the control measures in place are provided in Table 15.1.

Table 15.1. Description of the control measures and instruments of implementation in the EGPMF

Measure	Description	Instrument
Limited Entry	A limited number of Managed Fishery Licenses (15) are permitted to operate in the EGPMF.	EGPMF Management Plan
Effort Restrictions	The fishery currently operates under a maximum headrope capacity restriction of 395.02 metres (216 fathoms).	EGPMF Management Plan FRMA (Section 7 exemptions)
Gear Controls	Include controls on mesh size (≤ 60 mm) of nets, boat length, size of the ground chain (≤ 10 mm diameter) and the dimensions of the otter boards, including metal shoes.	EGPMF Management Plan FRMA (Section 7 exemptions)
Bycatch Reduction Devices (BRDs)	The fleet is required to have BRDs in the forms of grids and fish exclusion devices (FEDs), such as square mesh panels, in all standard nets.	MFL Condition

[78] Shot-by-shot information provided since 1998

Annual Closed Season & Cap on Fishing Days	The fishery is closed to fishing between November and April each year, with the aim of a maximum of 200 total fishing days each year.	EGPMF Management Plan (clause 10 annual notice)
Spatial Closures	The south-eastern area of Exmouth Gulf is permanently closed to trawling activities to preserve seagrass and other sensitive habitats that are essential nursery areas for prawns and other species.	EGPMF Management Plan
	There is a Port Area Closure in place within three nautical miles of Exmouth.	
	There are permanent trawling closures in place as part of the Ningaloo Marine Park and Muiron Islands Marine Management Area.	FRMA (Section 43 orders)
	Non-statutory rolling spatial closures in the management areas are used throughout the season to contain and direct overall fleet effort, control effort on brown tiger prawns, and provide industry the opportunity to maximise economic returns.	Co-operative arrangement (non-statutory)
Temporal Closures	Fishing is only permitted between 1800 and 0800 hours the following day, as prawns are nocturnal. In some years approval has been granted to fish later than 0800.	EGPMF Management Plan (clause 10 annual notice)
	Fishing closures also occur for a minimum of four days around each full moon.	Co-operative arrangement (non-statutory)
Reporting	Fishers are required to report all retained (target and non-target) species catches, effort, ETP species interactions and fishing location in statutory daily logbooks.	FRMR (regulation 64)
	Fishing activities are also monitored via the satellite VMS and the master must submit a nomination of intention to enter the fishery via VMS.	EGPMF Management Plan

15.3.1.2.3 Surveillance Activities

FMOs deliver compliance activities directed at commercial fisheries through pre-season briefings with the masters of the licenced fishing boats and pre-season inspections, as well as at-sea inspections and investigations resulting from suspected breaches detected via the VMS and intelligence-led operations.

FMO's follow a variety of established Standard Operating Procedures (SOPs) when undertaking patrol and inspection work. This procedure ensures that inspections are carried out safely, efficiently, correctly and with due regard to relevant policies. SOPs also ensure consistency in the delivery of compliance services and the ability to quickly familiarise new staff to the specifics of important compliance elements in a fishery.

The majority of surveillance activities in the EGPMF are undertaken by FMOs during field-based patrols. Compliance activities undertaken during patrols are recorded and reported by

FMOs using a daily patrol contact (DPC) form. The purpose of these forms is to record and classify contacts and time spent in the field for each FMO. These forms provide managers with information about:

- The number of field contacts made, which provides a context for the number of offences detected. This includes random contacts and offences from random inspections;
- The number of targeted[79] contacts made, which provides information on the effectiveness of the intelligence gathering capacity at identifying 'targets';
- The number of face-to-face contacts outside of a compliance context (referred to as 'A/L/E' contacts) made, which provides information on the educative effort of FMOs in a fishery; and
- Other routine information that can be used to help managers report on where and on which fisheries FMOs have undertaken patrols. This information is also used in patrol planning and risk assessments and ensures accountability of the compliance program.

A 'contact' occurs when an FMO has a chance of detecting illegal activity being undertaken by a fisher and includes personal contact (face-to-face), covert activities (e.g. deliberate, intensive surveillance), unattended gear checks (e.g. checking BRDs on a trawl net) and A/L/E contacts. VMS vessel days are also considered commercial compliance contacts. VMS vessel days are a proxy for fleet size and compliance coverage, representing each day that a vessel has an ALC operational (whether fishing or not) and therefore, a day that FMOs can assess whether it is complying with statutory spatial closures. In addition, VMS allows for a more targeted and cost effective on-ground compliance delivery.

The DPC form also includes a section to record details of individual commercial vessel inspections / checks. These inspections may involve:

- Inspection of all nets, BRD's, otter boards, VMS and other gear;
- Inspection of all authorizations; and
- Inspection of freezers and fish on board the boat.

Compliance field activity undertaken by FMOs operating from large (> 20 m) patrol vessels are reported and captured in the patrol vessel database (PVDB), which is available for use by compliance managers and other patrol vessels as needed.

The Department has also implemented an initiative called Fishwatch[80], whereby the community can report instances of suspected illegal fishing. The Fishwatch phone line provides a confidential quick and easy way to report any suspicious activity to Departmental compliance staff.

[79] A targeted contact is one that is initiated because available information indicates that an offence may have been committed or may be more likely to have been committed.
[80] http://www.fish.wa.gov.au/About-Us/Contact-Us/Pages/Fish-watch.aspx

15.3.1.3 Informal MCS Systems

There are a number of other informal factors that deter illegal activity including self-monitoring by skippers in the fishery, the homogeneity of the fishery in the EGPMF (all licences owned by one company) and market factors related to the demand / preference for different size prawns.

In order to assess compliance with voluntary area closures in place throughout the fishing season, vessel movements are monitored onshore by the licence holder (MG Kailis Pty Ltd) and skippers using real-time VMS data. Additional to the licence holder, skippers are able to monitor VMS lines on-board their boat and generally self-report any accidental incursions into closed areas. Additionally, as all skippers can see the activities of other boats, all skippers know when another vessel crosses a boundary and may also notify the skipper in question and / or Kailis when a boundary is breached.

Although compliance with the rolling opening / closing of various areas throughout the fishery is voluntary, the Department's VMS compliance team also monitor and report on VMS incursions annually. Information from these reports is used to assess general compliance levels in the fishery and inform the OCP and associated compliance activities for the following seasons.

15.3.2 Applying Sanctions

The EGPMF management system provides a number of incentives to fish both lawfully and sustainably. These incentives, combined with explicit penalties and comprehensive MCS systems, provide a robust framework for ensuring that licensed commercial fishers comply with the management arrangements.

There is an explicit and statutory sanction framework that is applied should a person contravene legislation relevant to the EGPMF. Sanctions applicable to the FRMA or FRMR are generally specific to each section or regulation. For example, section 74 of the FMRA sets out the sanctions applied when a clause of the *EGPMF Management Plan* is contravened[81], while section 77 sets out the sanctions applied should a condition of the MFL (e.g. the requirement to install prescribed bycatch reduction devices) be contravened.

Breaches in fishery rules may occur for a variety of reasons, and FMOs undertake every opportunity to provide education, awareness and advice to fishers; however, all offences detected in the fishery are considered to be of significant concern and are addressed by FMOs via the prosecution process outlined in the Department's *Prosecution Guidelines* and rules set out in the FRMA and FRMR. When an FMO detects a breach of the FRMA, the officer determines if the matter is prosecutable (according to the Department's *Prosecution Guidelines*) and where it is, a prosecution brief is prepared by the FMO and submitted to their supervisor. Based on the *Prosecution Guidelines*, there are four tiers of enforcement measures applied by FMOs when an offence is detected in the fishery including:

[81] Note that clause 19A of the Management Plan (offences and major provisions) is redundant as section 75 of the FRMA was revoked and replaced with section 74, which applies across all Fishery Management Plans

- Infringement warnings: These are written warnings issued for minor fisher offences. They do not incur a fine, but are a written record of a minor offence that may be referred to by Fishery Officers in the future. A certain number of infringement warnings for similar offences in a designated period may result in an infringement notice;
- Infringement notices: These are written notifications to pay a monetary penalty for an observed offence. Fishers issued infringement notices may choose to defend the matter in court; however, most fishers simply choose to pay the fine. The Department may initiate a prosecution brief for those fishers who appear to be habitual offenders;
- Letters of warning: A letter of warning (LOW) is an available sanction that achieves a formal record of a commercial offence where a prosecution may be unduly harsh under the circumstances. A LOW may be issued where an offence may have been committed but detected outside of the 45-day period where an infringement can be issued. There may not be a public interest in prosecution, but this still formally records the detected offence. A LOW formally advises the offender of their actions and seeks future 'voluntary' compliance.; and
- Prosecutions: These are offences of serious nature (prescribed in the FRMA) that immediately proceed to formal, legal prosecution. Such matters often incur hefty fines or can even result in incarceration, and matters brought before the court are often vigorously defended (especially by commercial fishers).

FMOs have the autonomy to issue an infringement warning after detecting some 'minor' offences that have resulted from a lack of understanding of the rules or an error of judgment, while infringement notices are used to apply a modified penalty and are usually used in cases where the offence does not warrant prosecution action that is likely to end up in court. Modified penalties are prescribed in Schedule 12 of the FRMR and can only be applied to particular sections of the FRMA (including contravening a provision of a Management Plan) and the FRMR[82]. A copy of the infringement notice is provided in Schedule 14 of the FRMR. If there is a dispute over an infringement notice, the offender can request the matter be heard in court.

More serious offences against the legislation will require the Department to seek to prosecute. The Department's Prosecution Advisory Panel (PAP) reviews recommendations made by the RSD in respect to alleged offending against the FRMA (or Pearling Act) and considers whether such decisions are in the 'public interest'. This process ensures fairness, consistency and equity in the prosecution decision-making process. The PAP consists of three panel members (representing legal and executive services and the compliance and aquatic management branches) who meet on a monthly basis or as necessary. The PAP operates on a majority basis, with the prosecution process continuing where the majority of the PAP agrees with the recommendation to prosecute. If the majority of the PAP disagrees with the recommendation to prosecute, the matter is referred to the Chief Executive Officer (CEO) of

[82] http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_1458_homepage.html

the Department, who will then make a determination on the matter. Should prosecution action be undertaken, the outcomes are generally released to the public via media releases and recorded on the Department's website[83]. Penalties for illegal activity in WA fisheries are commensurate with the value of the illegal fish involved and the type of illegal activity. This can sometimes result in large monetary penalties for certain types of activities, with large penalties considered necessary in order to create a deterrent effect for high-value species, such as western rock lobster or abalone. Additional penalty provisions that apply should there be a prosecution are provided in the FRMA under sections 222 (mandatory additional penalties based on value of fish), 223 (court ordered cancellations or suspensions of authorisations), 225 (prohibition on offender activities) and 218 (forfeiture of catch, gear, etc.).

A successful prosecution for a serious offence in a commercial fishery may result in a 'black mark' against the fisher or the commercial licence (as per section 224 of the FRMA). If an authorisation holder or a person action on behalf of the holder accumulates three black marks within a 10-year period, the authorisation is suspended for one year. Additionally, under section 143, the CEO has the administrative power to cancel, suspend or not renew an authorisation in certain circumstances, which can be used even if cancellations through the court are unsuccessful. These powers have been regularly used to deal with serious offending in other fisheries.

All fisheries offences in WA are recorded in a dedicated Departmental offences system, which also manages the workflow associated with infringements and prosecutions. In order to link this information with patrol data, FMOs include information about the fishery, DPC area, type of patrol and whether the offence resulted from a targeted inspection in all offence paperwork.

15.3.2.1 Sanctions in the EGPMF

Despite a continuing level of MCS in accordance with the OCP, there have been few offences in the last ten years (Table 15.2). Note the data provided here indicate offences that resulted in an outcome in-line with the enforcement measures described above. For example, in 2007/08 for EGPMF there was a prosecution brief developed which resulted in a letter of warning.

[83] Example of media release: http://www.fish.wa.gov.au/About-Us/Media-releases/Pages/Court-fines-hit-hard-for-out-of-season-lobster-fishing.aspx

Table 15.2. Summary of offences in the EGPMF from 2004/05 – 2013/14

Year	Infringement Warnings	Infringement Notices	Letters of Warning	Prosecution
2004/05	0	0	0	1
2005/06	0	0	0	0
2006/07	0	0	0	0
2007/08	0	1	1	0
2008/09	0	0	0	0
2009/10	0	0	0	0
2010/11	0	0	0	0
2011/12	0	0	0	0
2012/13	0	0	0	0
2013/14	0	0	0	0

15.3.2.1.1 Industry-initiated Sanctions

Although there are no industry-implemented sanctions in place, at the end of each fishing year in the EGPMF, skippers are eligible for a 'bonus' payment (from their employer), which is calculated based on the percentage of the total catch they landed during the season and their voluntary compliance[84] with industry closures during the season. Thus, skippers have a financial incentive to comply with voluntary closures in order to receive a higher bonus at the end of the season.

15.3.3 Level of Compliance

In recent years, FMO effort has been directed at building stronger relationships with industry through higher levels of contact both at sea and in port. For the 2013/14 financial year, the number of suspected breaches of closed waters detected through the VMS and other monitoring methods in the GCB has increased due to a more focused intelligence base of compliance; however, compliance in the GCB overall is assessed as being at an acceptable level across all the fisheries. Additionally, compliance staff assess that the commercial fishing industry in this area continues to demonstrate a positive approach to complying with regulations and playing their part to ensure the sustainability of their fisheries.

In evaluating compliance in a specific fishery, the Department uses a weight-of-evidence approach, which considers:

- Ongoing evidence of a sustainable fishery, i.e. whether ecological objectives continue to be met;
- Assessment of the risk posed by the fishery to target species and ecosystem components under the current management regime;
- Annual outputs arising from formal MCS systems —
    - Adequacy of commercial compliance coverage (patrol hours) including VMS;

[84] While not formally reported, voluntary compliance statistics and sanctions applied by the licence holders can be made available for assessment purposes if required.

    - Number of offences and successful prosecutions (dependent on whether compliance is undertaken in a random or targeted manner); and
    - Average non-targeted compliance rate;
- Number of reports of illegal activity logged by Fishwatch and from intelligence gathered by FMOs;
- General level of industry support / buy-in around fishing rules; and
- Level of compliance education and communications during key stakeholder engagement (at least annually).

Using this weight-of-evidence approach, there is a high degree of confidence that fishers in the EGPMF comply with the management system in place, including providing information of importance to the effective management of the fishery based on the following:

- There is ongoing evidence that the fishery is operating sustainably, as the performance indicators for each component (i.e. target species, retained non-target species, bycatch, ETP species, habitat and ecosystem processes) of the fishery has been maintained above threshold reference levels;
- In the most recent ecological risk assessment (2008) for the EGPMF, the highest risk indicated to any component was 'moderate' (i.e. the maximum acceptable level of impact). Where this was the case (i.e. brown tiger prawns), appropriate management actions have been implemented to mitigate this risk. The *Status Report of the Fisheries and Aquatic Resources of Western Australia* report on the evaluation of performance of the fishery annually;
- There have been no offences recorded (based on formal compliance systems) in the EGPMF within the last five years;
- There are 46 intelligence reports for the EGPMF on the Department's intelligence management system, "Seastar", over the last five years (Table 15.3).

Table 15.3. Summary of intelligence reports relating to the EGPMF

Year	ALL	VMS reports	Other reports
2009/10	11	11	0
2010/11	9	8	1
2011/12	20	20	0
2012/13	2	2	0
2013/14	4	4	0

- Additionally, apart from statutory requirements around submitting catch returns, the licensees actively participate in providing extra information for the effective management of the fishery, particularly through the provision of industry boats for Department surveys and the collection of additional data via industry surveys, which are delivered under a SLA with the Department.

The Department also measures compliance outcomes by estimating compliance and non-compliance rates. These terms refer to the proportion of fishers in a defined group (i.e. the EGPMF) that, on the basis of random inspections, were found observing fishing rules or not, respectively. Thus, the estimated average annual compliance rate is obtained by comparing the number of non-targeted contacts with fishers in the EGPMF against the number of detected offences. The average compliance rate for the EGPMF between 2007/08 and 2012/13 is estimated at 99.99 %. Based on the weight-of-evidence approach detailed above and the long-term compliance rate, there is no evidence of systematic non-compliance by the licensees and skippers in the EGPMF, nor is there evidence that the existing (negligible) level of non-compliance in the past five years is a risk to target prawn stocks or ecosystem components.

15.4 Research Plan

The EGPMF has a research plan in place that addresses the information needs for management.

15.4.1 Research Plan

The EGPMF research plan was developed in three parts by scientists, managers and stakeholders who are involved across stock status (MSC Principle 1); ecology (MSC Principle 2); and governance, policy, compliance (MSC Principle 3). There are four main ways that issues that require the development of further monitoring and research projects are identified:

- Existing monitoring that identifies issues that arise in the fishery (e.g. not achieving operational objectives; these can also be issues identified by stakeholders or researchers);
- Results of other research, management or compliance projects or investigations;
- Expert workshops (including risk assessments) and peer reviews of aspects of research and management; and
- Industry liaison.

Once an issue or risk has been identified, an expert group, workshop or review can be established to review the available information and make recommendations regarding what research should be undertaken, and in many instances, help develop an appropriate research framework.

The management actions in Fish Plan and the Research Strategic Plan inform the fishery-specific research plan to ensure that there is a coherent and strategic approach to research. The current research plan for the EGPMF is primarily detailed in two documents:

1. the *RMAD Plan* (pp 76 – 81 of DoF 2012b); and
2. the *EGPMF Bycatch Action Plan 2014 – 2019* (DoF 2014b).

However, the research plan for the EGPMF also comprises other research, as the need arises.

15.4.1.1 RMAD Plan

As discussed under Section 14.3, the Departments' *RMAD Plan* forms part of the planning cycle for determining research, monitoring and assessment needs for the EGPMF and specifically outlines the historical, current and proposed activities that will support the collection and analysis of data to assist the Department to meet the objectives of the FRMA over a five year period (currently 2011/12 to 2015/16).

The *RMAD Plan* contains a matrix that sets out the research activities associated with the following components of the EGPMF:

1. Target prawn species;
2. Habitat and ecosystem;
3. Ecosystem/environment;
4. Management analysis; and
5. Industry development.

The focus of current monitoring and research as set out in the *RMAD Plan* includes:

- Assessment of brown tiger and western king prawn stocks;
- Monitoring catch of non-target retained species against acceptable levels;
- Monitoring area of the fishery that is trawled;
- Monitoring ETP species interactions;
- Economic analysis; and
- Assessing biodiversity of trawled and untrawled areas.

The outcomes of monitoring and research undertaken in accordance with the *RMAD Plan* are reported in the annual *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries* (e.g. Fletcher & Santoro 2013).

Past research that has been undertaken for the EGPMF includes:

- Target species biology (1970s – 1990s);
- Assessment of brown tiger prawn abundance in nursery areas of Exmouth Gulf (1998);
- Impact of cyclones and macrophytes on the recruitment and landings of brown tiger prawns, *Penaeus esculentus*, in Exmouth Gulf (1999 – 2006; Loneragan et al. 2013);
- Implementation and assessment of bycatch reduction devices in the Shark Bay and Exmouth Gulf trawl fisheries (2002; Kangas & Thomson 2004);
- Studying catch / effort relationships and efficiencies;
- Comparing faunal assemblages in trawled and untrawled areas within the Exmouth Gulf prawn fishery (2004; Kangas et al. 2007); and

- Understanding factors relevant to the implementation of formal co-management (2008 and 2009; Kangas et al. 2008; Rogers 2009).

15.4.1.2 Bycatch Action Plan

It is Government policy to minimise bycatch in all commercial fisheries. The *EGPMF Bycatch Action Plan 2014 – 2019* (DoF 2014b) details a program of actions to be undertaken over 2014 – 2019 to address bycatch issues in accordance with the *EGPMF Harvest Strategy 2014 – 2019* (DoF 2014a). The focus of the BAP is on developing management responses to ecological risks associated with the fishery and developing appropriate management measures to minimise fishery interactions with species listed under the EPBC Act (i.e. ETP species).

The actions contained in the BAP are considered appropriate to meet ecological management objectives that are consistent with achieving the outcomes expressed by MSC Principle 2 as they relate to non-target retained species, bycatch, ETP species and ecosystem processes.

The BAP aims to:

- Develop and implement cost-effective strategies to pursue continual improvement in reducing bycatch;
- Review relative changes in bycatch due to bycatch mitigation and extend information on best practice to industry;
- Develop measures to further reduce interactions with, or impacts on, ETP species;
- Respond to adverse impact on Exmouth Gulf ecology from prawn fishing activity; and
- Develop measures to better utilise what would otherwise be discarded.

The BAP includes actions to monitor and manage impacts on high risk bycatch / ETP species, particularly sawfish and sea snakes, as limited information currently exists on the impact of the fishery on sea snake and sawfish populations in Exmouth Gulf. The BAP addresses the need for species-level identification and quantitative estimates of mortality through a bycatch monitoring program, as well as obtaining available information on local population abundances to provide assessments of the sustainability of bycatch and research on mitigation measures for these species.

15.4.1.3 Other Research

Following the marine heatwave in the summer of 2010/11, the first of two workshops was undertaken in May 2011. The first workshop focused on the oceanographic conditions associated with the event, as well as the short-term effects such as fish kill and southerly range extension of a number of tropical fish species. The second workshop was held on 11 March 2013, about two years after the original event (Caputi et al. 2014). About 80 scientists and stakeholders attended, and 16 presentations were made at the workshop. The second workshop concentrated on the oceanographic conditions since the first workshop and the longer-term (2 years) effect on fisheries and the marine environment.

As part of this process, the Department is currently finalising a report for FRDC Project No. 2010/535 *Management implications of climate change effect on fisheries in Western Australia: Part 1*. As part of this study, prawn species in WA were examined for climate change effects, and brown tiger prawns were assessed as being at high risk to impacts resulting from climate change. It is recognized that there is a need to ensure the harvesting approach for the EGPMF is sufficiently robust to be able to take into account long-term changes in abundance and distribution of prawn stocks that may be due to (particularly extreme) climate change effects.

The Department (in conjunction with the University of Western Australia) is currently in the process of applying for funding from the FRDC (currently at the second Expression of Interest [EOI] stage) for a high-priority project *Examining the relationship between fishery recruitment, essential benthic habitats and environmental drivers in Exmouth Gulf and Shark Bay* (see Section 5.3). Should the funding application be successful, the project is expected to start in mid-2015.

15.4.2 Research Results

The results arising from projects outlined in the EGPMF research plan are made publicly available in a timely manner on the Department's website[85] in the form of Fisheries Management Papers, Fisheries Research Reports and Fisheries Occasional Publications. For example, the research results relating to the FRDC 2000/189 (Kangas & Thomson 2004) were published in 2004, following the completion of the project in 2003. The results of some research projects are also published in international journals.

The performance of the fishery is provided to the licensee annually in the Season Report. This information is published later that year in *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries*. The results from recruitment and spawning stock surveys, as well as analyses of daily logbook data are communicated to the licensee immediately after they are completed so that in-season as decisions to open and close areas are made in a timely manner.

15.5 Monitoring and Management Performance Evaluation

There is a system for annually monitoring and evaluating the performance of all parts of the fishery-specific management system against its objectives. There is also effective and timely review of the EGPMF management system.

15.5.1 Evaluation Coverage

The EGPMF has in place mechanisms to evaluate all parts of the management system. Should any data arising from regular monitoring and evaluation indicate that the EGPMF is having an unacceptable impact, review processes (see Section 15.5.2) are triggered and decision-making processes (see Section 15.2) are implemented.

[85] http://www.fish.wa.gov.au/About-Us/Publications/Pages/default.aspx

15.5.1.1 Harvest Strategy Evaluation

Annual evaluation of the performance of the fishery against the reference levels contained in the harvest strategy is the main mechanism used to evaluate the fishery-specific management system. A review of one or more parts of the management system is triggered (see Section 15.5.2) if annual (or in-season) performance evaluation against the operational (short-term) objectives indicates the potential need for a management response (i.e. when below the target level). Thus, a precautionary approach is taken, and potential issues are recognised and addressed in a timely manner prior to the following fishing season or during the current season, to meet both operational and long-term management objectives.

Long-term annual monitoring of performance indicators, together with the evaluation of those indicators against the reference levels in the harvest strategy, indicates that the fishery-specific management system continues to be effective in achieving Principle 1, 2 and economic management objectives. The outcomes of annual monitoring and evaluation are reported annually in the *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries*.

15.5.1.2 Research

The status and progress of activities required under the EGPMF research plan are closely monitored by Research staff to ensure that actions are being undertaken within the designated timeframes. Any issues around milestones, monitoring, reporting, resourcing, etc., relevant to the EGPMF research plan are discussed with Management staff as they arise. In addition, the Research Division's Supervising Scientists group has fortnightly meetings to raise any issues, which could include risks around the timing of delivery of research programmes / information. This group develops actions to address slippages, and any significant issues can be included as standing items.

The regular monitoring framework applied to the EGPMF research plan may identify a need to undertake interim external or internal review of the research plan outside of the normal five year review cycle (see Section 15.5.2).

15.5.1.3 MCS System

Ongoing annual monitoring of compliance service delivery is undertaken at a Regional and local office level and relies on a weight-of-evidence approach considering information available from specialist units, trends and issues identified by local staff and Departmental priorities set by the Aquatic Management Division.

Offence types, numbers and sanctions relevant to the EGPMF are monitored on an annual basis by the Compliance Statistics Unit and, together with annual VMS days, patrol hours and contacts, are reported annually on a bioregional basis in *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries*. Based on this, data used to annually evaluate compliance effectiveness in the EGPMF include:

- level of fishing effort
- VMS vessel days

- patrol hours
- targeted and non-targeted contacts
- detected offences (type and number)

The estimated annual non-targeted compliance rate is obtained by comparing the number of non-targeted contacts with the EGPMF against the number of detected offences. In 2013, the estimated non-targeted compliance rate in the EGPMF was 100 %. Should the evaluation of the annual non-targeted compliance rate identify a decrease in the level of compliance in the EGPMF, a review is triggered to investigate the reasons, which may result in an immediate review of the MCS System (see Section 15.5.2).

15.5.1.4 ESD Performance Measures

Monitoring and evaluation against ESD performance measures is undertaken annually and reported in *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries*. In 2012 and 2013, all three performance measures relevant to the EGPMF were met (2012 outcomes provided in Fletcher & Santoro 2013). The 2013 evaluation will be provided in the next edition (2013/14) of *Status Report of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries*.

15.5.2 Internal and External Review

The fishery-specific management system is subject to regular internal and external review.

Current actions across the management, assessment / monitoring and research and compliance areas for the EGPMF over the five year period 2011/12 – 2015/16 were developed in consultation with key stakeholders and are set out in Fish Plan. However, internal or external reviews of the management system can occur at any time should patterns or trends emerge from annual monitoring and evaluation of the harvest strategy. Such reviews can identify management actions or any additional data needs (e.g. monitoring) or new research, management or compliance projects. Any major changes are reviewed with key stakeholders. Fish Plan was last reviewed in July 2014.

The statutory management framework is reviewed when there is evidence to support statutory changes to the longer-term management measures or to implement new longer-term measures. There is no need to regularly amend the Management Plan; thus, the EGPMF Management Plan was last amended in 2004 to update fishery boundary and areas, implement payment of access fees by instalment and to define the Exmouth Gulf Port Area.

As part of the Department's risk-based planning cycle, the current risk assessment for the EGPMF management system will be reviewed in 2016/17 and the Risk Register updated. The new risk assessment will inform a major review of the management system, including Fish Plan, the EGPMF research plan and compliance requirements. The review will also take into account the level of resourcing across the management, research and compliance for the EGPMF, which will be modified if a change to the level of risk has altered the level of management, compliance, monitoring or assessment required in the future. The risk assessment and management review involve extensive consultation with the key stakeholders.

15.5.2.1 Harvest Strategy

The EGPMF harvest strategy was recently subject to extensive internal review, followed by external review in consultation with the licensee, which resulted in the current harvest strategy (2014 – 2019; DoF 2014a). While the next review of the harvest strategy will occur in 2019, the appropriateness of the current performance indicators, reference levels and control rules will be further refined and updated during this time in consultation with the licensee as further relevant information becomes available (e.g. new research, risk assessments, expert advice, etc.).

15.5.2.2 Research

Any results arising from the research plan are generally externally peer reviewed, and always internally peer reviewed prior to publishing. The Supervising Scientists group manages the peer review process of all fisheries, including with external reviewers.

Regular reviews of Fish Plan and the higher level Research Strategic Plan (last reviewed in April 2012) may trigger an immediate review of the EGPMF research plan at any time. The five-year cycle review and risk assessment may also trigger a review of the research plan. The RMAD Plan will be reviewed in consultation with external stakeholders in 2016/17.

Requirements for new research can be identified at any time. For example, as part of the FRDC Project No. 2010/535 *Management implications of climate change effect on fisheries in Western Australia: Part 1*, prawn species were examined for climate change effects and brown tiger prawns were assessed as being at high risk to impacts resulting from climate change.

It is recognised that there is a need to ensure the harvesting approach for the EGPMF is sufficiently robust to be able to take into account long-term changes in abundance and distribution of prawn stocks that may be due to (particularly extreme) climate change effects. It is on this basis that the Department (in conjunction with University of Western Australia seagrass experts[86]) is currently in the process of applying for funding from the FRDC (currently at the second EOI stage) for a high-priority project entitled *Examining the relationship between fishery recruitment, essential benthic habitats and environmental drivers in Exmouth Gulf and Shark Bay.*

The stock assessment and research framework for the EGPMF was externally reviewed by Dr Malcolm Haddon (Marine Research Laboratory Tasmanian Aquaculture and Fisheries Institute, University of Tasmania) in November 2012 (see Section 7.6).

The EGPMF Bycatch Action Plan was recently subject to extensive internal review, followed by external review in consultation with the licensee, which resulted in the current *EGPMF Bycatch Action Plan 2014 – 2019* (DoF 2014b).

An internal review of the external 2001 ESD risk assessment for the EGPMF was completed in 2008. As a number of key changes had taken place in the fishery since 2001, the aims of

[86] http://www.uwa.edu.au/people/gary.kendrick

the internal risk assessment workshop were to revisit the risk ratings identified in 2001 and determine whether they were still relevant or whether they required amendment. In addition, any possible new risks were identified. A draft report of the outcomes was sent to stakeholders in 2009, with a copy of the final document made publically available (see Section 4.7 for more information).

15.5.2.3 Co-operative Management Framework

The co-operative management framework employed in the EGPMF is described in Kangas et al. (2008). Further to this, the EGPMF co-operative framework was used as a template to assess the feasibility of a local co-management governance model for other WA fisheries wishing to move to co-management. The results of the study were published in Rogers (2009).

15.5.2.4 ESD Accreditation Review

The EGPMF's export accreditation (and therefore its entire fishery specific management system) is externally reviewed (re-assessed) every five years by the Commonwealth DotE. The EGPMF fishery-specific management system was most recently reviewed by the DotE in 2013 and succeeded in achieving export accreditation the fishery for a period of five years (see Section 4.7 for more information). The EGPMF will undergo another external review when it is re-assessed in 2018.

15.5.2.5 US TED Accreditation Review

In 2005, the EGPMF successfully gained certification from the United States Department of State for its BRD-compliancy[87] and the use of turtle exclusion devices (TEDs), allowing licensees to export prawns to the U.S. market. In order to meet this requirement, the fishery was required to demonstrate that local legislation requiring fishers to use standard TEDs that meet US standards is in force and that the WA Government effectively monitors compliance and enforces penalties for violations.

This certification was reassessed most recently in 2014, which resulted in provisional certification dependent upon meeting required specification for US export approval by April 2015. The requirements will be met prior to the start of the 2015 season (see Section 4.7 for more information).

15.5.2.6 MCS System Review

Regular internal review of the EGPMF's MCS system is undertaken every 12 – 18 months by means of a compliance risk assessment. The EGPMF OCP is reviewed following the compliance risk assessment.

Gascoyne regional compliance staff and the VMS section primarily contribute to the compliance risk assessment process; however, management and research staff can attend and are given an opportunity to provide advice. Should the level of risk to compliance increase, further advice / resourcing can be sought from other areas of compliance (e.g. Special

[87] http://www.state.gov/e/oes/ocns/fish/bycatch/turtles/index.htm

Operations Unit). Following the compliance risk assessment review, the operational compliance plan is updated as required.

An external Auditor General's Public Sector Performance Report[88] on compliance in WA's commercial and recreational fisheries, including the EGPMF, was submitted to Parliament in June 2009. Following the Auditor General's Report, in November 2009, the Department's compliance program was evaluated with the aim of recommending optimisation in commercial and recreational fisheries in WA, the result of which were published in Green and McKinlay (2009).

As a result of these reviews, the Department has greatly improved its compliance program by:

- Developing regional and state-wide compliance risk assessments as a basis for its compliance program;
- Determining the level of compliance activity that is required to achieve effective compliance outcomes for individual fisheries; and
- Identifying and collecting the key information required for compliance reporting and management purposes.

The Department has recently applied for funding from the FRDC for a project entitled *Measurement of Fisheries Compliance Outcomes: A Preliminary National Study*, which began on 1 July 2014. Co-investigators include expert staff from AFMA, South Australian Fisheries and Victorian Fisheries. The project was requested by the National Fisheries Compliance Committee who has recognised that Fisheries Compliance groups face serious challenges demonstrating acceptable compliance outcomes as a result of their activities and the need for outcome indicators. The proposal is also strongly supported by the Australian Fisheries Management Forum.

Appropriate outcome indicators will measure whether compliance outcomes are being achieved in the long term. This will help to validate the effectiveness of the existing weight of evidence approach of combining compliance risks assessments and compliance outputs with sectoral involvement and research advice.

The measurement of compliance outcomes is different from fisheries compliance outputs. Output measures are relatively easy to determine (e.g. number of people fined), but fisheries compliance outcomes are not (i.e. a change in the skills, attitude, behaviour and circumstances of the target group or community in general). The project seeks to outline current best practice for compliance outcome measures, assess their strengths and weaknesses and where possible set a direction for the adoption of a national framework based on best practice. This is expected to result in a credible, reviewable framework for measuring fisheries compliance outcomes that can readily demonstrate value for money and an assessment of quality.

[88] https://audit.wa.gov.au/wp-content/uploads/2013/05/report2009_07.pdf

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17. Appendices

Appendix A: 2014 Internal PSA Risk Assessment Outcomes

1. Introduction

The Exmouth Gulf Prawn Managed Fishery (EGPMF) has a number of processes in place to assess and mitigate the potential impacts of the fishery on target, non-target retained, by catch and ETPs such as ecological risk assessments (ERA), spatial closures, bycatch action plans (BAPs), and compulsory reporting. All these processes are described in detail in the MSC Report for the EGPMF.

In addition to these processes, a Productivity Susceptibility Analysis (PSA) was conducted for all target and retained non-targeted species in EGPMF. All ETPs with recorded interactions and by catch species comprising >3% of the total landings of the fishery (based on surveys conducted by Kangas et al. 2007) were also included in the analysis. Where productivity attributes for a particular species were not available values for a similar species (in the same family) were used. If no productivity scores were available a pre cautionary approach was used and species were assigned the most conservative score. In some cases, where species identifications were uncertain similar species were grouped together. In these cases, the most conservative score was applied across the group i.e. cephalopods which grouped octopus, cuttlefish and squid. Where possible, productivity scores were obtained from Fishbase (www.fishbase.org) or the Department of Environment's Species Profile database (sprat) (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl). For productivity scores used in the PSA and explanation see Table 1.

Only 7 species / categories were assessed as medium risk; dolphins, four species of marine turtles (see below), sea snakes general, and indirect impacts with air breathing mammals (i.e. boat strikes). In addition, 1 category (sawfish) was assessed as high risk (see Table 2 for PSA scores). The species / categories assessed as medium and high risk were mainly scored at these levels due to their low productivity attributes rather than their susceptibility to the fishery per se as in many cases the PSA methodology does not allow sufficient scope to fully account for any mitigation that may be in place in the fishery to minimise interactions with these species. Some additional explanation for species/categories assessed as medium and high risk is provided below, additional information for ETPs is also available in Section 12 of the MSC Report for the EGPMF.

2. Medium species/categories from PSA

2.1. Dolphins

Dolphins were identified as a medium risk in the PSA. However, as trawlers do not operate at speeds greater than four knots it is unlikely that any cetacean would come in direct contact with a trawler or the gear being towed as they are able to remove themselves from the path. In addition, dolphins are common in inshore/coastal waters in Australia and there have been no interactions reported in the EGPMF in last 10 years. Therefore, despite the outcome of the PSA it is considered that the risk to dolphins from the EGPMF is negligible.

2.2. Marine Turtles

Four species of marine turtles (green turtle *Chelonia mydas*, loggerhead turtle *Caretta caretta*, flatback turtle *Eretmochelys imbricate* and hawksbill turtle *Natator depressus*) were assessed as medium risk by the PSA primarily due to the inability of the PSA to fully account for mitigation in the fishery that minimises the interactions with these species. Turtle bycatch mitigation in EGPMF has been addressed with the introduction of the mandatory use of grids in 2002/03. These grids have shown to be effective in the fishery with a 95 – 100 % reduction in turtle bycatch (Kangas & Thomson 2004). In addition, the fishery has gained certification from the US Department of State, one component of this certification was to demonstrate specific measures to mitigate interactions with marine turtles. In 2013, ten interactions with turtles were reported, all of which were returned to the water alive.

In 2010 the Northern Prawn Fishery (NPF), which is currently MSC certified, reported 27 interactions with marine turtles. A quantitative level 2.5 ERA of the NPF assessed 6 turtle species, including the four species with reported interactions with the EGPMF. None of the six species of marine turtles assessed were found to be at high risk due to the NPF largely due to the mitigation in place in the fishery and the fact that almost all turtles survive their interactions with the fishery (MRAG 2012). In comparison the EGPMF reported seven interactions with marine turtles in 2010, all of which were released alive.

Therefore, given the mitigation in place in the EGPMF, the scale of the interaction compared with a similar fishery (NPF) and the high likelihood of survival post release this level of interaction is considered to be a negligible risk to marine turtle populations, particularly as these species have wide distributions both within the Gulf and the greater Gascoyne Coast Bioregion (Kangas et al. 2006).

2.3 Sea Snakes General

Ten of the 22 sea snake species known to occur in WA have been recorded in Exmouth Gulf. In 2013, 111 sea snake interactions were reported in the EGPMF, with the majority of sea snakes returned to the water alive. Anecdotal evidence suggests that most sea snakes caught in the fishery are alive and aggressive when brought to the surface, which is thought to be an indication of health and lack of damage from the trawl. A study of sea snake survival following capture in trawlers in the Gulf of Carpentaria (Northern Territory) indicated that greater than 60 % of sea snakes survived capture in trawl nets (Wassenberg et al. 1994), it is likely that sea snakes in Exmouth Gulf have a similar level of survival.

Fish escape devices (i.e. a single panel of square mesh located in the top of the net posterior to the grid) have been a statutory requirement in the EGPMF since 2002/03. These devices, in combination with grids, have been successful in reducing the incidental capture of sea snakes by as much as 50% during experimental trials in 1995 (Brewer et al. 1998), although later testing indicated only a five per cent reducion (Brewer et al. 2006). Fisheye BRDs have also shown very promising results elsewhere, with a 43% reduction being reported in the NPF (Heales et al. 2008). Grids have also been shown to increase sea snake survival in the NPF by reducing the weight of the total (all species) catch in the net (Wassenberg et al. 2001). The

results of a study by Milton et al. (2009) in the NPF suggests that the short shot times (i.e. 60 – 180 minutes) in the EGPMF are also likely to increase the survival of captured sea snakes.

Similarly, sea snakes were highlighted as being of concern in a level 2.5 quantitative risk assessment of the NPF. Milton et al. (2008) found that the catch rates of the ten most common species have remained stable since 1976. The study also found that trawl induced mortality was below the reference points and no species appeared to be at risk based on the current levels of fishing effort in the NPF. Therefore, while sea snakes continue to be monitored in the NPF there are currently no sea snake species on the NPF list of priority species based on the outcomes of risk assessments.

Most sea snake species are considered to be abundant or common in Exmouth Gulf, and given the level of interactions with EGPMF, 152 recorded interactions with sea snakes in 2010 compared to 7 478 recorded interactions in the NPF, is not considered to have any significant detrimental effects on sea snake populations in Exmouth Gulf (Kangas et al. 2006).

However, it was recognised during the MSC pre-assessment that there is limited information on sea snake populations in Exmouth Gulf and that there is a need for species level identification, quantitative estimates of mortality and research on additional mitigation measures for sea snakes. In order to address this issue, the Department has developed the *EGPMF Bycatch Action Plan*, which includes an overview of ETP species issues, including sea snakes, in Exmouth Gulf and a proposed work plan for future / ongoing monitoring and research.

2.4 Indirect interactions with air breathing mammals (i.e. boat strikes)

Trawlers do not operate at speeds greater than four knots it is unlikely that any cetacean would come in direct contact with a trawler or the gear being towed as they are able to remove themselves from the path. Therefore this interaction is considered to pose a negligible risk to population of air breathing mammals.

3. High species / categories from PSA

3.1 Sawfish

Four of the world's seven species of sawfish are found in WA including the freshwater sawfish (*Pristis microdon*), dwarf sawfish (*Pristis clavata*), green sawfish (*Pristis zijsron*) and narrow sawfish (*Anoxypristis cuspidata*). Three species (*Pristis microdon*, *Pristis clavata* and *Pristis zijsron* are protected under the EPBC Act while *Anoxypristis cuspidata* is listed under Appendix I of CITES.

In Australian waters, green sawfish have historically been recorded in the coastal waters off Broome, Western Australia, around northern Australia and down the east coast as far as Jervis Bay, NSW (Stevens et al. 2005). However, there is little data on the species' relative abundance in northern Western Australian waters, although given that this region is less

populated by humans than the east coast, it may contain the healthiest populations of the species' in Australian waters (Stevens et al. 2005). Green sawfish have been recorded in very shallow water (<1 m) to offshore trawl grounds in over 70 m of water (Stevens et al. 2005). The toothed rostrum of sawfish, combined with their active hunting behaviour, makes them highly susceptible to capture in all fisheries that use nets. Studies of shark and ray bycatch in the NPF have identified the green sawfish as a species that is particularly susceptible to capture, based on the species' behaviour and habitat preferences.

The Australian distribution of the dwarf sawfish was previously considered to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in Western Australia (McAuley et al. 2005, Stevens et al. 2008, Last and Stevens 2009). However, there are insufficient data available to estimate the total numbers of mature individuals of dwarf sawfish in Australian waters The dwarf sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats and the species' range is restricted to brackish and salt water (Thorburn et al. 2007). A study in north-western Western Australia found that estuarine habitats are used as nursery areas by dwarf sawfish, with immature juveniles remaining in these areas up until three years of age (Thorburn et al. 2007). Adults are known to seasonally migrate back into inshore waters (Peverell 2007), although it is unclear how far offshore the adults travel, as captures in offshore surveys are very uncommon. As the majority of fishing in the EGPMF occurs in water depths between 7-30 m, which would suggest that the spatial overlap of the species' distribution and fishing effort would be restricted.

The freshwater sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula, Queensland. Whilst the total population of the Freshwater sawfish is unknown, DNA studies have shown that the species, though highly mobile when adult should be considered as populations, rather than a single population in Australian waters (Phillips et al. 2008). A study on the movement patterns of other sawfish species, *P. clavata* and *P. zijsron*, showed that the species had a high fidelity to an area, with movements restricted to only a few square kilometers within the coastal fringe, and influenced by tides (Stevens et al. 2008). Similar to the dwarf sawfish, as the majority of fishing in the EGPMF occurs in water depths between 7-30 m (with much of the coastal fringe protected as nursery grounds), this would suggest that the spatial overlap of the species' distribution and fishing effort would be restricted.

Sawfish have also been previously recognised as potentially high risk species in the NPF with a level 2 PSA rating for five sawfish species (*Pristis microdon*, *Pristis clavata*, *Pristis zijsron*, *Pristis pectinata* and *Anoxypristis cuspidata)* as high risk. The high risk rating was primarily due to a high overlap of the species' distributions with the NPF, their high degree of endemism and high susceptibility to capture and mortality due to their rostrum teeth entangling in the net mesh. Subsequently the five sawfish species identified as high risk in the NPF level 2 PSA were included in a Sustainability Assessment for Fishing Effects (SAFE) which determined a lower risk level of all five species. Although the SAFE findings did not consider sawfish to be high risk, given their EPBC status, *Pristis microdon*, *Pristis clavata*

and *Pristis zijsron* were included in the NPF priority species for monitoring (Brewer et al. 2007, MRAG 2012).

The use of grids has been shown to reduce the capture of narrow sawfish (*Anoxypristis cuspidata*) in the NPF by 73 % (Brewer et al. 2004). The reduction in sawfish landings following the implementation of grids in the EGPMF in 2007 is unquantifiable as there is no data available on sawfish interaction rates prior to grid implementation. However, anecdotal evidence from long standing skippers/crew suggests a similar level of reduction may have been achieved.

Interactions with sawfish have only been reported by the EGPMF since 2010 and interactions are not reported on a species basis due to issues with identification, therefore it is difficult to identify any changes in abundance or interaction rates. Fourteen interactions were reported in 2013, although the number of interactions has been variable over the past four years. The number of recorded interactions with sawfish in the EGPMF is low compared with other tropical trawl fisheries, such as the Northern Prawn Fishery which reported 380 interactions in 2010 compared to seven reported interactions in the EGPMF.

Sawfish have always been considered to be particularly vulnerable to fishing however, the long history of fishing in the EGPMF and continued low level of interactions with sawfish would tend to suggest that populations in Exmouth Gulf are being maintained. It would appear that the PSA is overly driven by productivity attributes and thus scores sawfish as high risk primarily due to their low productivity without due consideration the overlap between the spatial distribution of the species and fishing effort and level of recorded interactions. To further investigate the productivity of sawfish a demographic analysis was also conducted (see below). Consideration of recent information indicates that sawfish may have a higher productivity than previously thought, which in turn suggests a higher degree of resilience to fishing pressure than was considered to be the case in past years. Nonetheless, the global history of depletion for sawfish indicates that fishery related risks should not be ignored.

Table 1: Productivity and Susceptibility attributes and associated explanations of species/categories included in PSA.

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live baarer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Western king prawns	~0.5 y	1-2 y	>100000	~6 cm CL	~2.5 cm CL	BS	3	~27 % [A]	High	High	Retained	
Brown tiger prawns	~0.5 y	1-2 y	>96000	~5.5 cm CL	~3 cm CL	BS	3	~27 % [A]	High	High	Retained	
Banana prawns	~0.5 y	1-2 y	>100000	~2.5 cm CL	~4 cm CL	BS	3	~27 % [A]	High	High	Retained	
Coral prawns	~0.5 y*	1-2 y*	>20000*	~3 cm CL	~1 cm CL	BS	3	~27 % [A]	High	High	Retained	* Metapenaeopsis spp and Metapenaeus spp. Based on information for other prawn species
Blue endeavour prawns	~0.5 y	1-2 y	296000	4.7 cm CL	~2.6 cm CL	BS	3	~27 % [A]	High	High	Retained	
Blue swimmer crab	0.5-1 y	3-4 y	>68000	25 cm CL	9 cm CL	BS	3	~27 % [A]	High	High	Retained	
Bugs	3 y	4-8 y	32230	9.5 cm CL	<40 cm CL*	BS	3	~27 % [A]	High	High	Retained	*Based on max size being 9.5 cm CL
Cephalopods	0.5-1 y	< 2 y	~20-100000s	Typically <100 cm	Typically 15-25 cm ML	DEL	4	~27 % [A]	Medium	High	Retained	Includes cuttlefish, octopus and squid. As the fecundity of cephalopods can vary widely, it was assigned a precautionary score based on the lower value of the range.

[A] For all by product species, a precautionary approach has been adopted assuming that the stock of each species in Exmouth Gulf is functionally independent of other stocks. Thus the percentage overlap of the fishery with the stock is calculated as the average percentage of the fishery area trawled over the past five years.

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live bearer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Other portunid crabs						BS		Low	High	High	Released alive	Biology poorly known, biology assumed to be similar to blue-swimmer crab. Wide-distribution outside fishery.
Asymmetrical goatfish				30		BS	3.5	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Hair-finned leatherjacket				11		BS	3.1	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Trumpeter				30		DEL	3.5	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Scorpionfish							3.2	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maximum size not >100cm, and maturity inferred to be <40cm. Wide distribution outside fishery.
Gross' stinkfish				20		BS	3.3	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Rusty flathead				35		BS	3.7	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Zig-zag ponyfish				11.2		BS	3.2	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.
Blotched javelinfish				30		BS	4	Low	High	High	Majority released dead	Biology poorly known, but assumed to be fast-maturing, short-lived and fecund. Maturity inferred to be <40cm. Wide distribution outside fishery.

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live bearer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Dolphins, general	10-15 years	40 years	1 off-spring every 3 years	2.3 m	2 m	LB	> 3	Low	Low	Excluded from nets via grids	Majority released alive	Common in inshore/coastal waters along Australia; biological traits based on *T. aduncus* no interactions reported in the EGPMF in last 10 years
Green turtle	25 years	40 years	500 eggs per season, but only breed every 1 – 9 years (i.e. < 100 eggs per year)	1 m CCL	30 – 40 cm CCL	DEL	2	Low	Medium	Excluded from nets via grids	Majority (> 95 %) released alive	WA population estimated to be 20000 individuals; Juveniles occur throughout EG, but adults primarily found in seagrass/algae areas where they forage; EG is key nesting and interesting area for green turtles (at Muiron Islands); 10 'general turtle' interactions reported in EGPMF in 2013, with 5 'green turtle' interactions reported in 2012
Loggerhead turtle	25 years	> 25 years	500 eggs per season, but females do not breed each year (i.e. < 100 eggs per year)	1 m CCL	70 cm CCl	DEL	> 3	Low	Medium	Excluded from nets via grids	Majority (> 95 %) released alive	WA population separate from East Coast population; Adults primarily found in coral and rocky reefs, seagrass beds and muddy bays where they forage; major nesting and interesting area (150-350 females annually) around Muiron Islands and North West Cape (50 -150 females annually); 10 'general turtle' interactions reported in EGPMF in 2013 (all released alive)

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live bearer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Flatback turtle	? (precautionary score of 3)	> 25 years	150 eggs per season, but females do not breed each year (i.e. < 100 eggs per year)	1 m CCL	? (precautionary score of 3)	DEL	> 3	Low	Medium	Excluded from nets via grids	Majority (> 95 %) released alive	Found throughout tropical waters of N. Australia and PNG, although nesting is confined to Australia; Major nesting areas in WA at Barrow Island and Mundabullangana Station near Cape Thouin; Stay in continental shelf waters after hatching, with adults likely to feed in turbid, shallow water (10 – 40 m depths); 10 'general turtle' interactions reported in EGPMF in 2013 (all released alive);
Hawksbill turtle	? (precautionary score of 3)	> 25 years	500 eggs per season, but females do not breed each year (i.e. < 100 eggs per year)	80 cm CCL	? (precautionary score of 3)	DEL	> 3	Low	Medium	Excluded from nets via grids	Majority (> 95 %) released alive	WA population separate from East Coast population; fond in tropical tidal and subtidal coral and rocky reef habitat; feed on sponges, algae, fish, molluscs, etc.; Major nesting area at Varanus Is. And Rosemary Is. (around 3000 nest in WA annually); Cape Preston to Onslow also important feeding grounds; 10 'general turtle' interactions reported in EGPMF in 2013 (all released alive);

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live bearer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Green Sawfish	Approx. 9 years?	? (likely > 25 years)	< 100 offspring per year	6 m	? (precautionary score of 3)	LB	4	Medium	High	High	Majority likely to be dead when released	Interactions with Sawfish only reported since 2010 in EGPMF: 3 in 2012, 23 in 2011 and 7 in 2010 (no species level ID available; for comparison, the NPF had 310 interactions in 2010); likely to be dead when released, as many are removed from net by cutting rostrum; however, survival may be increased if kept in water and detangled from net, but this is dangerous for fishers. Lack of biological data on *Pristis* species, but likely to be long-lived, produce few pups and mature late in life (Stevens et al. 2005; Walker 1998). Some recent evidence suggests *Pristis* may mature earlier than thought. Green sawfish found around N. Australia, with collective evidence of decline in *Pristis* spp. in Australian waters over last 15 – 20 years; Green sawfish found in muddy bottom habitats in shallow to deep offshore waters (1 – 70 m depths)
Freshwater Sawfish	7 years	> 40 years	1-12 pups per year	7 m	3 m	LB	4	Medium	High	High	Majority likely to be dead when released	As above (*Pristis* spp. general) Juvenile and sub-adult freshwater sawfish found in rivers and estuaries, but large adults occur in coastal and offshore waters up to 25 m depth; found in soft muddy bottom habitats
Dwarf Sawfish	9 years	> 40 years	< 100 offspring per year	100 -300 cm (PSA score 2)	3 m	LB	4	Medium	High	High	Majority likely to be dead when released	As above (*Pristis* spp. general) Australian population of dwarf sawfish likely to comprise majority of global population; Dwarf sawfish are found in shallow (2-3 m) coastal and estuarine habitats as juveniles, with some inshore movement as adults; prefer silt/sand habitat with high turbidity

Species/Group	Productivity							Susceptibility				Comments
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy (BS - broadcast spawner DEL - demersal egg layer LB - live bearer)	Trophic level	Availability (Areal overlap)	Encounterability (Vertical overlap)	Selectivity	Post-capture mortality	
Sea snakes (Hydrophiinae)	2 years	10 years	Small broods with high mortality (< 100 per year)	1 - 2 m	Likely 40 – 200 cm	LB	> 3	Low	Medium	High	Released alive; use of hoppers may increase survival	Most sea snakes considered abundant or common SB and are found throughout N. Aus.; Sea snakes may be damaged if caught in mesh, but generally in good condition inside of net; Trawl duration within breath-holding capabilities for most species (i.e. < 2 hours); majority reported as returned alive (351 of the 363 individuals reported in 2013)
Short-nosed sea snake	? (as above used as proxy)	? (as above used as proxy)	Small broods with high mortality (< 100 per year)	60 cm length	Likely 40 – 200 cm	LB	> 3	Low	Medium	High	Released alive; use of hoppers may increase survival	Endemic to North West WA; occupies reef flats or shallow water along outer reef edge in up to 10 m depths; reported in EG during biodiversity sampling (Kangas et al. 2007)
Syngnathids (*Hippocampus* spp.)	< 5 years	< 5 years	Small brood size (< 100 offspring per year)	~ 20 – 30 cm	~ 10 cm	LB	> 3	Low	Medium	High	Majority released alive	Relatively low population densities, with strong habitat association (generally found around edges of seagrass beds and macroalgae-dominated reefs); low natural rates of mortality; very few reported in SBPMF(< 10 every few years), but likely to be under-reported since difficult to see and count within trawl catch
Boat strikes: Air-breathing megafauna (Cetaceans, dugongs, marine turtles)	Scored as high productivity across all categories as per most precautionary species							Low	Low	Low	Likely to survive due to low trawl speed	Trawl speed very low (3-4 knots), allows for avoidance of large megafauna; no boat strikes reported in recent years This includes humpback whales as EG and SB used as resting areas during southern migration period (Sept- Oct)

Table 2: Results of PSA for EGPMF

Species/Group	Productivity								Susceptibility					PSA Score	MSC Score
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy	Trophic level	**Total Productivity**	Availability	Encounterability	Selectivity	Post-capture mortality	**Total Susceptibility**		
Western king prawns (*Penaeus latisulcatus*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Brown tiger prawns (*Penaeus esculentus*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Banana prawns (*Penaeus merguiensis*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Coral prawns (*Metapenaeus* spp., *Metapenaeopsis* spp.)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Blue endeavour prawns (*Metapenaeus endeavouri*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Blue swimmer crab (*Portunus armatus*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Bugs (*Thenus orientalis*)	1	1	1	1	1	1	2	1.14	2	3	3	3	2.33	2.59	81.6
Cephalopods (cuttlefish, squid, octopus)	1	1	3	1	1	2	3	1.71	2	2	3	3	1.88	2.54	83.0

Species/Group	Productivity								Susceptibility					PSA Score	MSC Score
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy	Trophic level	**Total Productivity**	Availability	Encounterability	Selectivity	Post-capture mortality	**Total Susceptibility**		
Other portunid crabs (*Portunus tenuipes and P. rubromarginatus*)	1	1	1	1	1	1	2	1.14	1	3	3	2	1.43	1.83	97.3
Asymmetrical goatfish (*Upeneus asymmetricus)*	1	1	1	1	1	1	3	1.29	1	3	3	3	1.65	2.09	93.4
Hair-finned leatherjacket (*Paramonacanthus choirocephalus)*	1	1	1	1	1	1	2	1.14	1	3	3	3	1.65	2.01	94.8
Trumpeter (*Pelates quadrilineatus*)	1	1	1	1	1	2	3	1.43	1	3	3	3	1.65	2.18	91.7
Scorpionfish (*Paracentropogon vespa*)	1	1	1	1	1	2	2	1.29	1	3	3	3	1.65	2.09	93.4
Gross' stinkfish (*Callionymus grossi*)	1	1	1	1	1	1	3	1.29	1	3	3	3	1.65	2.09	93.4
Rusty flathead (*Inegocia japonica*)	1	1	1	1	1	1	3	1.29	1	3	3	3	1.65	2.09	93.4
Zig-zag ponyfish (*Equulites moretoniensis*)	1	1	1	1	1	1	2	1.14	1	3	3	3	1.65	2.01	94.8
Blotched javelinfish (*Pomadasys maculatus*)	1	1	1	1	1	1	3	1.29	1	3	3	3	1.65	2.09	93.4

Species/Group	Productivity								Susceptibility					PSA Score	MSC Score
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy	Trophic level	**Total Productivity**	Availability	Encounterability	Selectivity	Post-capture mortality	**Total Susceptibility**		
Dolphins, general (Family *Delphinidae*)	2	3	3	3	3	3	3	**2.86**	1	1	1	2	**1.03**	**3.04**	**66.0**
Green turtle (*Chelonia mydas*)	3	3	3	3	3	3	2	**2.86**	1	2	1	1	**1.03**	**3.04**	**66.0**
Loggerhead turtle (*Caretta caretta*)	3	3	3	3	3	3	3	**3.00**	1	2	1	1	**1.03**	**3.17**	**60.3**
Flatback turtle (*Eretmochelys imbricate*)	3	3	3	3	3	3	3	**3.00**	1	2	1	1	**1.03**	**3.17**	**60.3**
Hawksbill turtle (*Natator depressus*)	3	3	3	3	3	3	3	**3.00**	1	2	1	1	**1.03**	**3.17**	**60.3**
Sawfish (green, freshwater, dwarf) (*Pristis* spp.)	2	3	3	3	3	3	3	**2.86**	2	3	3	3	**2.33**	**3.68**	**34.8**
Short-nosed sea snake (*Aipysurus apraefrontalis*)	2	2	3	1	2	3	3	**2.29**	1	2	3	2	**1.28**	**2.62**	**80.8**
Sea snakes, general (Subfamily Hydrophiinae)	2	2	3	2	2	3	3	**2.43**	1	2	3	2	**1.28**	**2.74**	**76.8**
Sygnathids, general (*Hippocampus* spp.)	1	1	3	1	1	3	3	**1.86**	1	2	3	3	**1.43**	**2.34**	**88.3**
Air-breathing megafauna (Cetaceans, Dugongs and Marine Turtles)	3	3	3	3	3	3	3	**3.00**	1	1	1	2	**1.03**	**3.17**	**60.3**

Demographic analysis of sawfish (Family: Pristidae)

Sawfish are a circumtropical family of marine and euryhaline elasmobranchs comprising two genera and five species. They are shark-like batoids characterised by a toothed rostrum and large adult body size of 3.1 to 7.3 m (Last and Stevens 2009). Species of the genera *Pristis* are anadromous and likely philopatric; females give birth in tropical river systems where pups live during the first few years of their life before migrating into coastal waters. The only fully marine sawfish is in the genus *Anoxypristis*, with pups born in estuarine nurseries. Historically, sawfish were reportedly abundant although the populations of all species have reduced primarily due to anthropogenic impacts, such as fishing and habitat modification. All sawfish are currently assessed as Endangered or Critically Endangered by the IUCN (IUCN 2014). There are four species of sawfish found in northern Australian waters, and it is one of the few regions globally with viable populations of sawfish.

The PSA presented above for the EGPMF indicated that sawfish were a high-risk species with low productivity and high susceptibility scores. This demographic analysis investigates the biological productivity of sawfish to better understand their vulnerability to fishing. The analysis updates the recent demographic analysis undertaken by Moreno-Iturria (2012) to include more recent taxonomic and life history studies.

Methods

Life table analysis

Demographic analysis was carried out using life tables based on the discrete Euler-Lotka equation (Stearns 1992):

$$\sum_{x=0}^{\omega} l_x \, e^{-r} m_x = 1$$

where ω is maximum age, l_x is the proportion of female sharks surviving to age x, r is the intrinsic rate of population increase, and m_x is the annual number of females produced by females of age x. Age specific survival schedules were calculated as:

$$l_x = l_{x-1} e^{-M_x}$$

where M_x is natural mortality at age x, assumed to be constant and inversely proportional to longevity (Hoenig 1983):

$$M \approx \frac{4.3}{\omega}$$

Annual female fecundity was calculated as:

$$m_x = \begin{cases} 0 \, , x < \alpha + 1 \\ \dfrac{f}{2F} \, , x \geq \alpha + 1 \end{cases}$$

where f is average female fecundity,F is the frequency of reproduction, and total reproductive output was divided by 2, assuming an even sex ratio. A year was added to age at maturity, α, to account for the gestation period.

A range of additional quantities were calculated from the life table including the net reproductive rate (Simpfendorfer 2000):

$$R_0 = \sum_{x=0}^{\omega} l_x m_x$$

the mean generation length:

$$G = \frac{\sum_{x=0}^{\omega} l_x m_x x}{R_0}$$

the population doubling time:

$$T_2 = \frac{ln(2)}{r}$$

and the stable age distribution (proportion of individuals in each age class, C_x):

$$C_x = \frac{l_x e^{-rx}}{\sum_{x=0}^{\omega} l_x e^{-rx}}$$

Results and Discussion

Life History Information

Moreno-Iturria (2012) recently reviewed literature on the life history of sawfishes; these data formed the basis for the demographic analysis (Table 1). Since then a small number of additional studies were published and the taxonomy of the genus *Pristis* has also been revised by Faria et al. (2013). The large-tooth sawfish, *Pristis perotetti* and freshwater sawfish, *Pristis microdon* are now regarded as a single, circumtropical species, *Pristis pristis*. The present analysis includes the five currently recognised species. Length-weight relationships for three Australian sawfish (Salini et al. 2007) not included in Moreno-Iturria's (2012) study were also included here. In the absence of available data an assumption of Moreno-Iturria's (2012) study was that *Pristis* species have a two year reproductive cycle and average fecundity is 12. This assumption is also used here.

Table 1. **Sawfish life history information used in the demographic analysis. L_∞, is asymptotic length (cm), K is the Von Bertalanffy growth coefficient (year^{-1}), t_0 is age at length 0 cm, L_0 is length in cm at age 0, α is age at maturity (years) ω is maximum age (years), F is littler size, Freq is frequency of reproduction (years), and a and b are coefficients of a length-weight relationship.**

Species	L_∞	K	t_0	L_0	α	ω	F	Freq	a	b
Narrow sawfish	377	0.34	-0.53	62.17	2	9	15	1	5.00e-05	2.474
Dwarf sawfish	508	0.08	-2.09	78.22	8	34	12	2	3.00e-06	3.006
Smalltooth sawfish	448	0.22	-0.81	73.12	7	30	12	2	1.71e-06	3.040
Freshwater sawfish	638	0.08	-1.55	74.40	6	35	12	2	3.00e-06	2.998
Green sawfish	540	0.12	-1.12	67.91	5	24	12	2	1.71e-06	3.040

Narrow sawfish

The narrow sawfish, *Anoxypristis cuspidata* is the sole species within the genus *Anoxypristis* and the only species not known to use freshwater habitats in any life stages (Last and Stevens 2009). Peverell (2008) describes the life history of *A. cuspidata* from the Gulf of Carpentaria, and found the species to be relatively fast-growing (K = 0.34 year^{-1}) and early-maturing (α = 2 years). These growth rates have not been validated, however, are corroborated by Tobin et al. (2014) who reported a 96% increase in the length of age 0+ *A. cuspidata* over a 7-month period in the waters off Townsville. Narrow sawfish are relatively fecund; Stevens and Lyle (2009) report that litter size is approximately 15 and reproduction takes places each year. The narrow sawfish is among the smaller sawfish species, but still attains a relatively large size (W_∞ = 118 kg).

Dwarf sawfish

The biology of the dwarf sawfish, *Pristis clavata*, is highly uncertain. A small number of individuals were aged by Peverell (2008) up to 9 years of age, and a growth curve fitted to these data was used to estimate maturity and longevity parameters (α = 8 years, ω = 34 years). The maximum observed length for this species (310 cm) is not consistent with the growth curve, L_∞=508 cm, and no estimate of fecundity or breeding frequency is available for this species. Peverell (2008) notes anecdotal reports of *P. clavata* to 485 cm, suggesting that it may attain a similar size to other *Pristis* species.

Smalltooth sawfish

The smalltooth sawfish, *Pristis pectinata* is the only species that does not occur in Australia. Its listing in 2003 as 'Endangered' in the US has resulted in a substantial amount of research in the past decade leading to greater certainty in its life history. A recent vertebral growth analysis, verified using mass spectrometry, revealed this species to be relatively fast-growing (K = 0.22 year^{-1}). These findings are consistent with a tag-recapture study on juveniles (Simpfendorfer et al. 2008). It is likely moderately quick to mature and has a biennial reproductive cycle (α =7 years, Carlson and Simpfendorfer 2014). The smalltooth sawfish attains a large size (W_∞ = 196 kg).

Freshwater sawfish

Information on the life history of the freshwater sawfish, *Pristis pristis*, is relatively scant. Peverell (2008) aged 40 juveniles and 1 adult *P. pristis* from the Gulf of Carpentaria and concluded that the species was relatively long-lived (ω = 35 years) and slow-growing (K = 0.08 yr^{-1}). Although *P. pristis* attains a very large size ($W_\infty = 772$ kg) and may take a long time to reach this size, Moreno-Iturria (2012) concluded that female maturity likely occurs at a relatively young age (α = 6 years).

Green sawfish

Life history traits of the green sawfish, *Pristis zijsron*, are also highly uncertain. Peverell (2008) aged 18, *P. zijsron* up to a maximum age of 18 years, and concluded that the species lives to at least 24 years. Few observations of mature individuals have been made, however on the basis of a length at maturity of 300 cm, and using the growth curve of Peverell (2008), Moreno-Iturria (2012) estimated maturity to occur at a relatively young age (α = 5 years). Like most of the other *Pristis* species, *P. zijsron* attains a large size ($W_\infty = 346$ kg).

Demographic analysis

Based on the available life history information, intrinsic rates of population increase ranged from r = 0.15 year^{-1} for Dwarf sawfish to r = 0.38 year^{-1} for Narrow sawfish (Table 2). These rates of r suggest *Pristis* species are moderately productive, and imply a population doubling time, T_2, of 3.25 to 4.55 years. Rates of population increase for the Narrow Sawfish are indicative of a productive species, and imply a T_2 of just 1.84 years. The long lifespan and proportionally young age at maturity imply a relatively high reproductive output, R_0, (lifetime production of female offspring) for *Pristis* species of between 6.03 and 10.67. Figure 1 compares the stable age distribution for each of the five species, showing the expected proportion of individuals in each age class based on the demographic model.

Table 2. Demographic characteristics of sawfish species based on life-table analysis. *r* is the intrinsic rate of population increase (year^{-1}), R_0 is reproductive output, *G* is generation time (years), and T_2 is population doubling time (years)

Species	*r*	R_0	*G*	T_2
Narrow sawfish	0.38	4.54	4.38	1.84
Dwarf sawfish	0.15	7.79	15.41	4.55
Smalltooth sawfish	0.16	6.87	13.60	4.30
Common sawfish	0.21	10.67	13.80	3.25
Green sawfish	0.20	6.03	10.44	3.52

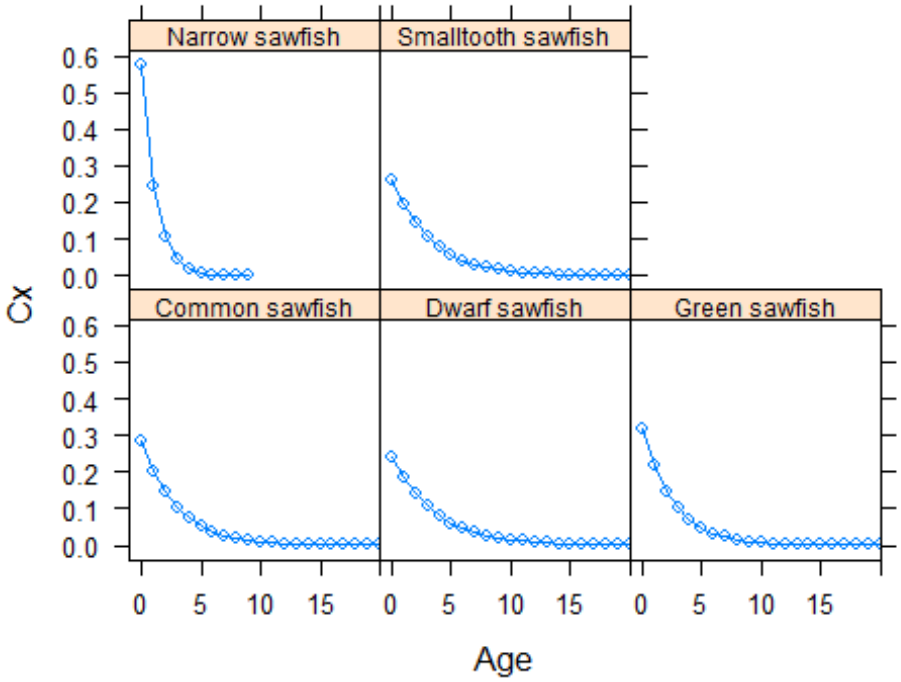

Figure 1. Stable age distribution for five sawfish species. Points indicate the proportion of individuals in each age class as predicted by the demographic model.

Conclusions

Early studies on the demography of sawfish indicated that several species have particularly low biology productivity (i.e. *P. pectinata* and *P. pristis)* (Simpfendorfer 2000). However, as additional data on the life history traits of these species has been collected it appears that earlier studies may have been overly conservative particularly with estimates of growth (Carlson and Simpfendorfer 2014). Growth estimates now available for two species, *A. cuspidata* and *P. pectinata* indicate that growth is rapid. Rapid growth rates imply ages at maturity of as young as 2-3 years for *A. cuspidata* and 5-10 years for *Pristis* species. Therefore, sawfish appear to mature at proportionally young ages, and in turn may have higher reproductive output than previously thought.

Notwithstanding the disparate distribution of sawfish species compared to fishing activities (i.e. there is not a complete overlap so populations are not fully exposed to fishing gear), the higher than thought reproductive output may partly explain the persistence of populations in some parts of Australia, despite their susceptibility to many types fishing gears. Examples of this include the ongoing persistence of *A. cusipdata* in areas of high fishing pressure off the east coast of Queensland (Salini et al. 2007) and also the ongoing low level of interactions of *Pristis* species with the EGPMF despite a long history of fishing.

Although many aspects of their life cycle and biology make them inherently vulnerable to anthropogenic impacts, simple demographic analyses such as this suggest that they appear to have a higher level of productivity than many other large sharks (e.g. dusky sharks, McAuley et al. 2007) and are therefore at less risk than previously thought. Furthermore, there has been

a strong trend across much of northern Australia for decreases in net fishing effort which equates directly to less fishing pressure on sawfish than has historically been experienced.

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Appendix B: Fishing Efficiency Analysis

Summary of fishing efficiency analysis for the Exmouth Gulf Prawn Managed Fishery

Kangas, M. & Thomson, A.

June 1999

1. Introduction

During the 1999 fishing season in Exmouth Gulf, the performance of twin gear (2 nets with 7.5 ftms head-rope) and quad gear (4 nets with 4.5 ftms head-rope) was compared using catch rate data (1) from fishery-independent surveys and (2) from logbooks completed by commercial fishers. The aim of the analyses was to establish a conversion ratio for twin to quad gear to allow for an adjustment of the brown tiger prawn catch rate threshold that is currently in place for twin gear (16 kg / hr).

2. Methods

The catch rates of two vessels were compared during the recruitment surveys, whereas the catch rates of five vessels were compared during the spawning stock surveys. For all the survey data, to reduce the bias, weighted (by time trawled) least square linear regression was used to estimate the ratio of quad gear catch rates relative to twin gear catch rates. The surveys were conducted in the main brown tiger prawn fishing grounds and hence the catch rates observed for brown tiger prawns were higher compared to other species including as western king and blue endeavour prawns. As a consequence, only brown tiger prawn catch rates were used in the analyses of survey data.

For the analyses of commercial logbook data, vessels that utilised try-gear for much of the fishing season are omitted from the final analysis as this biased catch rates. As with the survey data, direct comparison and weighted least squares linear regression was used to estimate the ratio of quad gear catch rates relative to twin gear catch rates. Commercial catch rates were obtained for brown tiger prawns, western king prawns and blue endeavour prawns as they were targeted in the main habitats and times appropriate for those species. The 1999 season data allowed for analysis of catch rates for all time periods in the fishery (April to November) to provide a less biased estimate.

3. Results

3.1. Survey data

The catch rates of brown tiger prawns obtained from the recruitment and spawning stock surveys were greater for quad gear compared to twin gear in each fishing ground sampled (Table 1). Weighted least squares linear regression demonstrated that the increase in catch rates when using quad gear compared to twin gear was 20.19 ± 2.0 % (Figure 1). The increase in fishing efficiency (kg/hour/ftm of net) resulting from converting from twin to quad gear for brown tiger prawns was estimated to be 0.16 ± 0.03 %.

Table 1. Mean tiger prawn catch rate (kg / hr) (and standard deviation) during recruitment and spawning stock surveys using twin and quad trawl gear in Exmouth Gulf in 1999.

Fishing ground	Twin gear	Quad gear
P2	27.00 (21.37)	32.04 (24.86)
Q1	23.19 (10.75)	27.21 (12.86)
Q2	16.00 (5.51)	22.45 (8.72)
Q3	39.39 (23.10)	49.94 (27.91)
Total	24.72 (16.07)	30.10 (19.33)

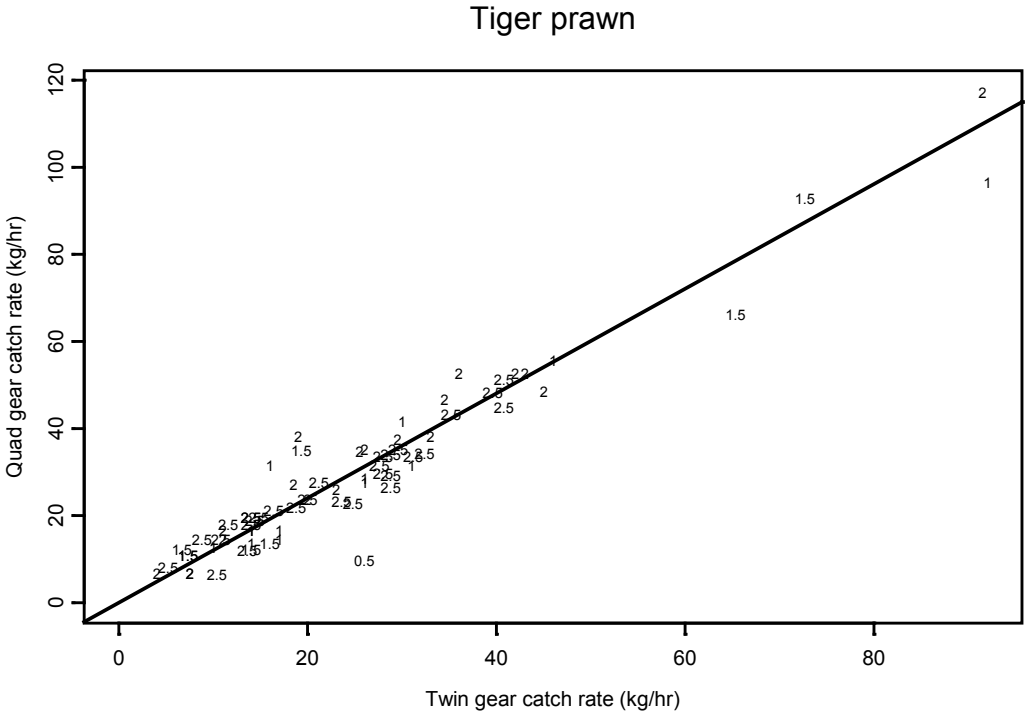


Figure 1. Weighted least squares linear regression used to estimate the ratio between twin and quad gear catch rates of tiger prawns. Numbers indicate the duration of each survey trawl shot.

3.2. Commercial logbook data

The commercial catch rate for each species increased from twin gear to quad gear (Table 2). The weighted least squares regressions indicate differences in catch rates between months and species (Figure 2), however, the overall estimate is biased due to unequal sampling sizes (hours fished) each month.

Table 2. Percent increases in catch rates for quad gear compared with twin gear from commercial logbook data.

Methods	% Increase in catch rate for quad gear (2726 shots) compared with twin gear (2345 shots) (logbook data April-November)			
	Brown tiger prawns	Western king prawns	Blue endeavour prawns	Overall
Overall ratio	27.30	28.50	26.60	27.40
Weighted (total effort) least squares linear regression method (WLSR) (standard error)	24.80 (0.019)	27.80 (0.058)	25.00 (0.052)	28.10 (0.021)

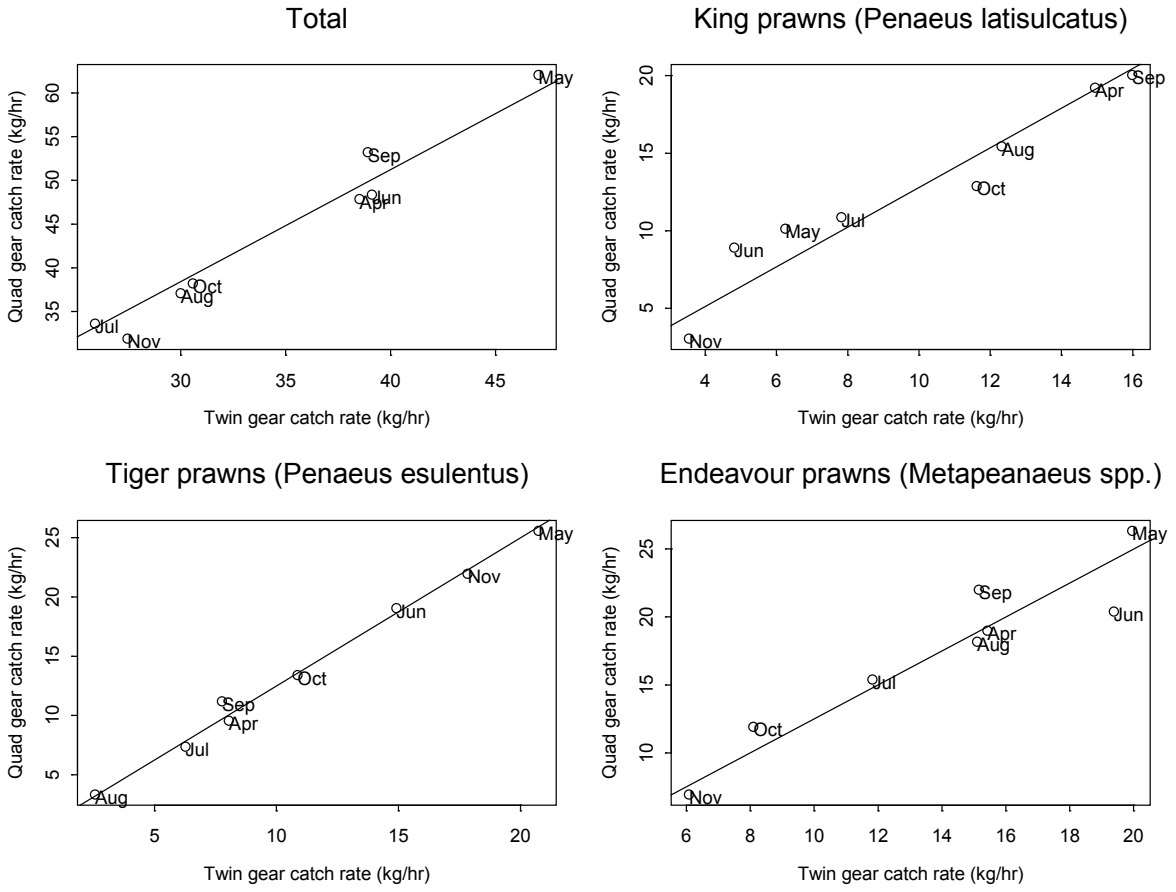


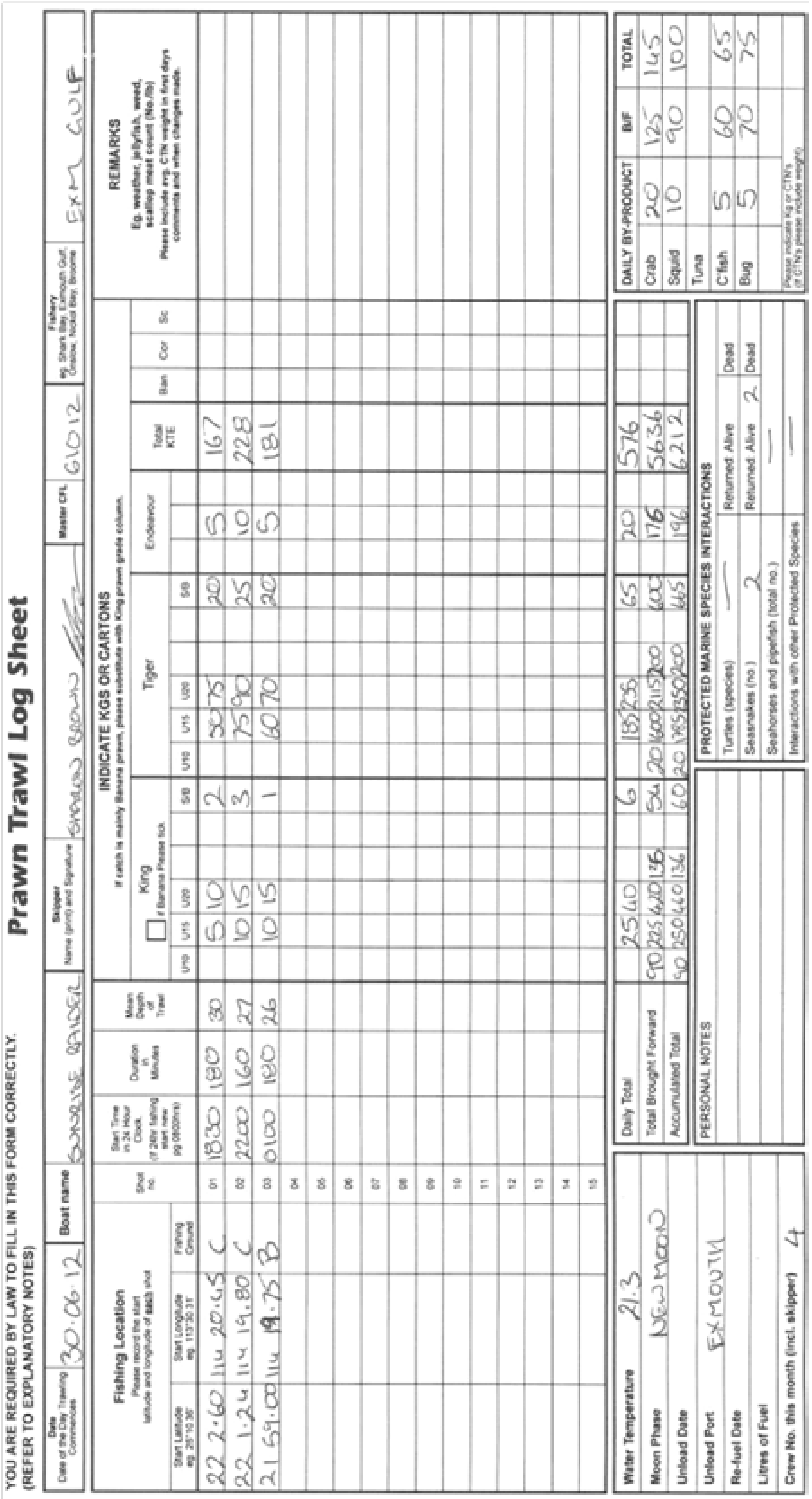
Figure 2. Weighted least squares linear regressions used to estimate the ratios between twin and quad gear catch rates.

4. Discussion

The percentage increase in catch rates resulting from converting from twin to quad gear for brown tiger prawns is between 20 and 27% (but there is 20% more net used by quad gear rigged boats). It is considered that the 27% overall increase estimated using the commercial logbook data is more reliable than the experimental survey trials due to the short duration of surveys relative to the entire fishing season. Also a limited number of boats were used whereas the logbook data represents information for the whole season providing seasonal variability. It should be noted, however, that the more experienced and efficient skippers were masters of the vessels towing quad gear.

The current threshold for brown tiger prawns to retain sufficient spawning stock needs (16 kg / hr) to be adjusted to account for the increased catch rate using quad gear. The recommended new catch rate threshold is 20 kg / hr for brown tiger prawns for vessels using quad gear.

Appendix C: Daily Trawl Logbook Sheet



YOU ARE REQUIRED BY LAW TO FILL IN THIS FORM CORRECTLY. (REFER TO EXPLANATORY NOTES)

Prawn Trawl Log Sheet

Date (Date of the Day Trawling Commences)	Boat name	Skipper Name (print) and Signature	Master CFL	Fishery (eg. Shark Bay, Exmouth Gulf, Onslow, Nickol Bay, Broome)
30.06.12	SUNRISE RAIDER	SHADOW BROWN	G1012	EXM GULF

Fishing Location: Please record the start latitude and longitude of each shot

INDICATE KGS OR CARTONS – If catch is mainly Banana prawn, please substitute with King prawn grade column.

Start Latitude eg. 25°10.56'	Start Longitude eg. 113°30.31'	Fishing Ground	Shot no.	Start Time in 24 Hour Clock (if 24hr fishing start new pg 0800hrs)	Duration in Minutes	Mean Depth of Trawl	King U10	King U15	King U20	King	King	King S/B	Tiger U10	Tiger U15	Tiger U20	Tiger	Tiger	Tiger S/B	Endeavour	Endeavour	Total KTE	Ban	Cor	Sc	REMARKS
22 2·60	114 20·65	C	01	1830	180	30		5	10			2		30	75			20	5		167				
22 1·24	114 19.80	C	02	2200	160	27		10	15			3		75	90			25	10		228				
21 59·00	114 19·75	B	03	0100	180	26		10	15			1		60	70			20	5		181				
			04																						
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REMARKS: Eg. weather, jellyfish, weed, scallop meat count (No./lb). Please include avg. CTN weight in first days comments and when changes made.

	King U10	King U15	King U20	King	King S/B	Tiger U10	Tiger U15	Tiger U20	Tiger	Tiger S/B	Endeavour	Total KTE
Daily Total		25	40		6		135	235		65	20	576
Total Brought Forward	90	225	420	136	54	20	1600	2115	200	600	176	5636
Accumulated Total	90	250	460	136	60	20	1765	2350	200	665	196	6212

Water Temperature	21.3
Moon Phase	NEW MOON
Unload Date	
Unload Port	EXMOUTH
Re-fuel Date	
Litres of Fuel	
Crew No. this month (incl. skipper)	4

PERSONAL NOTES

PROTECTED MARINE SPECIES INTERACTIONS		Returned Alive	Dead
Turtles (species)	—		
Seasnakes (no.)	2	2	
Seahorses and pipefish (total no.)		—	
Interactions with other Protected Species		—	

DAILY BY-PRODUCT		B/F	TOTAL
Crab	20	125	145
Squid	10	90	100
Tuna			
C'fish	5	60	65
Bug	5	70	75

Please indicate Kg or CTN's (If CTN's please include weight)

Appendix D: Bycatch Species List from BRD Trials (2008/09)

Species lists and catch numbers from Exmouth Gulf mesh panel trials in 2008 and 2009 (Tables 1 and 2)

Table 1. Fish species and catch numbers sampled during square versus standard diamond mesh trials in September 2008 and April 2009 (DoF unpublished data)

Exmouth Gulf Square Mesh Trials		Diamond	Square	Diamond	Square
Common name	**Scientific name**	**2008**	**2008**	**2009**	**2009**
Barracuda	*Sphyraena barracuda*	0	0	2	1
Bigeye, threadfin	*Priacanthus tayenus*	0	0	6	7
Black-banded kingfish	*Seroilina nigrofasciata*	0	0	1	1
Bullseye, slender	*Parapriacanthus ransonneti*	0	0	3	1
Butterflyfish, longfin bannerfish	*Heniochus acuminatus*	0	0	0	1
Cardinalfish, broad-banded	*Apogon quadrifasciatus*	0	0	0	1
Cardinalfish, brown-spotted	*Apogon fuscomaculatus*	1	0	0	0
Cardinalfish, flagfin	*Apogon ellioti*	0	0	1	0
Cardinalfish, many-banded	*Apogon brevicaudatus*	1	1	0	0
Cardinalfish, pearly-finned	*Apogon poecilopterus*	3	2	20	11
Cardinalfish, two-eyed	*Apogon nigripinnis*	0	1	0	0
Catfish, salmon	*Arius* sp.	8	7	10	2
Damsel, gulf	*Pristotis jerdoni*	3	2	0	0
Dragonet, fingered	*Dactylopus dactylopus*	1	1	0	0
Emperor, blue lined	*Lethrinus* sp.	0	0	1	1
Flathead, bar-tailed	*Platycephalus endrachtensis*	1	1	0	0
Flathead, fringe-eyed	*Cymbacephalus nematophthalmus*	0	1	0	1
Flathead, Harris's	*Inegocia harrisii*	2	20	0	1
Flathead, heart-headed	*Sorsogona tuberculata*	1	0	0	0
Flathead, rusty	*Suggrundus japonica*	25	0	3	2
Flounder, freckled	*Psammodiscus ocellatus*	0	1	0	0
Flounder, intermediate	*Asterhombus intermedius*	0	1	1	1
Flounder, large-toothed	*Pseudorhombus arsius*	1	7	3	1
Flounder, peacock	*Pseudorhombus argus*	0	1	0	0
Flounder, Queensland halibut	*Psettodes erumei*	0	0	1	0
Flounder, small-toothed	*Pseudorhombus jenynsii*	0	0	0	0
Flounder, spiny	*Pseudorhombus spinosus*	0	2	0	0

Flounder, spiny-headed	*Engyprosopon grandisquama*	2	3	3	4
Flounder, threespot	*Grammatobothus polyophthalmus*	1	0	0	0
Flounder, twinspot	*Pseudorhombus diplospilus*	0	0	0	1
Flutemouth, smooth	*Fistularia commersonii*	0	0	1	6
Goatfish, asymmetrical	*Upeneus asymmetricus*	20	9	10	5
Goatfish, goldband	*Upeneus moluccensis*	2	0	0	1
Goatfish, ochre-banded	*Upeneus sundaicus*	7	9	8	5
Goatfish, sunrise	*Upeneus sulphureus*	15	8	26	3
Goby, shadow	*Yongeichthys nebulosus*	1	0	0	8
Grunter, banded	*Terapon theraps*	4	4	6	4
Gurnard, long-finned	*Lepidotrigla argus*	1	0	0	0
Herring, Australian spotted	*Herklotsichthys lippa*	0	0	1	1
Herring, blackburn	*Herklotsichthys blackburni*	0	1	0	0
Herring, ditchelee	*Pellona ditchela*	3	2	0	0
Herring, wolf	*Chirocentrus dorab*	0	0	0	0
Javelinfish, blotched	*Pomadasys maculatum*	4	4	0	0
Leatherjacket, fan-bellied	*Monacanthus chinensis*	2	1	0	0
Leatherjacket, hair-finned	*Paramonacanthus choirocephalus*	10	11	20	34
Leatherjacket, pot-bellied	*Pseudomonacanthus peroni*	0	0	0	1
Leatherjacket, threadfin	*Paramonacanthus filicauda*	0	9	0	0
Little jewfish	*Johnius vogleri*	9	8	0	2
Lizardfish, large-scaled grinner	*Saurida undosquamis*	8	8	46	30
Lizardfish, painted grinner	*Trachinocephalus myops*	1	0	1	0
Lizardfish, variegated	*Synodus variegatus*	0	0	1	0
Mackerel, Queensland school	*Scomberomorus munroi*	0	0	1	3
Monocle bream, red-spot	*Scolopsis taeniopterus*	5	11	21	21
Monocle bream, western butterfish	*Pentapodus vitta*	26	20	1	3
Perch, moses	*Lutjanus russelli*	0	1	0	0
Ponyfish, banded	*Leiognathus fasciatus*	4	20	2	1
Ponyfish, common	*Leiognathus equulus*	23	31	0	0
Ponyfish, pugnose	*Secutor ruconis*	0	0	1	7
Ponyfish, Smithurst's	*Leiognathus smithursti*	0	0	1	0
Ponyfish, toothpony	*Gaza minuta*	11	8	10	26
Ponyfish, whipfin	*Leiognathus leuciscus*	30	29	31	51

Pufferfish, many-striped	*Anchisomus multistriatus*	0	0	0	1
Sardine, gold-striped	*Sardinella gibbosa*	0	0	0	2
Scad, mackerel	*Decapterus macarellus*	1	5	2	0
Scad, oxeye	*Selar boops*	0	0	1	0
Scad, purse eyed	*Selar crumenthalmops*	0	0	1	0
Scad, Russel's mackerel	*Decapterus russelli*	0	0	0	1
Scad, small-mouthed	*Alepes* sp.	0	0	0	1
Scad, yellowtail	*Atule mate*	0	0	0	3
Scorpionfish, long-finned wasp	*Apistus carinatus*	0	0	1	1
Scorpionfish, plumb-striped stingfish	*Minous versicolor*	0	1	0	1
Scorpionfish, spotfin waspfish (bullrout)	*Paracentropogon vespa*	12	3	0	0
Seamoth, slender	*Pegasus volitans*	1	0	0	0
Seaperch, saddle-tailed	*Lutjanus malabaricus*	0	1	1	2
Searobin	*Dactylopus* sp.	0	0	1	0
Silver belly, common	*Gerres subfasciatus*	84	78	70	77
Silver biddy, common	*Gerres oyena*	0	0	5	10
Silver belly, long-finned	*Penaprion longimanus*	0	0	0	1
Silver belly, whipfin	*Gerres filamentosus*	2	2	4	4
Smudgespot spinefoot	*Siganus canaliculatus*	5	3	0	1
Sole	*Aesopia heterorhinos*	0	1	0	0
Sole, tufted	*Dexillichthys muelleri*	0	1	0	0
Stinkfish, spotted	*Repomucenus calcaratus*	52	33	15	5
Threadfin bream, notched	*Nemipterus peronii*	0	0	4	5
Threadfin bream, rosy	*Nemipterus furosus*	4	6	0	0
Threadfin, Gunther's	*Polydactylus multiradiatus*	1	3	0	0
Toadfish, milk-spotted	*Chelonodon patoca*	1	0	0	0
Toadfish, orange spotted	*Torquigener pallimaculatus*	0	1	1	2
Toadfish, rough golden	*Lagocephalus lunaris*	1	2	2	2
Trevally, blue-spotted	*Caranx bucculentus*	3	4	0	0
Trevally, bump-nosed	*Carangoides helandensis*	0	0	4	0
Trevally, cale cale	*Ulua mentalis*	0	0	1	0
Trevally, Japanese	*Carangoides uii*	0	1	2	2
Trevally, smooth-tailed	*Selaroides leptolepis*	2	2	1	4
Trevally, unidentified		0	0	0	3
Trevally, white-tongued	*Carangoides talamparoides*	0	2	4	5
Tripodfish, black flag	*Tripodichthys angustifrons*	1	1	0	1
Trumpeter, 4-lined	*Pelates quadrilineatus*	25	27	9	16

Trumpeter, 6-lined	*Pealtes sexlineatus*	13	7	11	5
Tuskfish, purple	*Choerodon cephalotes*	1	1	1	0
Unidentified fish		0	0	1	1
Whiting, northern	*Sillago sihama*	4	0	0	0
Whiting, trumpeter	*Sillago maculata*	58	29	35	19
Total Fish		**507**	**459**	**420**	**424**

Table 2. Invertebrate species (excluding target prawn species) and catch numbers sampled during square versus standard diamond mesh trials in September 2008 and April 2009 (DoF unpublished data)

Invertebrates		**Diamond**	**Square**	**Diamond**	**Square**
Common name	**Scientific name**	**2008**	**2009**	**2008**	**2009**
Ascidian	*Phallusia millari*	0	0	0	0
Ascidian (compound)		1	0	0	0
Basket stars		0	1	0	0
Blue swimmer crab	*Portunus pelagicus*	0	2	6	12
Brittlestars		1	0	0	0
Crabs	*Charybdis truncata*	1	0	19	44
Crabs	*Charybdis anisodon*	0	1	64	124
Crabs	*Charybdis jaubertensis*	0	1	1	0
Crabs	*Charybdis natator*	0	1	0	0
Cuttlefish	*Sepia* sp.	1	1	0	0
Cuttlefish		0	0	2	3
Endeavour prawn	*Matpenaeus endeavouri*	0	0	3	2
Hardback prawn	*Trachypenaeus anchoralis*	3	3	0	2
Isopoda (parasite)		2	0	1	1
Long eyed crab	*Podophthalmus vigil*	0	0	4	4
Mantis shrimp	*Alimopsoides* sp.	1	0	1	0
Mantis shrimp	*Oratosquilla oratoria*	0	2	0	0
Octopus		0	0	1	0
Polychaetes		0	1	0	0
Prawn	*Metapenaeopsis crassissima*	3	5	0	0
Sea cucumber	*Loisetta amphictene*	1	0	0	0
Sea cucumber	*Cercodemas anceps*	1	1	0	0
Sea cucumber	*Colochirus crassus*	1	1	0	0
Sea cucumber	*Holothurian* sp.	0	0	0	1
Sea pens		3	0	0	0
Seaweed crab	*Zaxia* sp.	1	0	0	0
Slipper lobster	*Scyllus martensii*	9	8	1	0
Southern velvet prawn	*Metapenaeopsis palmensis*	0	0	4	1
Sponges		0	1	0	0
Squid	*Loligo* sp.	0	0	0	1
Starfish	*Comatula solaris*	1	0	0	0
Starfish	*Zygometra microdiscus*	1	0	0	0
Starfish	*Anthenea* sp.	0	1	0	0
Swimmer crab	*Portunus rubromarginatus*	15	23	34	48

Swimmer crab	*Portunus hastatoides*	1	1	3	2
Swimmer crab	*Portunus pseudoargentatus*	1	0	0	0
Triton	*Cymatium* sp.	1	0	0	0
Unidentified crab		0	0	5	3
Western school prawn	*Metapenaeus dalli*	2	0	0	0
	Family: *Nephropidae*	0	0	0	0
Total Invertebrates		**51**	**54**	**149**	**248**

Appendix E: ETP Species in the Exmouth Gulf Region

Endangered, threatened and protected species occurring within the Exmouth Gulf region: CE: Critically endangered; E: Endangered; V: Vulnerable; NT: Near threatened; LC: Least concern; DD: Data deficient; NA: Not yet assessed by the IUCN. (Species lists compiled from LeProvost Dames and Moore 2000, Environment Australia 2002, SEWPaC 2012a)

Common Name	Scientific Name	WC Act[i]	EPBC Act[ii]	CITES[iii]	IUCN[iv]
Marine Mammals					
Sirenia					
Dugong	*Dugong dugon*	Schedule 4	Migratory, Marine	Appendix I	VU
Cetaceans					
Minke whale	*Balaenoptera acutorostrata*		Cetacean	Appendix I	LC
Sei whale	*Balaenoptera borealis*	Schedule 1	Vulnerable, Migratory, Cetacean	Appendix I	EN
Bryde's whale	*Balaenoptera edeni*		Migratory, Cetacean	Appendix I	DD
Pygmy blue whale	*Balaenoptera musculus brevicauda*		Cetacean	Appendix I	DD
Fin whale	*Balaenoptera physalus*	Schedule 1	Vulnerable, Migratory, Cetacean	Appendix I	EN
Common dolphin	*Delphinus delphis*		Cetacean	Appendix II	LC
Southern right whale	*Eubalaena australis*	Schedule 1	Endangered, Migratory, Cetacean	Appendix I	LC
Pygmy killer whale	*Feresa attenuata*		Cetacean	Appendix II	DD
Risso's dolphin	*Grampus griseus*		Cetacean	Appendix II	LC
Humpback whales	*Megaptera novaeangliae*	Schedule 1	Vulnerable, Migratory, Cetacean	Appendix I	LC
Blainville's beaked whale	*Mesoplodon densirostris*		Cetacean	Appendix II	DD
Killer whales	*Orcinus orca*		Migratory, Cetacean	Appendix II	DD
Sperm whale	*Physeter macrocephalus*		Migratory, Cetacean	Appendix I	VU

[i] Current list of threatened fauna (Specially protected fauna notice- 17 Feb 2012) <http://www.dec.wa.gov.au/management-and-protection/threatened-species/listing-of-species-and-ecological-communities.html>
[ii] EPBC protection status <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
[iii] CITES Appendices Listing <http://www.cites.org/eng/app/appendices.php>
[iv] IUCN Redlist 2012 <iucnredlist.org>

Indo-Pacific humpback dolphin	*Sousa chinensis*		Migratory, Cetacean	Appendix I	NT
Spotted dolphin	*Stenella attenuata*		Cetacean	Appendix II	LC
Long-snouted spinner dolphin	*Stenella longirostris*		Cetacean	Appendix II	DD
Rough-toothed dolphin	*Steno bredanensis*		Cetacean	Appendix II	LC
Bottlenose dolphin	*Tursiops aduncus*		Cetacean	Appendix II	DD
Marine Reptiles					
Marine turtles					
Loggerhead turtles	*Caretta caretta*	Schedule 1	Endangered, Migratory, Marine	Appendix I	EN
Green turtles	*Chelonia mydas*	Schedule 1	Vulnerable, Migratory, Marine	Appendix I	EN
Leatherback turtles	*Dermochelus coriacea*	Schedule 1	Endangered, Migratory, Marine	Appendix I	CE
Hawksbill Turtles	*Eretmochelys imbricata*	Schedule 1	Vulnerable, Migratory, Marine	Appendix I	CE
Olive ridley turtles	*Lepidochelys olivacea*	Schedule 1	Endangered, Migratory, Marine	Appendix I	VU
Flatback turtles	*Natator depressus*	Schedule 1	Vulnerable, Migratory, Marine	Appendix I	DD
Sea snakes					
Short-nosed sea snake	*Aipysurus apraefrontalis*	Schedule 1	Critically endangered, Marine		CE
Horned sea snake	*Acalyptophis peronii*		Marine		LC
Dubois' sea snake	*Aipysurus doboisii*		Marine		NA
Spine-tailed sea snake	*Aipysurus eydouxii*		Marine		LC
Olive sea snake	*Aipysurus laevis*		Marine		LC
Shark Bay sea snake	*Aipysurus pooleorum*		Marine		NA
Stokes' sea snake	*Astrotia stokesii*		Marine		LC
Spectacled sea snake	*Disteira kingii*		Marine		LC
Olive-headed sea snake	*Disteira major*		Marine		LC
Turtle-headed sea snake	*Emydocephalus annulatus*		Marine		LC
North-western mangrove sea snake	*Ephalophis greyi*		Marine		LC
Fine-spined sea snake	*Hydrophis czeblukovi*		Marine		DD

Elegant sea snake	*Hydrophis elegans*		Marine		LC
Ornate sea snake	*Hydrophis ornatus*		Marine		LC
Yellow-bellied sea snake	*Pelamis platurus*		Marine		LC
Protected Fish Species					
Sharks, rays and sawfish					
Grey nurse shark	*Carcharias taurus*	Schedule 1	Vulnerable		VU
White Shark	*Carcharodon carcharias*	Schedule 1	Vulnerable, Migratory	Appendix II	VU
Giant manta ray	*Manta birostris*		Migratory	Appendix II	VU
Green sawfish	*Pristis zijsron*	Schedule 1	Vulnerable	Appendix I	NA
Freshwater sawfish	*Pristis pristis*		Vulnerable	Appendix I	CR
Dwarf sawfish	*Pristis clavata*		Vulnerable	Appendix I	CE
Narrow sawfish	*Anoxypristis cuspidata*			Appendix I	CE
Giant guitarfish	*Rhynchobatus djiddensis*				VU
Syngnathids and Solenostomids					
Braun's pughead pipefish	*Bulbonaricus brauni*		Marine		NA
Three-keel pipefish	*Campichthys tricarinatus*		Marine		NA
Pacific short-bodied pipefish	*Choeroichthys brachysoma*		Marine		NA
Muiron Island pipefish	*Choeroichthys latispinosus*		Marine		NA
Pig-snouted pipefish	*Choeroichthys suillus*		Marine		NA
Many-banded pipefish	*Doryrhamphus multiannulatus*		Marine		NA
Banded pipefish	*Doryrhamphus dactyliophorus*		Marine		DD
Cleaner pipefish	*Doryrhamphus janssi*		Marine		LC
Flagtail pipefish	*Doryrhamphus negrosensis*		Marine		NA
Ladder pipefish	*Festucalex scalaris*		Marine		NA
Brock's pipefish	*Halicampus brocki*		Marine		NA
Gray's pipefish	*Halicampus grayi*		Marine		NA
Glittering pipefish	*Halicampus nitidus*		Marine		NA
Spiny-snout pipefish	*Halicampus spinirostris*		Marine		NA

Ribboned pipefish	*Haliichthys taeniophorus*		Marine		NA
Beady pipefish	*Hippichthys penicillus*		Marine		LC
Winged seahorse	*Hippocampus alatus*		Marine	Appendix II	DD
Western spiny seahorse	*Hippocampus angustus*		Marine	Appendix II	DD
False-eyed seahorse	*Hippocampus biocellatus*		Marine	Appendix II	NA
Spiny seahorse	*Hippocampus histrix*		Marine	Appendix II	VU
Spotted seahorse	*Hippocampus kuda*		Marine	Appendix II	VU
Flat-faced seahorse	*Hippocampus planifrons*		Marine		NA
Zebra seahorse	*Hippocampus zebra*		Marine	Appendix II	DD
Tidepool pipefish	*Micrognathus micronotopterus*		Marine		NA
Black rock pipefish	*Phoxocampus belcheri*		Marine		NA
Common weedy sea dragon	*Phyllopteryx taeniolatus*		Marine		NT
Gunther's pipefish	*Solegnathus lettiensis*		Marine		DD
Robust ghost pipefish	*Solenostomus cyanopterus*		Marine		NA
Spotted pipefish	*Stigmatopora argus*		Marine		NA
Alligator pipefish	*Syngnathoides biaculeatus*		Marine		DD
Short-tailed pipefish	*Trachyrhamphus bicoarctatus*		Marine		NA
Long-nosed pipefish	*Trachyrhamphus longirostris*		Marine		NA
Migratory Sea and Shorebirds					
Fork-tailed swift	*Apus pacificus*	Schedule 3	Migratory, Marine		LC
Great egret	*Ardea modesta*	Schedule 3	Migratory, Marine		LC
Ruddy turnstone	*Arenaria interpres*	Schedule 3	Migratory, Marine		LC
Sanderling	*Calidris alba*	Schedule 3	Migratory, Marine		LC
Red knot	*Calidris canutus*	Schedule 3	Migratory, Marine		LC
Curlew sandpiper	*Calidris ferruginea*	Schedule 3	Migratory, Marine		LC
Red-necked stint	*Calidris ruficollis*	Schedule 3	Migratory, Marine		LC
Great knot	*Calidris tenuirostris*	Schedule 3	Migratory, Marine		VU
Large sand plover	*Charadrius leschenaultii*	Schedule 3	Migratory, Marine		LC

Lesser sand plover	*Charadrius mongolus*	Schedule 3	Migratory, Marine	LC
Oriental plover	*Charadrius veredus*	Schedule 3	Migratory, Marine	LC
Silver gull	*Chroicocephalus novaehollandiae*		Marine	LC
Eastern reef egret	*Egretta sacra*	Schedule 3	Migratory, Marine	LC
Oriental pratincole	*Glareola maldivarum*	Schedule 3	Migratory, Marine	LC
White-breasted sea eagle	*Haliaeetus leucogaster*	Schedule 3	Migratory, Marine	LC
Grey-tailed tattler	*Heteroscelus brevipes*	Schedule 3	Migratory, Marine	LC
Barn swallow	*Hirundo rustica*	Schedule 3	Migratory, Marine	LC
Bar-tailed godwit	*Limosa lapponica*	Schedule 3	Migratory, Marine	LC
Southern giant petrel	*Macronectes giganteus*	Schedule 1	Endangered, Migratory, Marine	LC
Eastern curlew	*Numenius madagascariensis*	Schedule 3	Migratory, Marine	VU
Whimbrel	*Numenius phaeopus*	Schedule 3	Migratory, Marine	LC
Brindled tern	*Onychoprion anaethetus*	Schedule 3	Migratory, Marine	NA
Osprey	*Pandion haliaetus*		Migratory, Marine	LC
Grey plover	*Pluvialis dominica*	Schedule 3	Migratory, Marine	LC
Pacific golden plover	*Pluvialis fulva*	Schedule 3	Migratory, Marine	LC
Soft-plumaged petrel	*Pterodroma mollis*		Vulnerable, Marine	LC
Wedge-tailed shearwater	*Puffinus pacificus*	Schedule 3	Migratory, Marine	LC
Lesser crested tern	*Sterna bengalensis*	Schedule 3	Migratory, Marine	LC
Crested tern	*Sterna bergii*		Marine	LC
Caspian tern	*Sterna caspia*	Schedule 3	Migratory, Marine	LC
Roseate tern	*Sterna dougallii*	Schedule 3	Migratory, Marine	LC
Sooty tern	*Sterna fuscata*		Marine	LC
Greenshank	*Tringa nebularia*	Schedule 3	Migratory, Marine	LC
Common redshank/Marsh sandpiper	*Tringa totanus*	Schedule 3	Migratory, Marine	LC
Terek sandpiper	*Xenus terek*	Schedule 3	Migratory, Marine	LC

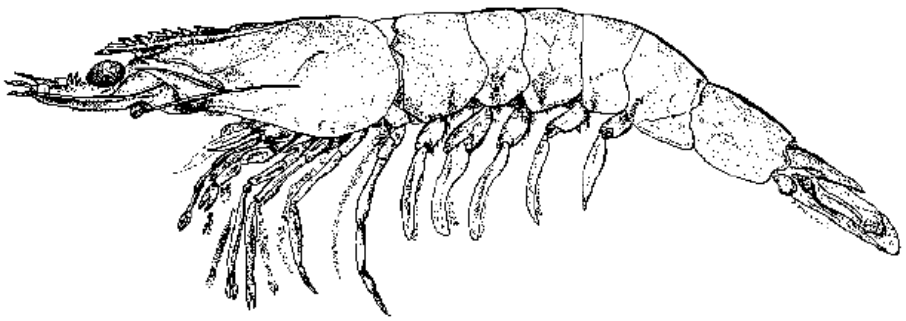
Appendix F: 2013 Season Report for the EGPMF

EXMOUTH PRAWN MANAGED FISHERY SEASON REPORT

2013

Preliminary

March 2014



Compiled by Invertebrate trawl Research

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In consultation with the Exmouth Gulf Fishing Industry

Fish for the future

Exmouth Gulf Prawn Managed Fishery 2013 Season Report

FISHERY DESCRIPTION

The Exmouth Gulf Prawn Managed Fishery targets western king prawns *(Penaeus latisulcatus)*, brown tiger prawns *(Penaeus esculentus)*, endeavour prawns (*Metapenaeus* spp.) and banana prawns *(Penaeus merguiensis)*. Fishing is undertaken using otter trawl fishing gear.

Governing legislation/fishing authority

Exmouth Gulf Prawn Management Plan 1989

Exmouth Gulf Prawn Managed Fishery License

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

Consultation process

Annual meetings between the Department of Fisheries, licence holders and WAFIC to consider the status of the stocks and recommend changes to the opening and closing dates that operate within the season. These are designed to protect smaller prawns and allow access to the various target species, primarily tiger and king prawns, at appropriate times.

Boundaries

The boundaries of the Exmouth Gulf Prawn Managed Fishery are 'the waters of the Indian Ocean and Exmouth Gulf below high water mark lying south of a line starting at Point Murat and extending northeasterly to the southern extremity of South Muiron Island; thence generally northeasterly along the southeastern shore of that island to its eastern most extremity; thence northeasterly to the southern extremity of North Muiron Island; thence northeasterly and northerly along the southeastern and eastern shores of that island to its northern extremity; thence easterly to the northern extremity of Serrurier Island; thence generally southerly along the western shores of that island to its southern extremity; thence southeasterly to the southern extremity of Locker Island and then due south to the mainland.

Management arrangements

Management of this fishery is based on input controls, which include limited entry, season and area openings and closures, moon closures, and gear controls. These management arrangements are designed to keep fishing effort at levels that will maintain sufficient spawning biomass of prawns (particularly tiger prawns).

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year depending on environmental conditions, moon phase and the results of fishery-independent surveys, which monitor tiger and king prawn recruitment. Management arrangements in recent seasons have provided a maximum number of nights to fish in the season. The number of nights actually fished are based on two factors; the

predicted abundance of tiger prawns from the recruitment surveys and the catch rate target level to cease fishing on this species. For king prawns, the information from the recruitment surveys abundance (catch rate kg/hr) and size composition is used to determine the commencement of fishing and in the latter part of the season the size structure (in particular proportion of small size prawns) and the catch rate (kg/hr) is also used to determine the timing to cease fishing.

For the 2013 season, official opening and closing dates were set at 8 April and 14 November. This is a flexible arrangement and the season actually commenced on 15 May based on results from pre-season surveys and fishing ceased 0800 hrs 10 November (144 days fished). There were spatio-temporal closures during the early part of the season (May to 26 July) to avoid fishing on small prawns.

Stringent measures are in place to ensure that spawning stock levels are adequate and that the prospect of both recruit and growth over-fishing is avoided. These measures will continue to be applied while incorporating a flexible fishing regime to optimise size and value of tiger prawns. There is a consultative process in operation whereby the Research Division and industry jointly decide on the timing and extent of areas to be fished or closed due to size and abundance of prawns. This process allows industry to undertake supervised research surveys to determine changes in prawn distribution, abundance and size composition during the season, thus enabling a rapid response to resource fluctuations to maximize tiger and king prawn size for market value, while still providing a sustainable approach to stock management.

The Research Division monitoring of the fleet for catch and effort and providing real time advice when to open and close areas is part of the fishery's management strategy for the control of spatial and temporal closures.

Management of the tiger prawn spawning stock requires a closure of the tiger prawn spawning area when the catch rate falls to a target (previously referred to as a threshold) level of 25 kg/hr based on catch rate of vessels with 10.71 m (6 fathom) nets in quad gear configuration (four nets) or late July/early August based on lunar phase, whichever is the sooner. From 1 November, after the main spawning period, the catch rate reference level is reduced from 25 kg/hr to 19 kg/hr.

Management of king prawns overall is to cease fishing when the size composition reaches approximately 40-50% or greater of prawns in the size grade categories of 21-30 and 31+ count per pound (454 g).

The vessel monitoring system continues to monitor the activities of all boats.

The fishery as a whole is subject to a maximum headrope allocation (216 fathoms). However, the gear configuration package (net and board sizes) permitted within this total allocation are under review, with vessels operating under an exemption allowing the use of 'quad gear' (four smaller nets) rather than the standard twin 13.71 m (7.5-fathom) nets and board size. This includes a reduction in total fathoms to account for 10% efficiency from moving from twin to quad gear. This has resulted in a reduction in the number of boats with most of the headrope allocation redistributed among the remaining boats. The reduction of boat numbers

and overall net allocation is continuing with the aim of maximizing economic efficiency whilst maintaining overall catches in this fishery as well as stock sustainability. For the 2012 season the boat numbers were further reduced from 9 to 6 and all the boats were fitted with freezer storage capacity for processing at sea. Six boats also fished during 2013.

Bycatch reduction devices (grid and secondary devices) are implemented in this fishery, with all vessels required by way of a condition on the managed fishery license to fish with a grid and secondary BRD in each net.

Industry, in association with the Department, has successfully gained certification from the U.S. Department of State that the fishery is BRD-compliant in terms of potential turtle captures. This allows licensees to export product to the U.S. market. This certification was reviewed in April 2008, with subsequent review in 2011. The U.S. accreditation team delayed the review and was reviewed in 2012 with subsequent approval. However, because of increase in net size towed by the trawl fleet compared to the 2008 visit, modifications to the grid and opening sizes were sought by the U.S. accreditation team during their visit in 2012. These modifications have been undertaken by Industry and although not in place for the 2013 season, trials were undertaken of the new style grids built during the 2013 season. Industry has also installed 'hopper' in-water sorting systems in 2002. This provides an improved quality of prawns and reduces mortality for some bycatch species. A comprehensive ESD assessment of this fishery has determined that performance should be reported annually against measures relating to the breeding stocks of target prawn species, bycatch species impacts, protected species interactions, habitat effects and provisioning effects.

Research summary

Research activities continue to focus on stock assessment and pre season surveys to monitor annual recruitment of tiger and king prawns and breeding stock surveys to monitor spawning stock levels. Monitoring of fleet nightly catch rates occurs for the closure of the tiger prawn spawning area. All boats complete detailed logbooks, which together with survey data and factory unload information, to validate and adjust logbook catch information, provide the information sources for managing the fishery.

The joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing.

RETAINED SPECIES

Commercial production (season 2013): 585 tonnes

Landings

The preliminary total landings of major penaeids for the 2013 season were 585 t, comprising 95 t of tiger prawns, 331 t of king prawns, 85t of endeavour prawns and 74 t of banana prawns.

The tiger prawn landings were well below the normal catch range (250-550 t). There has been a slow recovery of the tiger prawn annual landings but it has come from an unprecedented

extremely low stock abundance level recorded in 2012.

The king prawn landings were also just below the target catch range (350-500 t) but much higher than in 2012. The king prawn landings remain low, a trend that is consistent with other prawn fisheries in the northern bio-region.

Endeavour prawn landings were below the normal catch range of 120-300 t.

Banana prawn landings were the highest recorded since the fishery started and likely reflect the more favourable environmental conditions (continued moderate rainfall over the summer months December to March for three years) for this species. In 2012, there was an improved but still relatively low abundance (33 t) of banana prawns in the fishery and these provided the spawning stock resulting in higher recruitment of banana prawns in 2013. Since the early 1980s, when banana prawns occur in relatively high abundance the tiger prawn abundance generally declines to low levels. However, banana prawn abundance can decline to an extremely low level the following year and are typically of low abundance in Exmouth Gulf (Table 1).

Recorded landings of by-product were; 7.4 t of blue swimmer crab *(Portunus armatus)*, 2.9 t of squid, 1.0 t of bugs (*Thenus orientalis*), 2.4 t of coral prawns, 2.7 t of cuttlefish and negligible landing of octopus (Table 2). The coral prawn catch was low and is primarily because there did not seem to be coral prawn abundance in areas where they are normally taken in the northern part of the fishery.

Landings of blue swimmer crabs were low this season and just below the historical range (8 to 58 t). The low effort and spatial distribution of fishing where crabs are abundant, in 2013 were reflected in the low catches. Crabs and other byproduct are taken incidentally and are variable depending on abundance available on the trawl grounds each year. Fishers retain crabs at a minimum size of approximately 137 mm spine to spine measurement (compared to the recreational minimum size of 127 mm). The larger minimum size was introduced on a voluntary basis into this fishery in 2007. Because of the low trawl effort this season, all retained landings of by product was the lowest since 2002.

Table 1.

Prawn Landings Exmouth Gulf 1963 - 2013

Catches are measured to the nearest tonne, heads on. Effort is measured in hour trawled.
The number of boats represents the maximum number of vessels fishing during any one month.
* = estimates S = small quantities

Year	Tiger		King		Endeavour		Banana Catch (t)	Total Prawn (t)	Nominal Effort (hrs)	Adj. Effort (hrs)	No. Boats
	Catch (t)	Catch Rate (kg/hr)	Catch (t)	Catch Rate (kg/hr)	Catch (t)	Catch Rate (kg/hr)					
1963	15	8.4	1	0.6	S		52	68	1799	1799	12
1964	33	16.2	17	8	S		60	110	2063	2063	6
1965	135	16.1	16	1.9	S		57	208	8380	8380	13
1966	420	37.9	72	6.5	S		39	531	11097	11097	15
1967	704	42.3	41	2.5	S		22	767	16651	16651	17
1968	212	12	167	9.5	S			379	17667	17667	17
1969	473	18	77	2.9	105	4		655	26245	26245	17
1970	888	22.9	208	5.4	295	7.6		1391	38764	38764	20
1971	234	7.9	135	4.6	150	5.1		519	29706	29706	20
1972	673	14.9	364	8.1	210	4.7		1247	45039	45039	22
1973	596	12.6	278	5.9	277	5.9		1151	47296	47296	22
1974	514	12.4	206	5	223	5.4	1	944	41478	41478	22
1975	1239	27.5	312	6.9	450	6.7	2	2003	45066	45066	22
1976	745	15	233	4.7	286	5.8	17	1281	49726	49726	22
1977	639	12.5	340	6.7	237	4.6	1	1217	51035	51035	22
1978	883	16.2	377	6.9	423	7.8		1683	54388	54388	22
1979	572	11.2	272	5.3	328	6.4		1172	51097	51097	23
1980	647	12.3	216	4.1	191	3.6		1054	52710	52710	23
1981	320	6.8	298	6.4	256	5.5		874	46712	46712	23
1982	116	2.8	374	8.9	239	5.6		729	42183	42183	23
1983	77	2	309	8.1	268	7.1		654	37748	37748	21
1984	167	4.3	313	8.1	252	6.6		732	38487	38487	19
1985	226	5.2	483	11.2	310	7.2		1019	43108	43108	19
1986	372	8.4	520	11.7	237	5.3		1129	44570	44570	19
1987	529	11.5	490	10.7	190	4.1		1209	45959	45959	19
1988	445	10.4	320	7.5	336	9.9		1101	42781	42781	19
1989	231	5.8	326	8.2	301	7.6		858	39531	39531	19
1990	564	15.7	389	10.2	198	5.5	5	1156	36008	36008	16
1991	340	9.4	442	12.2	175	4.8		957	36182	36182	16
1992	339	9.9	504	14.7	193	5.6		1036	34376	34376	16
1993	355	9.4	420	11.1	245	6.5		1020	37745	37745	16
1994	682	18.5	377	10.2	217	5.9		1276	36820	36820	16
1995	306	8.4	502	13.8	293	8.1	9	1110	36331	36331	16
1996	205	5.8	370	10.5	137	3.9	59	771	35097	35097	16
1997	253	6.9	430	11.7	121	3.3	11	815	36833	36833	16
1998	377	11.1	508	14.9	170	5	3	1058	33953	35628	15
1999	451	13.8	471	14.4	543	16.6	2	1467	32756	34903	15
2000	82	3.0	299	10.9	122	4.4	62	565	27415	33447	13
2001	208	7.7	330	12.2	131	4.8	1	670	27043	33023	13
2002	395	15.0	244	9.3	170	6.5		809	26358	32186	13
2003	633	23.3	231	8.5	225	8.3		1089	27161	33167	13
2004	629	25.3	436	17.5	282	11.4	0	1347	24874	32165	12
2005	416	17.3	449	18.7	203	8.4		1068	24039	31097	12
2006	258	12.2	442	20.9	199	9.4		899	21184	27511	12
2007	248	15.2	342	21	200	12.3		790	16278	24650	9
2008	576	31.8	279	15.4	315	17.4	0	1170	18123	28119	9
2009	412	22.9	284	15.8	132	7.4	1	829	17971	27851	9
2010	388	23.3	254	15.3	138	8.3	0	779	16606	25787	9
2011	749	56.7	97	7.3	130	9.4	3	976	13220	20531.6	9
2012	46	6.6	157	22.3	51	7.2	33	254	7042	12813.6	6
2013	95	10.0	331	34.8	85	8.9	74	511	9503	17123.7	6

Catches are measured to the nearest tonne, heads on. Effort is measured in hour trawled. The number of boats represents the maximum number of vessels fishing during any one month. * = estimates; S = small quantities

Table 2. Recorded landings of byproduct species in the Exmouth Gulf Prawn fishery 1990 -2013

Year	Coral	Bugs	Crabs	Cuttlefish	Octopus	Squid	Scallop	Fish	Shark
1990	28.9	1.5	13.7	4.3	0.3	11.3	7.6	12.1	3.6
1991	45.0	1.4	11.3	5.3	0.7	45.9	1.2	22.5	4.6
1992	74.2	0.8	10.6	5.2	0.7	29.5	0.0	5.6	3.9
1993	116.0	2.1	7.0	4.1	0.7	51.8	6.1	13.3	4.2
1994	16.3	5.6	34.1	7.2	0.3	50.6	0.0	12.3	9.9
1995	84.9	1.7	20.2	14.0	1.0	98.8	0.0	14.8	6.3
1996	86.9	9.7	18.5	30.9	0.3	37.2	0.0	19.3	18.3
1997	59.6	5.3	20.9	11.6	1.0	30.2	0.0	12.2	9.6
1998	40.7	11.2	32.0	8.8	1.0	62.4	0.0	5.3	5.9
1999	19.8	7.5	41.4	6.0	0.4	46.5	0.0	8.7	6.2
2000	59.0	12.0	6.0	9.3	0.4	24.3	0.1	2.3	5.2
2001	NA	15.4	9.6	20.7	2.6	26.1	0.1	2.8	4.9
2002	NA	15.0	16.8	25.2	2.2	44.7	0.0	8.3	2.2
2003	NA	5.8	20.8	12.5	0.6	76.0	0.0	2.1	1.2
2004	47.0	6.8	32.8	8.8	1.3	77.3	0.0	7.4	0.3
2005	32.0	9.6	18.1	10.1	1.3	58.1	0.0	3.3	0.4
2006	58.0	1.3	10.8	2.5	1.2	6.1	0.0	0.0	0.0
2007	39.0	1.6	8.0	0.5	0.9	9.5	0.0	0.0	0.0
2008	12.0	3.3	25.3	0.0	0.6	7.6	0.0	0.0	0.0
2009	25.2	2.0	10.1	0.0	0.7	5.7	0.0	0.0	0.0
2010	18.0	2.2	16.4	0.0	1.5	17.2	0.0	0.0	0.0
2011	0.8	2.1	57.6	0.0	0.3	5.7	0.0	0.0	0.0
2012	11.5	0.5	2.1	1.4	0.0	2.6	0.0	0.0	0.0
2013	2.4	1.0	7.4	2.7	0.4	2.9	0.0	0.0	0.0
AVERAGE	41.8	5.2	18.8	8.0	0.8	34.5	0.6	6.3	3.6

Fishing effort/access level

Historical changes to boat numbers and headrope towed

From 2007 to 2011, boat numbers have remained at nine, fishing with a total headrope capacity of 376.73 m (206 fathoms). However, to date not all nine boats have towed the same size nets. For the 2012 season the number of boats was reduced to 6.

In 2013, six boats operated towing a total of 292.6 m (160 fathoms) of net heardrope. 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) because four of the six boats would have production difficulties at this stage if they towed the larger 14.63 m headrope length nets.

Total nominal effort for the 2013 season was 9503 hours a slight increase compared to the extremely low nominal effort recorded in 2012 (7042 hours). The adjusted effort (to twin gear) in 2013 was 17,124 hours (Table 1). Fishing effort (in hours) in 2013 was was the second lowest in 40 years but commensurate with the low prawn abundance. Generally the effort on 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 2013 year mainly because of the low effort during the early part of the season (a combination of banana and tiger prawn fishing in the Central area) and shifting effort to the latter part of the season. The season ceased on 10 November with 144 days actually fished, only 27 more fishing nights compared to 2012.

STOCK ASSESSMENT

Assessment complete:	**Yes**
Assessment method	**Direct survey/catch rate**
Breeding stock levels:	**Adequate**

The adjusted catch per unit effort data from the fishery is an indicator of abundance, which can be used to monitor changes in stock levels from year to year. The average catch and catch rates are compared to a ten-year reference point (1989 to 1998) for each species (Figure 1).

King prawns:

The preliminary adjusted catch rate 19.3 kg/hr, for king prawns is above reference catch rate level of 11.7 kg/hr. There is still, however, some concern for the king prawn stock as total landings were below the acceptable catch range even though there was an increase in the total landings compared to 2011 and 2012 seasons (Table1). Fishing effort does not appear to be the main cause of the decline in annual landings at current effort levels, however, there may need to be a consideration of implementing a small area closure during the spawning season to provide protection to some of the spawning stock. Fishery-independent surveys are undertaken to measure the recruitment strength and spatial distribution and catch and effort information from logbooks is used during the spawning phase to assess the stock status and to understand the distribution of king prawns in the gulf.

The season commenced on 15 May, almost 1 month earlier than the previous season. King prawns were fished conservatively during the early part of the season and effort in the northern area (the main king prawn fishing grounds) was focused mainly in the latter part of the season. Also in the early part of the season areas where small size king prawns were located were closed to fishing to ensure that size and quality were maintained. Overall, fishing ceased in 2013 because of the fishing protocol set out in the season arrangements related to king prawn size composition.

Tiger prawns:

The preliminary adjusted annual catch rate of 5.5 kg/hr for tiger prawn was lower than the reference catch rate of 10 kg/hr. As in 2012, the low catch rate of tiger prawns reflect their low abundance. The likely cause of the continued low abundance (low recruitment levels) may be a result of three years of very high water temperatures since 2011 (highest observed in 2013) and its possible continued impact on the spawning stock and/or inshore structured habitats. The tiger prawn breeding stock levels in 2012 were lower (17.3 kg/hr) than the target and the Threshold (20 kg/hr) but not the limit of 15 kg/hr, because the recruitment in 2012 was extremely low. During 2013 fishing on the tiger prawn stock was again conservative and only parts of the Central area was open to fishing. Fishing for tiger prawns was undertaken from 15 May to 26 July after which the Tiger Prawn Spawning Area (TPSA) closed. There were six subsidiary openings in the Central area whilst the Eastern area remained closed for the entire season (Attachment 1 subsidiary openings 15 May to 26 July

2013). When fishing ceased on 26 July the TPSA was not re-opened to fishing for the remainder of the season.

The low effort on the tiger prawn stock was also reflected in a low endeavour prawn preliminary catch rate of 5.0 kg/hr, which is slightly below the reference point catch rate of 5.6 kg/hr.

The tiger and king prawns stocks are assessed each year using standardised fishery-independent surveys, which allows variations to the harvesting strategy using flexible arrangements within the season to optimise catch and size grades and reduce effort to ensure sustainability.

For tiger prawns, this process involves analysis of survey-based indices of recruitment (Figure 2) and spawning stock (Figure 3), which are assessed against the spawning stock recruitment relationship. Three tiger prawn recruitment surveys were carried out in March and April 2013. The survey indices provided tiger prawn catch prediction of 210 t (range of 170 to 250 t). For the 2013 season (and also for 2012) the annual total landings were below the prediction range, based on recruitment survey indices, and this partially reflects the record-low fishing effort that was applied in these years.

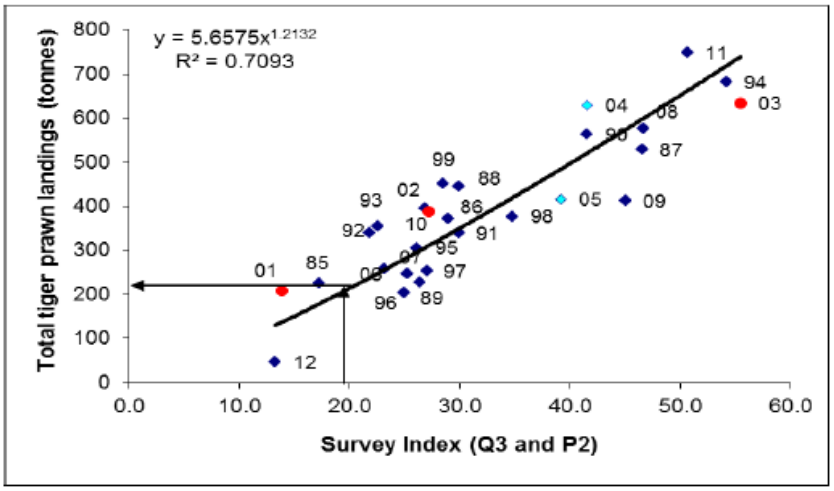


Figure 2. Relationship between annual recruitment index (Q3 and P2) and total tiger prawn landings, using twin gear catch rates and a linear relationship (arrow indicates index and catch prediction for 2013).

Catch monitoring:

Monitoring of the tiger prawn catch rates is normally undertaken prior to the TPSA closure date (1 August) to determine when fishing should cease in the main tiger prawn fish grounds. This strategy is aimed at maintaining the spawning biomass of tiger prawns above the historically determined biological reference point. The present target (previously called threshold) catch rate is 25 kg/hr based on 6-fathom nets in quad gear configuration (which is reduced to 19 kg/hr after 1 November).

For the 2013 season it was difficult (as it was in 2012) to monitor the tiger prawn catch rates because of the intermittent nature of fishing between the tiger prawn area and the northern king prawn area and, the presence of banana prawns in the Central area which fishers targeted instead of tiger prawns. When boats shift effort between areas monitoring tiger prawn catch rates on a daily basis is difficult. 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. For this reason a survey was undertaken on 3 July to obtain standardised fishery-independent tiger prawn catch rate information east of the spawning area. The Central area was closed between 2 and 15 July and re-opened for a limited fishing period between16 to 25 July with the area of fishing activity restricted eastward of the Heron Line (Figure 3). All areas east of the Heron Line and the eastern Area remained closed to fishing for the remainder of the season.

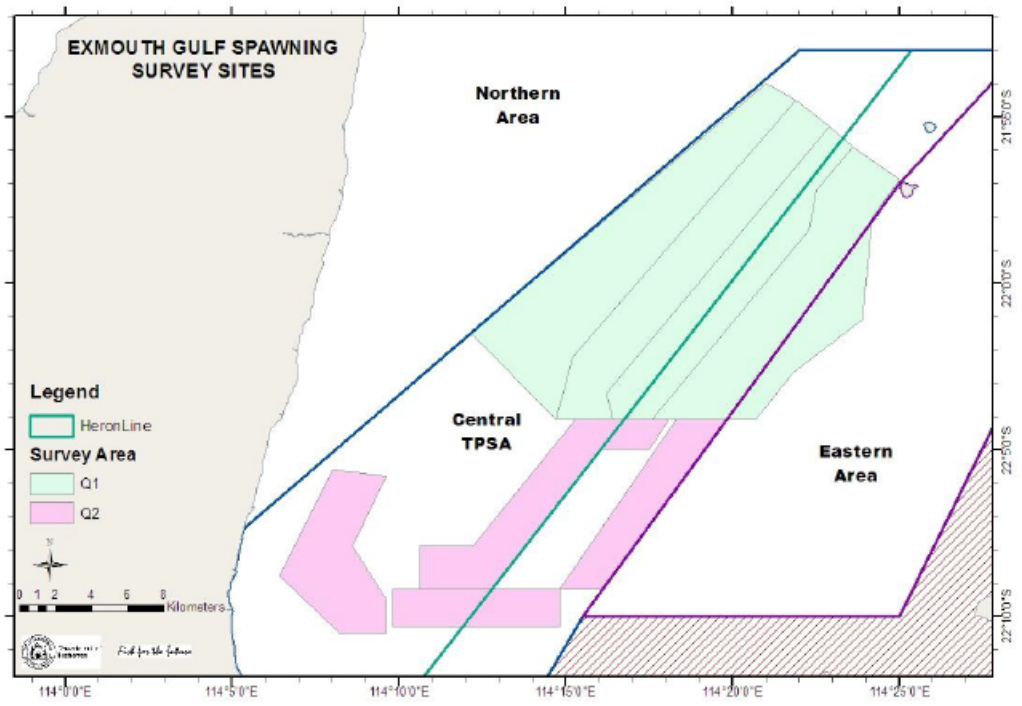


Figure 3. Map of spawning survey sites including the Heron line

Fishery-independent surveys

Three standardised tiger prawn breeding stock surveys carried out in August, September and October (Figure 3). The survey results showed an average quad gear CPUE of 14.7 kg/hr and 30.4 kg/hr in the spawning areas (Q1 and Q2 respectively, Tables 3 and 4) with an overall mean catch rate of 22.6 kg/hr. This level is an increase on the spawning stock observed in 2012 (Figure 4) and is above the threshold reference point (20 kg/hr) but is still below the target level (25 kg/hr).

Table 3: Spawning stock survey indices for Q1

SPECIES	MONTH	JULY/AUGUST	SEPTEMBER	OCTOBER	AVERAGE
TIGERS	Total catch (kg)	304	320	252	292
	Duration (hr)	20	20	19.5	20
6 Fathom	Quad Gear Catch Rate (kg/hr)	15.2	16.0	13.0	14.7
	Twin Gear Catch Rate (kg/hr)	9.4	9.9	8.0	9.1
KINGS	Total catch (kg)	365	400	137	301
	Duration (hr)	20	20	19.5	20
6 Fathom	Quad Gear Catch Rate (kg/hr)	18.3	20.0	7.0	15.1
	Twin Gear Catch Rate (kg/hr)	11.3	12.4	4.3	9.3
ENDEAVOURS	Total catch (kg)	121	243	422	262
	Duration (hr)	20	20	19.5	20
	Quad Gear Catch Rate (kg/hr)	6.0	12.2	21.6	13.2
	Twin Gear Catch Rate (kg/hr)	3.7	7.5	13.3	8.2

Table 4: Spawning stock survey indices for Q2

SPECIES	MONTH	JULY/AUGUST	SEPTEMBER	OCTOBER	AVERAGE
TIGERS	Total catch (kg)	477	682	667	609
	Duration (hr)	20	20	20	20
	Quad Gear Catch Rate (kg/hr)	23.9	34.1	33.3	30.4
	Twin Gear Catch Rate (kg/hr)	14.8	21.1	20.6	18.8
KINGS	Total catch (kg)	308	377	251	312
	Duration (hr)	20	20	20	20
	Quad Gear Catch Rate (kg/hr)	15.4	18.9	12.6	15.6
	Twin Gear Catch Rate (kg/hr)	9.5	11.7	7.8	9.6
ENDEAVOURS	Total catch (kg)	74	165	174	138
	Duration (hr)	20	20	20	20
	Quad Gear Catch Rate (kg/hr)	3.7	8.2	8.7	6.9
	Twin Gear Catch Rate (kg/hr)	2.3	5.1	5.4	4.3

Note: Twin gear is calculated by dividing the 5.5 Fa quad gear catch rate by an efficiency factor of 1.2176
Note: Twin gear is calculated by dividing the 6.0 Fa quad gear catch rate by an efficiency factor of 1.6176
Quad gear (4x6 fathom nets catch rate = 25kg/hr) Twin gear (2x7.5 fathom nets C/R =16kg/hr)

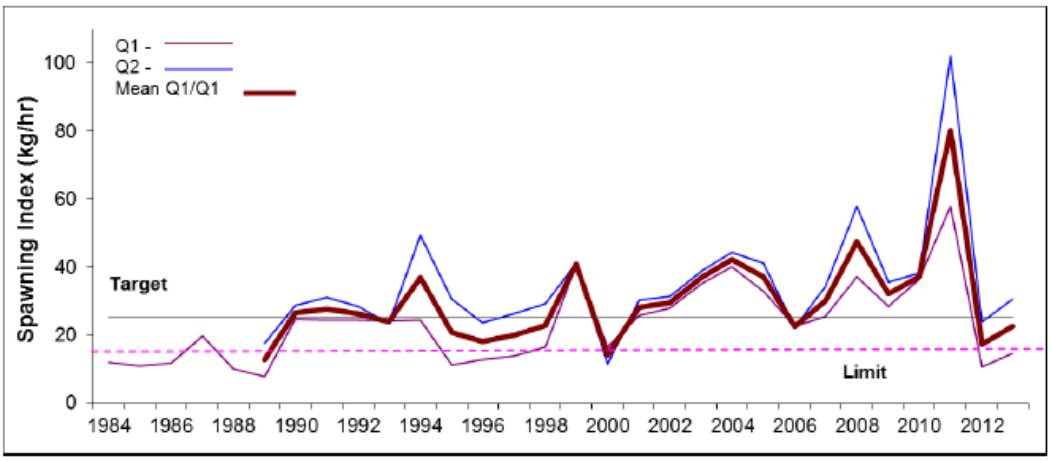


Figure 4. Mean tiger prawn spawning stock index (August to October) in Q1 and Q2 and Q1/Q2 combined (1984 to 2013). The black line indicates the target reference point (25 kg/hr) and the pink dashed line indicates the limit reference point (15 kg/hr).

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort, their extended breeding period and lower catchability of the species compared to tiger prawns.

Recruitment surveys were also undertaken for king prawns in the northern part of the fishery that provided prawn size structure and catch rate information. These surveys commenced in 2003 but there was some modification to survey site locations in the first two years. From 2005, king prawn surveys have been conducted in March and April and these two surveys are combined to provide a catch prediction. The 2013 pre-season survey index (mean catch rate for March and April) provided a catch prediction of 315 t with a range between 250 and 380 t. The annual landing of 331 t was within the catch prediction range (Figure 5).

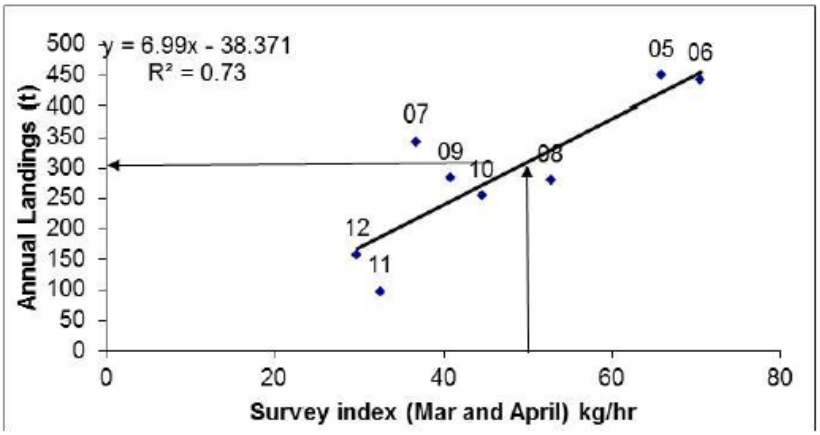


Figure 5. The relationship between fishery-independent mean survey catch rates (March and April) and the annual landings of western king prawns in the Exmouth Gulf prawn fishery. Note the survey index and landings are for the same year. The index and catch prediction for 2013 is indicated by the arrows.

There is no formal stock assessment for endeavour prawns, a secondary target species whose distribution overlaps that of tiger prawns, and they are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns. The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the tiger prawns and the 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 tiger and king prawns.

Projected catch next season (2014)

The catch prediction for tiger and king prawns is based on the relationships between recruitment survey indices (early and late March and early April) and the season's landings. The projected catch for 2014 will be provided on completion of the recruitment surveys.

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. In addition to grids, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. All boats also use hoppers (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality.

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.

Protected species interaction: Low

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive. Grids are now compulsory, which has largely eliminated the capture of any turtle or other large animal. This season 10 turtles (2 green, 1 loggerhead and 7 unidentified turtles) were reported as being caught in nets and returned alive. One hundred and eleven sea snakes were also reported as being caught with all but six of reported as returned alive to the sea. Fourteen sawfish were also reported as being caught in a net with their release status unknown.

ECOSYSTEM EFFECTS

Food chain effects: **Low**

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

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 effect of the record high water temperatures in the Gascoyne region in early 2011 and continued warm water conditions in Exmouth Gulf and their possible effect on habitat structure after the record low abundance of tiger prawns will also be examined.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. The performance measure for 2013 needs to be calculated however, it is likely to be met as the total area trawled is expected to be only a slight increase compared to 2012 (approximately 273 square nautical miles (24%) and should remain below the 40% level. Over the past eight years the area trawled has been between 27 to 32% of the permitted trawl area in Exmouth Gulf.

FISHERY GOVERNANCE

Target catch range: **771 – 1,276 tonnes**

Current fishing level: **Acceptable**

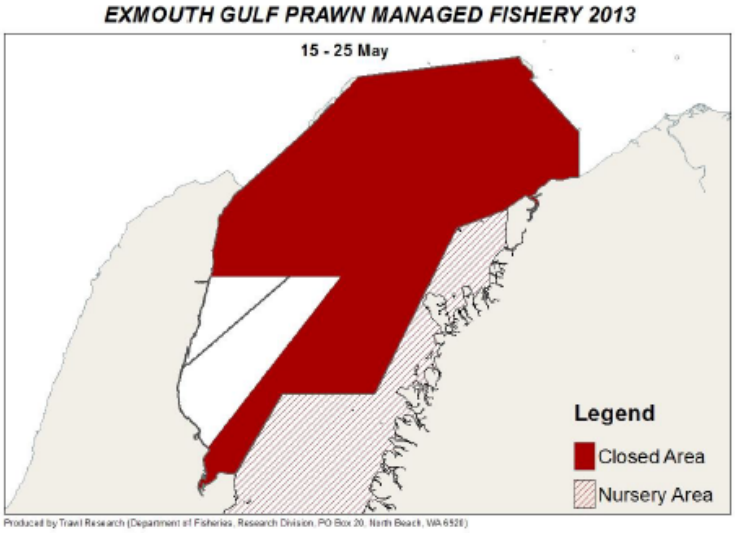
Under current fishing effort levels, the target catch range for major penaeids is 771–1,276 t. The long-term target catch ranges for individual species are king prawns 350–500 t, tiger prawns 250–550 t and endeavour prawns 120–300 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are for normal environmental conditions and are generally based on a 10-year average (1989-1998). Tiger prawns were well below the target catch range and king prawns slightly below their target range. Endeavour prawn landings were also below the range, however the adjusted effort level for 2013 was very low.

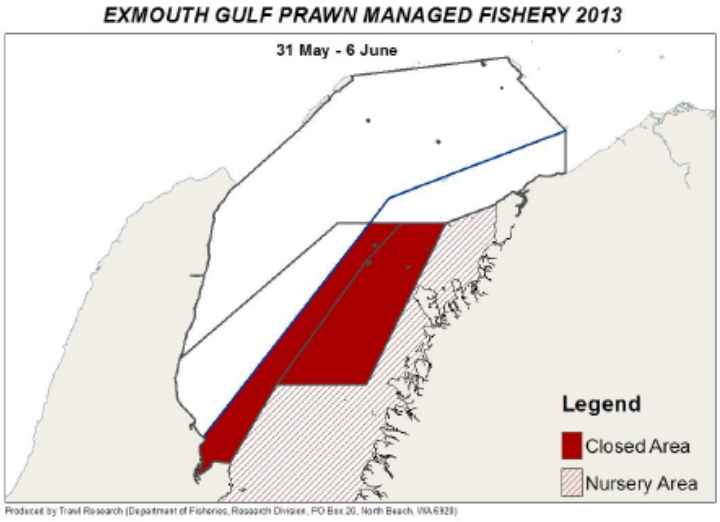
New management initiatives (2014):

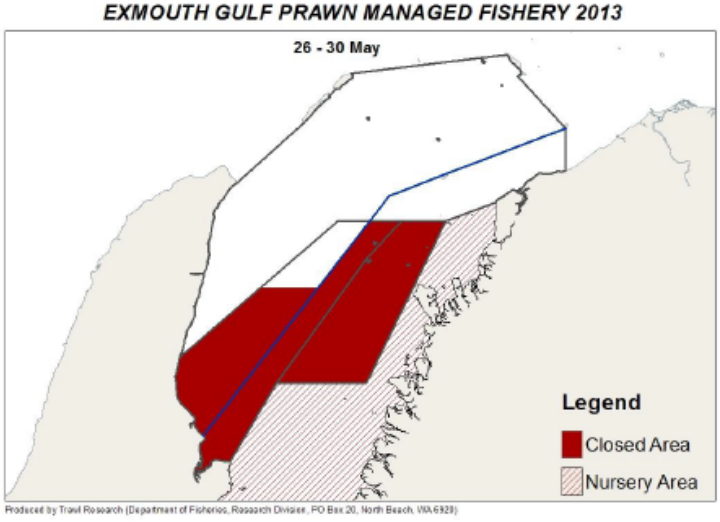
For the 2014 season the number of fishing boats will remain as 6 but new net mesh size and shape (i.e. not conventional diamond mesh) and board types will be trialled. The fleet will consist of 4 boats towing 10.97 m (6 fathom nets) and 2 larger boats (larger than ever before in this fishery) towing 14.63 m (8 fathom nets) in quad gear configuration. Five boats will have reduced Bison otter board sizes (the 8 fathom boats will tow No. 7 Bison boards and three 6 fathom boats will tow No. 5 Bison boards). One 6 fathom boat will tow small dimension Thyboron type otter boards. This will require monitoring by the Research Division to evaluate the catch per fathom difference between the two net sizes and different board types. The tiger prawn stock will need to be monitored using the 6-fathom net boat catch rates as the trigger to cease fishing at the appropriate catch rate level until this evaluation is completed.

There will be consultation with the industry on the formalisation of the harvest strategy for the fishery for king and tiger prawns.

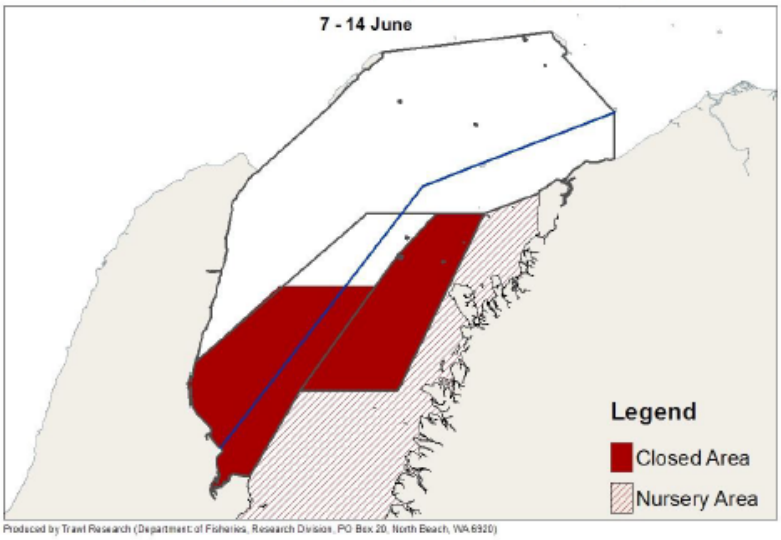
Attachment 1 – Subsidiary openings om the Exmouth Gulf prawn fishery 2013







EXMOUTH GULF PRAWN MANAGED FISHERY 2013



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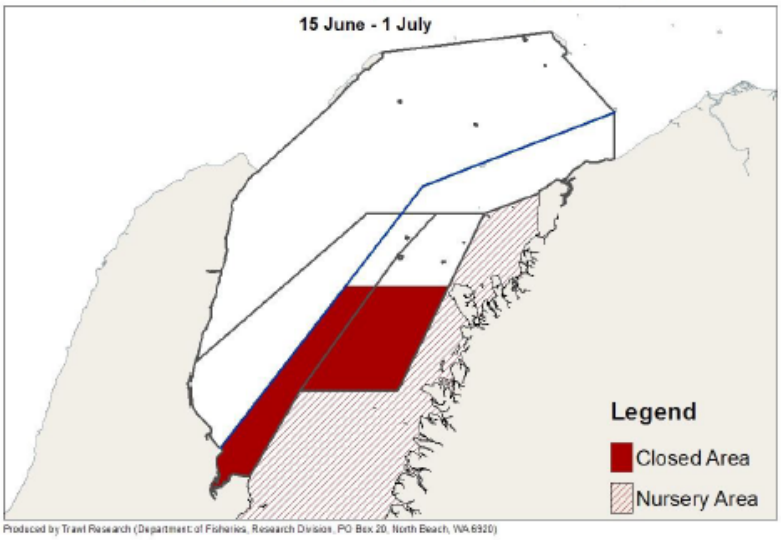

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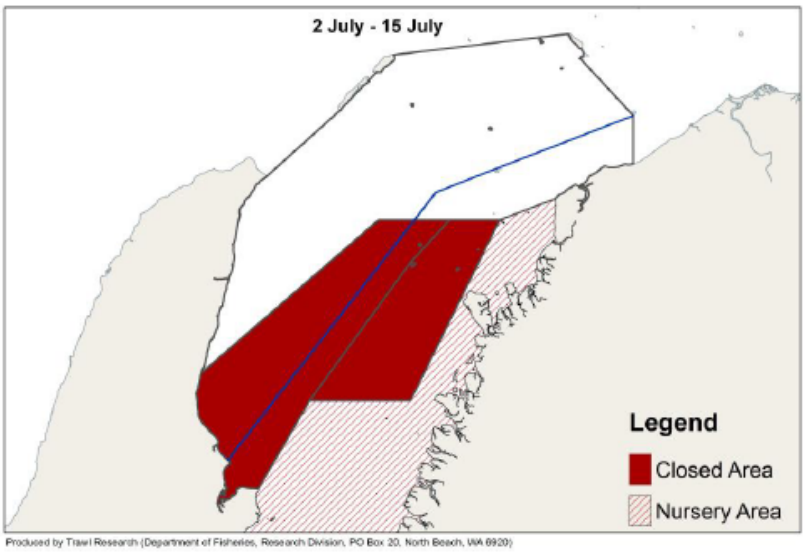

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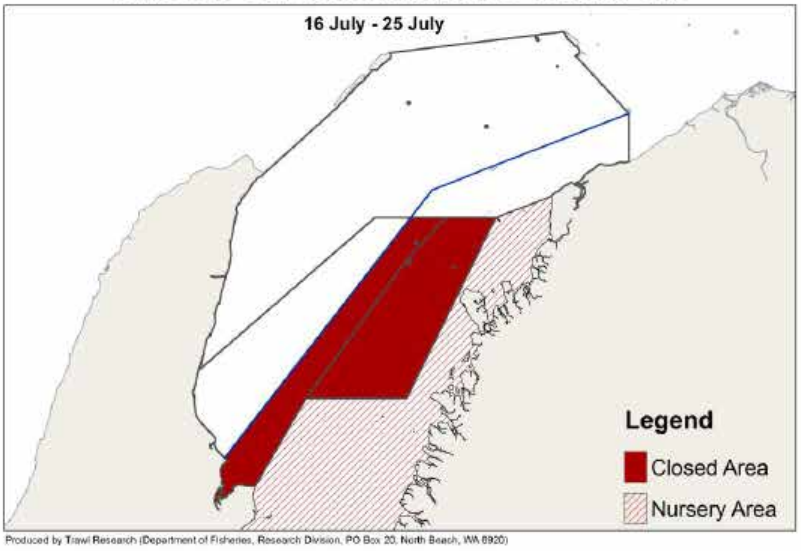

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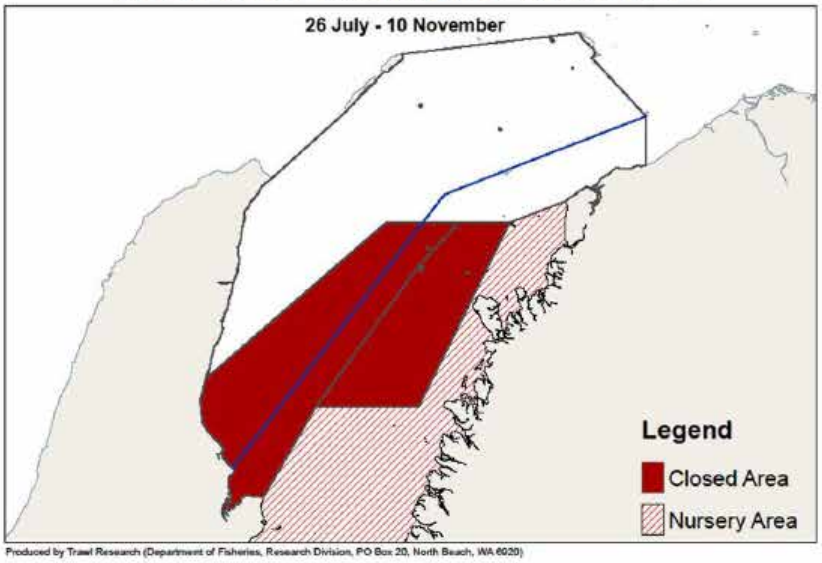

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Appendix G: 2014 Skipper's Briefing Package

2014 EXMOUTH GULF PRAWN MANAGED FISHERY

GUIDE TO MANAGEMENT AREAS

ALL POSITIONS RELATED TO GDA 94

PLEASE NOTE: the information covered in this package is a guide only and should be read in conjunction with the current 2014 Notice, season arrangements and the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989.*

A copy of the current *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* can be located under Legislation on the Department of Fisheries Western Australia website at **www.fish.wa.gov.au**.

This package contains a written description and maps of the management areas within the Exmouth Gulf Prawn Managed Fishery for the 2014 fishing season. The purpose of this package is to aid fishers' understanding of the 2014 fishing arrangements and management areas. The package has been broken into 2 main sections as follows:

PART 1

2014 EXMOUTH GULF PRAWN MANAGEMENT PLAN SCHEDULE

The information provided in this section covers the management areas outlined in the *Exmouth Gulf Prawn Managed Fishery Management Plan 1989* (the Plan). These areas are opened and/or closed by Notice from the Chief Executive Officer (CEO), as provided for under clause 10 of the Plan.

PART 2

2014 EXMOUTH GULF PRAWN MANAGEMENT AREAS AS PER SEASON ARRANGEMENTS

The information provided in this section covers the management areas which are not outlined in the Plan, but are included in the 2014 season arrangements.

PART 1

2014 EXMOUTH GULF PRAWN MANAGEMENT PLAN SCHEDULE

SCHEDULE 1

Item 1 (The Fishery)

All waters of the Indian Ocean and Exmouth Gulf bounded by a line commencing at Point Murat at the intersection of 21°48.917' south latitude and 114°11.449' east longitude; thence north easterly along the geodesic to the intersection of 21°42.70' south latitude and 114°18.35' east longitude; thence north easterly along the geodesic to the intersection of

21°37.50’ south latitude and 114°23.35’ east longitude; thence east by north along the geodesic to the intersection of 21°35.495’ south latitude and 114°39.921’ east longitude; thence generally south easterly and south westerly along the high water mark on the western side of Serrurier Island to the intersection of 21°37.80’ south latitude and 114°41.00’ east longitude; thence south easterly along the geodesic to the intersection of 21°43.20’ south latitude and 114°46.00’ east longitude; thence south along the meridian to the intersection of 21°47.78’ south latitude and 114°46.00 east longitude; thence generally south, west, then north along the high water mark of the coastline to the commencement point.

Item 2 (Nursery Area)

All waters of Exmouth Gulf bounded by a line commencing from the intersection of 22°18.293’ south latitude and 114°10.645’ east longitude at Point Lefroy; thence north east by north along the geodesic to the intersection of 22°10.00’ south latitude and 114°15.50’ east longitude; thence east along the parallel to the intersection of 22°10.00’ south latitude and 114°25.00’ east longitude; thence north east along the geodesic to the intersection of 21°53.00’ south latitude and 114°33.40’ east longitude; thence east north east along the geodesic to the intersection of 21°50.989’ south latitude and 114°38.692’ east longitude at Tubridgi; thence generally south, west, then north along the high water mark of the coastline to the commencement point.

Item 3 (Gear Trial Area)

All waters of the fishery bounded by a line commencing at the intersection of 22°00.00’ south latitude and 114°08.60’ east longitude; thence east along the parallel to the intersection of 22°00.00’ south latitude and 114°09.60’ east longitude; thence south by west along the geodesic to the intersection of 22°03.00’ south latitude and 114°09.00’ east longitude; thence west along the parallel to the intersection of 22°03.00’ south latitude and 114°08.00’ east longitude; thence north by east along the geodesic to the commencement point.

Item 5 (Port Area)

The Port Area is the area within 3 nautical miles of latitude 21°57.445’ south and 114°08.477’ east longitude (Exmouth Marina and associated area).

PART 2

2014 EXMOUTH GULF PRAWN MANAGEMENT AREAS as per THE 2014 SEASON ARRANGEMENTS

The area descriptions below are a guide and are provided for illustration purposes only.

Northern Area

That part of the fishery bounded by a line commencing at the intersection of 21°48.917' south latitude and 114°11.449’ east longitude at Point Murat; thence north easterly along the geodesic to the intersection of 21°42.70' south latitude and 114°18.35' east longitude; thence continuing north easterly along the geodesic to the intersection of 21°37.50’ south latitude and 114°23.35’ east longitude; thence east by north along the geodesic to the intersection of 21°35.495’ south latitude and 114°39.921’ east longitude; thence generally south easterly and south westerly along the high water mark on the western side of Serrurier Island to the intersection of 21°37.80’ south latitude and 114°41.00’ east longitude; thence south easterly along the geodesic to the intersection of 21°43.20’ south latitude and 114°46.00’east longitude; thence south along the meridian to the intersection of 21° 47.78’ south latitude and 114° 46.00 east longitude; thence generally south westerly along the high water mark of the coastline to the intersection of 21°50.989' south latitude and 114° 38.692’ east longitude at Tubridgi Point; thence south westerly along the geodesic to the intersection of 21°53.00’ south latitude and 114°33.40’ east longitude; thence west along the parallel to the intersection of 21°53.00’ south latitude and 114°28.70’ east longitude; thence due west along the parallel to the intersection of 21°53.00' south latitude and 114°22.00' east longitude; thence south westerly along the geodesic to the intersection of 22°07.40' south latitude and 114°05.30’ east longitude; thence generally northerly along the high water mark of the coastline to the commencement point.

Central Area

That part of the fishery bounded by a line commencing at the intersection of 22°07.40' south latitude and 114°05.30’ east longitude; thence north easterly along the geodesic to the intersection of 21°53.00' south latitude and 114°22.00' east longitude; thence east along the parallel to the intersection of 21°53.00’ south latitude and 114°28.70' east longitude; thence south westerly along the geodesic to the intersection of 21°57.00' south latitude and 114°25.00' east longitude; thence south westerly along the geodesic to the intersection of 22°10.00' south latitude and 114°15.50' east longitude; thence south westerly along the geodesic to the intersection of 22°18.293’ south latitude and 114°10.645’ east longitude at Point Lefroy; thence generally northerly along the high water mark of the coastline to the commencement point.

Eastern Area

The part of the fishery bounded by a line commencing at the intersection of 22°10.00' south latitude and 114°15.50' east longitude; thence north easterly along the geodesic to the intersection of 21°57.00' south latitude and 114°25.00' east longitude; thence north easterly along the geodesic to the intersection of 21°53.00' south latitude and 114°28.70' east longitude; thence east along the parallel to the intersection of 21°53.00’ south latitude and 114°33.40’ east longitude; thence south westerly along the geodesic to the intersection of 22°10.00’ south latitude and 114°25.00’ east longitude; thence west along the parallel to the commencement point.