

# Co-management in the Exmouth Gulf Prawn Fishery with comparison to the Shark Bay Prawn Fishery

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## 1. INTRODUCTION

The Exmouth Gulf and Shark Bay prawn (shrimp) fisheries are the two most valuable prawn fisheries in Western Australia (WA) (Figure 1), with annual values of US\$8–17 million and US\$17–25 million, respectively. Both fisheries experienced overfishing in the early 1980s, but remedial action since and good co-operation between licensees and the Department of Fisheries has ensured relatively stable catches under normal environmental conditions. This has provided a level of confidence for the industry to try innovative and adaptive management strategies to ensure sustainability while gaining maximum economic return. These industry strategies include support for reductions in fishing gear, support for various kinds of regulatory closures and voluntary industry-implemented closures. These closures help to reduce the costs of fishing and to increase the size and value of prawns.

The current ownership of licensees in both fisheries is quite unusual. One company owns 15 of the 16 licences in Exmouth Gulf fishery. Eight licensees own the 27 licences in Shark Bay, with one company owning 15 of these licences. This provides for ease of communication when dealing with industry. The large commitment in investment, particularly by the companies owning many licences, provides an incentive for making them proactive and keen to optimize their return on investment.

Because prawns are short lived and have highly variable recruitment, TAC management is not especially appropriate for these species. Input controls, and especially spatial/temporal closures, are better strategies to achieve biological and economic goals, but these kinds of effort control regimes can be difficult to implement. A particular problem is that technological progress slowly renders

FIGURE 1  
Location of the Exmouth Gulf and Shark Bay prawn fisheries



any input-control system ineffective unless on-going adjustment of the system occurs. When the industry accepts the logic of the input-control system and works to support it, then the system can work even though it is complex. This is what has successfully occurred in both Exmouth Gulf and Shark Bay. In contrast, in confrontational regulatory systems, this kind of adaptive management is impossible, in part because the industry has individual incentives to find ways to circumvent conservation regulations.

In this case study, the primary focus is on the Exmouth Gulf prawn fishery, which has moved toward strong, industry-initiated co-operative management. Comparisons to the Shark Bay prawn fishery will be noted when relevant.

## 2. HISTORY OF EXPLOITATION OF TARGET SPECIES IN EXMOUTH GULF

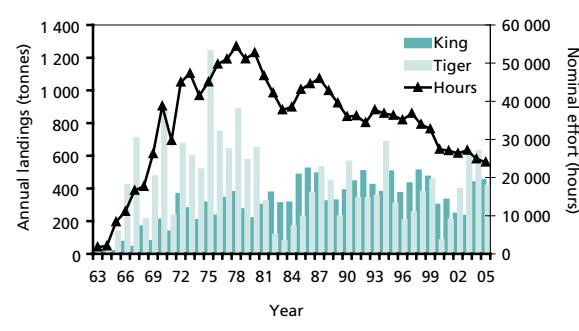
The Exmouth Gulf prawn fishery began in 1963. It initially targeted banana prawns (*Penaeus merguiensis*) with 12 boats landing 68 tonnes of prawns comprised of: 52 t of banana prawns; 1 t of western king (*Penaeus latisulcatus*) and 15 t of brown tiger prawns (*Penaeus esculentus*). This early stage of the fishery was a daylight fishery for banana prawns, but changed to an entirely night fishery for tiger, king and endeavour prawns. As the fishery expanded, the target species changed as tiger prawns became more catchable. Since the early 1980s, when the fishing management strategy changed, the two main target species of this fishery have been the brown tiger prawn and the western king prawn. Western king prawns are the staple species in the catch contributing on average 505 t of the total landings each year (Figure 2).

A smaller proportion of endeavour prawns (*Metapenaeus endeavouri*) and a small quantity of coral prawn species (mainly *Metapenaeopsis* sp. and *Trachypenaeus* sp.) are also caught. On occasion, banana prawns make up the remainder of the catch. In addition to prawns, the trawl catch consists of a number of other species that are retained as by-product, which include crabs, squid, cuttlefish, tuna, slipper lobsters, and low numbers of various finfish species.

Until 1980, tiger prawns were the dominant catch and during these years the effort on this species increased (Penn *et al.*, 1997). In 1975, landings of tiger prawns peaked at 1 239 tonnes. Catches then declined to a low of 77 tonnes in 1983 (Figure 2). In 1981 and 1982, growth and recruitment overfishing occurred when boats commenced fishing earlier on smaller prawns and fished longer seasons. Boats began fishing further to the east where the recruitment grounds are located (targeting small prawns) rather than the traditional fishing grounds. This resulted in a serious decline in recruitment and subsequent catches of tiger prawns. Rigid management restrictions were introduced to reduce fishing effort and to rebuild the tiger prawn stocks. Variable closures of the main tiger prawn fishing grounds were introduced. Extension of permanent closure areas (nursery grounds) to allow sufficient escapement to provide a spawning stock irrespective of annual recruit strength were also introduced (Penn *et al.*, 1997). By using historical catch and effort data, Penn and Caputi (1986) concluded that a strong spawning stock-recruitment relationship existed for the tiger prawn. Since the introduction of the additional management measures, tiger prawn stocks have improved, breeding stocks have increased, and tiger prawn catches have been more stable.

During the 1970s, king prawns were under-exploited as effort was focussed on tiger prawns. From the early 1980s, targeting of effort increased on catching king prawn.

FIGURE 2  
Catch and effort (nominal hours) history of king and tiger prawns in the Exmouth Gulf prawn fishery 1963 to 2005



Due to their behaviour (burying, nocturnal and a strong lunar relationship) and high reproductive output, king prawns appear to be less susceptible to recruitment overfishing in Exmouth Gulf. This has been demonstrated by the increased effort on king prawns since the 1980s with no evidence of lower production. The annual landings of king prawns generally reflect the overall effort in the fishery and the level of targeting of king prawn areas. This targeting has been a function of the annual abundance of king prawns in the northern sector of the fishery relative to the tiger prawn stocks in the more protected southern sector.

Annual variation in the catches of all species is evident, which are most likely due to weather and especially tropical cyclone events, which may provide either a positive or negative effect (Penn and Caputi, 1985). For example, the 1999 category-5 tropical cyclone Vance probably contributed to record landings in 1999 and a decrease in landings in 2000. On 22 March 1999, cyclone Vance passed through the middle of the Gulf and produced the strongest winds ever recorded in Australia and heavy rainfall. This assisted the movement of tiger and endeavour prawns onto the trawl grounds and increased the level of suspended sediments in the Gulf. This created high turbidity and thus a high survival rate for these species for several months. The short-term effects of the cyclone appeared to be higher catch rates, particularly of endeavour prawns, for the 1999 season.

Conversely, inshore areas (nursery habitats) of Exmouth Gulf were adversely affected by the cyclone. The tidal surge, reported to be approximately 6 metres, had devastating impact on the eastern side of the Gulf, where juvenile tiger prawns and important seagrasses and algal communities are located. A survey carried out by CSIRO in November/December 1999 was unable to find significant quantities of juvenile tiger prawns, which was associated with very low seagrass/algal abundance. Structured habitats, such as seagrass beds, are preferred by juvenile brown tiger prawns (Coles and Lee Long, 1985; Kenyon, Loneragan and Hughes, 1995; Loneragan *et al.*, 1998). Three subsequent recruitment surveys by the Department of Fisheries, in March to April 2000, showed low recruitment indices in the area that contributes around 70 percent of the catch. This low tiger prawn recruitment to the fishery had a negative impact on the 2000 season. The low tiger prawn catch in 2000 was also due in part to the management controls, which ensured that sufficient tiger prawns were left to become the spawning stock for 2001.

During the history of this fishery, low catch years have been followed by several years of rebuilding the stock to average and above average levels. In this multi-species fishery, the primary target species (western kings and brown tigers) and secondary species (banana and endeavour) have overlapping habitats, but different capture rates and spawning strategies. Management must ensure that fishing for one species does not jeopardise the sustainability of the other. The management arrangements try to optimize, not maximize, the catch.

Since 1984, industry funded buy-back schemes have resulted in the removal of seven boats, which reduced the fishing fleet from of 23 to 16 boats. The first of these schemes was initiated by the Department of Fisheries but relied on industry co-operation to remove potential latent effort and active boats for both sustainability and economic reasons. The second buy-back was industry-initiated to remove three boats for improved economic performance. Both buy-back schemes were government assisted via a loan mechanism.

The 16 boats tow twin 7.5-fathom nets to meet the overall headrope net limitation of 240 fathoms (439 metres). Currently, due to internal gear amalgamations, 12 boats operated in the fishery in 2006. This was an industry initiative following consultation with the Research Division about the merit of reducing boat numbers and about gear trials to assess the appropriate net size for the boats. There is an ongoing commitment to further reduce boat numbers.

### 3. SHARK BAY PRAWN FISHERY

The Shark Bay prawn fishery began in 1962 with a catch of 152 tonnes of king and tiger prawns by four boats. The fishery quickly expanded to a maximum of 35 boats in 1976, landing 1 511 t of king and 771 t of tiger prawns (Figure 3). A peak catch of 2 370 t of predominantly king (2 014 t) and tiger (324 t) prawns was landed in 1981. During the period 1980 to 1989, the annual tiger prawn catch declined to an average of 303 t due to overfishing, as compared with an average of 649 t during the 1970s. In 1990, a buy-back scheme was implemented, which reduced the number of boats to 27, which was the capacity until 2005. The Research Division, Department of Fisheries, WA (DOF) introduced an innovative management and fishing strategy that resulted in the tiger prawn landings returning to acceptable, sustainable catch levels over 500 t.

### 4. FISHING METHODS

Both fisheries tow low-opening demersal otter trawl nets to harvest prawns, mainly at night (see gear configurations in Figure 4). Each tow is between two and three hours in Exmouth Gulf, while trawls in Shark Bay are under one hour in duration. Two nets had been towed in these fisheries until 1999, when trials by five boats towing four nets (quad-gear) were undertaken in Exmouth Gulf. The lateral spread between headrope and ground rope is vital to the catching efficiency of trawl gear and this determines the area swept. The twin gear spread ratio is around 70 percent of the headrope length. Quad-gear net configuration decreases drag, which improves efficiency of fuel usage and provides increased net spread of 80 to 85 percent. This increases swept area as compared to twin gear. Since 2000, net amalgamations have occurred and all boats in Exmouth Gulf now tow four nets (quad-gear) and the number of boats has been reduced from 16 to 11. Quad-gear trials were undertaken in Shark Bay in 2005 and 2006. Positive results from these trials and economic circumstances prompted the entire fleet to be fitted with quad-gear and to reduce boat numbers from 27 to 18 for 2007. There has been a regulatory decrease in the total headrope allowance for the fleet to account for increased swept area and increased catch rate efficiency for quad-gear boats.

Bycatch reduction devices (BRDs) are compulsory in these fisheries and comprise both grids (Figure 5) (often referred to as Turtle Exclusion Devices) and secondary devices such as square-mesh panels.

FIGURE 3  
Catch and effort (nominal hours) history of king and tiger prawns in the Shark Bay prawn fishery 1970 to 2005

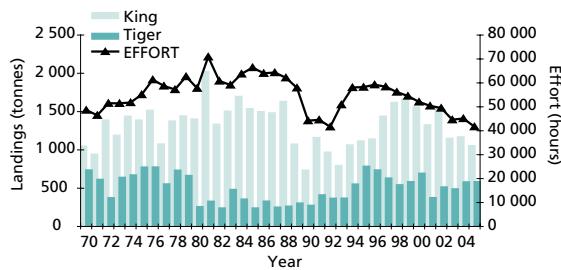
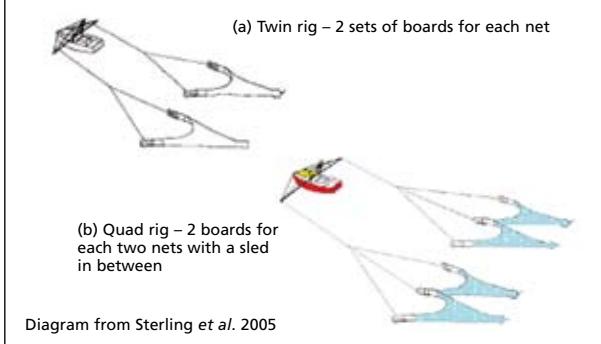


FIGURE 4  
(a) Standard twin otter rig gear used by prawn trawlers in Exmouth Gulf and Shark Bay  
(b) quad-gear now being trialled



### 5. ECONOMIC ENVIRONMENT

The major markets for the brown tiger prawns are Japan and Taiwan, where they are sold whole raw. Australia, Europe, USA and Taiwan are the major markets for western king prawn, where it is sold whole cooked. The endeavour prawn is mainly sold in Australia and New Zealand whole cooked. The major markets for the banana prawns are Australia, China, Japan and the USA, where the prawns are sold cooked with head

on. Beach prices in Australia are mainly determined by the world price of prawns, including those fished from the wild and those grown through aquaculture.

In Exmouth Gulf, prawns and retained by-product species are generally chilled, rather than frozen, due to the close proximity of the fishing grounds to a state-of-the-art processing facility. This enables prawns to be landed fresh and fine-graded prior to freezing or delivery fresh to local markets, thereby maximizing economic return. In Shark Bay, prawns and retained by-product species are packed in 10 kg boxes and snap frozen at sea.

The distribution of prawn fishing effort has shifted to later in the year (May/June instead of March/April) due to industry/management efforts. These management measures have been designed to encourage later harvesting of prawns in order to improve their size and quality.

Prawn prices had risen steadily until about 2000, but have undergone a steady decline since then. The reduction in beach price since 2000 can be attributed to two factors, the rising Australia dollar and increasing competition from aquaculture. World prices of prawns began declining from a peak of \$17/kg in 1996. The fall in the Australian dollar buffered producers from 1997 to 2003, but in recent years, the Australian dollar value has increased to its current level at a 19 year high of \$0.83.

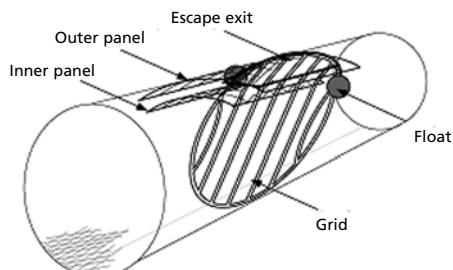
In the long term, competition from aquaculture will be especially challenging. Future prices are likely to be, at best, around US\$11/kg, down from a (inflation adjusted) peak of US\$17/kg. This price decline is affecting local Australian markets, as well as international export markets. In November and December of 2004 alone, imports of *Penaeus vannamei* into Australia averaged, for the first time, 2 500 tonnes a month (Sydney Morning Herald, 22 May 2004), which is equivalent to twice the total annual prawn production in Exmouth Gulf.

The other important factor is the cost of fishing. The three major costs of trawling are: fuel and other variable costs; labour costs, typically set as 25 percent of the catch; and fixed costs (including depreciation). Recent fuel cost increases, and prospects for continuing increase in the real cost of fuel, are especially challenging.

The ongoing efforts to improve trawling efficiency have underpinned the fleet's efforts to maintain profitability. Industry has responded by implementing operational changes (e.g. moon closures and targeting larger, higher-value prawns) and more fuel-efficient fishing gear such as bison boards, computerised engine management systems, but the economic margins have become thinner and thinner. Trawling efficiency has been increased over the years as a result of several management measures and research surveys that have had several results:

- i. industry-financed fleet reduction;
- ii. movement to quad gear, with associated reduction in total headrope;
- iii. introduction of moon closures that suspend fishing for periods of up to 6 or 7 days in Exmouth Gulf and up to 12 days in Shark Bay over the low catch periods of the full moon;
- iv. temporal/spatial closures that encourage greater effort later in the season with concentration on areas where catches are higher; and
- v. surveys to establish prawn size and abundance and provide information for appropriate seasonal commencement of fishing (differing from legislated opening and closing dates) and re-opening of areas formally closed to fishing if abundance (above catch-rate threshold limits) is adequate.

**FIGURE 5**  
**Diagrammatic representation of bycatch reduction device used in Exmouth Gulf and Shark Bay**



King prawns are the main species caught in terms of weight and total value, though tiger prawns usually have a higher unit value. On average, this differential is about 20 percent and in 2002 it was 39 percent. The temporal pattern of catch and the differences in value of king prawns and tiger prawns could have a bearing on the economics of fishing within a season, although this difference is smaller than the difference in total catch rates and the change in value of prawns as they mature into different size grades.

Harvesting larger quantities of prawns per vessel with the same number of crew means that individual crew members, who are paid on catch shares, have a higher income. This is crucial given the current tight labour market. The structured openings and closings allow crew to arrange activities during down time as well as reducing impacts of fatigue. The longer moon-related closures allow crews to return to their home towns to be with their families.

The final advantage of these flexible fishing arrangements is the ability to target prawns at a time when the market demand is highest, or the economic returns are greatest. While sustainability of the prawn stocks are paramount for fisheries managers, industry operators have the “triple-bottom-line” to consider, and the current management and harvest strategies go far towards addressing these concerns.

## 6. MANAGEMENT

### 6.1 Overview

Both fisheries are input controlled and have a complex set of management restrictions, including limited entry, boat size, gear controls and spatial and temporal closures. These management controls, and in particular the spatial and temporal closures, help to sustain all of the prawn species, to maintain the supporting environment and to maximize the size of the prawns at capture. Fishing effort in the fishery is monitored to reduce ineffective trawl hours (i.e. around full moon phases), to maintain high catch rates and to improve economic and energy efficiency within the fleet. The fisheries are managed under a constant escapement policy, designed to leave a minimum level for the tiger prawn spawning stock. Tiger prawns are the management focus with respect to sustainability, as they have been shown to be vulnerable to overfishing (Penn and Caputi, 1986). Industry takes an active and sometimes pro-active approach in management decision processes and implementation of changes through both formal and informal mechanisms that are discussed in Section 6.3.

### 6.2 Evolution of management

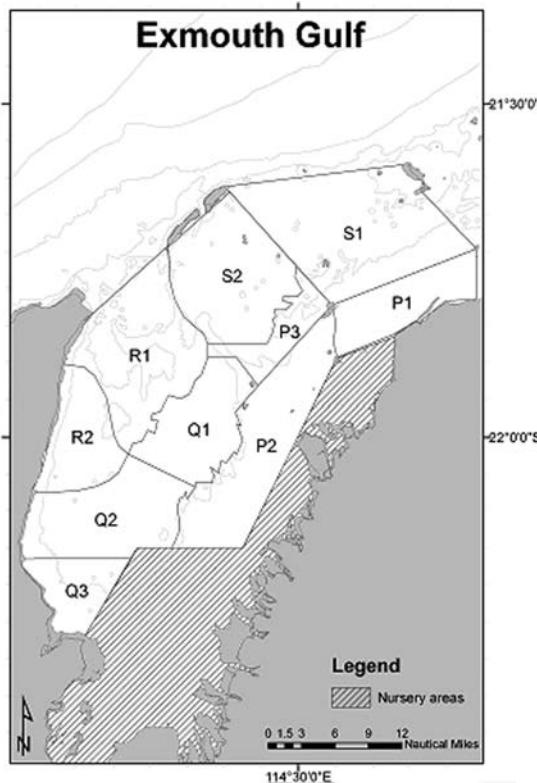
The early years of the Exmouth Gulf fishery had a low level of management activity and the Exmouth Gulf fishery was first subjected to limited entry in 1965 when 15 licences were issued. Additional licences were issued until the number of licences was capped at 23. Logbook catch and effort data was gathered from the early 1960s by the Research Division. This data formed the cornerstone for the decision making process over time and for the understanding of the fishery today. No seasonal or area closures were in place, as there was little understanding of spatial and temporal variation in abundance. Between 1965 and 1972, fishers could commence fishing at any time, anywhere, but they primarily stayed in the centre of Exmouth Gulf (areas Q1 and Q2, Figure 6). In 1973, a more structured closure system was introduced in the southern and eastern side of the Gulf, where mainly small prawns were taken. In 1978, a permanent nursery area was introduced on the eastern side of the Gulf (Figure 6). In 1979, an extension of the nursery area was implemented with a complete closure for a limited period of time early in the year (1 December to 28 February).

Due to the collapse of tiger prawn stocks in the early 1980s, further intervention was required, which was achieved primarily by various kinds of closures. This included rotational closures in the southern and eastern parts of the Gulf, both the number of boats and timing, under “roster fishing”. In August 1982, because of the

decline of the tiger prawn stock to very low commercial catch levels the Research Division implemented a specified spawning area to be closed when the catch rate fell to threshold level to maintain adequate tiger prawn breeding stock. Further, in 1983 the level of monitoring and Departmental involvement in the fishing activities in the southern part of the Gulf increased because of the unprecedented poor levels of recruitment of tiger prawns over the previous two years due to over-fishing in 1981 and 1982.

The Research Division monitored the daily catches of tiger prawns in Area B and the southeast part of the Gulf known as the extended nursery area (ENA). The ENA was subsequently divided into Area C and the nursery area (permanently closed). Areas B and C were closed to fishing when the specified catch rate minimum was reached. Fishing initially ceased at a low tiger prawn catch rate of around 5 kg/hr; this rate was subsequently set at 12 kg/hr (standardized effort). Prior to the start of fishing in these areas, a one-boat two-day survey was done to determine tiger prawn recruitment levels and size grades.

FIGURE 6  
Fishing grounds in Exmouth Gulf prawn fishery and permanently closed area



### 6.3 Current management

#### 6.3.1 Management structure

The current management plans for the Exmouth Gulf and Shark Bay prawn fisheries are a formal statutory document. In Exmouth Gulf, the Exmouth Gulf Prawn Management Plan 1989 ("the Plan") dictates the management measures. The fisheries are two of Western Australia's six major fisheries and are operated under full cost recovery via an access fee. Day-to-day operational management arrangements are carried out cooperatively between the Department and the two existing licensees in Exmouth Gulf and the Industry Association that represents all licensees in Shark Bay. The Industry Association has an Executive Officer, who is the initial contact person. He organizes all relevant meetings/discussions between industry and the Department, and disseminates key information to licensees and skippers.

A Trawl Management Advisory Committee (TMAC) provides broader stakeholder input into the higher-level policy issues. The TMAC provides cooperative management at this higher level through the provision of advice directly to the Minister. The membership on the TMAC includes representation from community and conservation groups to ensure an open and broad consultative process. The advice provided allows the management arrangements to be tailored to achieve maximum economic return from the prawn resource as well as to maintain the sustainability of each fishery and to ensure cost effective management.

#### 6.3.2 Limited entry and gear controls

There are a limited number of boats operating in both the Shark Bay and the Exmouth Gulf fisheries. In Exmouth Gulf, the number of boats has been reduced as fishing efficiency has increased. Currently, there are sixteen Managed Fishery Licences with

an allowable total of 240 fathoms (440 metres) of headrope using twin gear (two 7.5 fathom [13.7 m] nets per boat). Fifteen of these are owned by one operator. Since the introduction of quad-gear, net headrope length has been redistributed to four, 4.5-fathom (8.2 m) nets per boat, and the fleet reduced to 13 boats. There has been an overall net reduction/discount of 8–10 percent imposed by the Department to adjust for the increased catch efficiency of quad-gear and for general technological improvements. As the number of boats was reduced, the remaining boats have been upgraded to tow larger nets in quad configuration. The fleet has reduced to 11 boats for the 2007 season.

These arrangements are expected to be formalised in the unitisation of headrope (but with maintenance of standard net sizes) and in the relaxation of vessel size controls (with some maximum) in the longer term. The unitisation of headrope has been proposed to provide a long-term basis for gear amalgamation and increased economic fishing whilst also maintaining standardised effort indices. To provide flexibility in this process, trawl head-rope length will be unitised into standard, transferable entitlements that can be traded among Shark Bay prawn operators. However, given the differences in catching efficiency associated with different gear configurations, it is intended that a standardised gear requirement will remain a feature of this fishery. The planned unit size 10 cm and current legislation requires at least a unit of fishing gear to remain on a licence for it to exist. Other gear controls include restrictions on the mesh size and the size of the trawl otter boards and ground chains.

In Shark Bay, there are 27 licences currently operating in the fishery. The number was reduced from a peak of 35 through a buy-back of licences in 1990. As in Exmouth Gulf, for the 2007 fishing season, gear amalgamation of net allocations have resulted in quad-gear configuration nets (4x5.5 fathom [10.1 m]) being towed by fewer boats (18). The pool allocation of net headrope was reduced 8 to 10 percent to offset increased catch efficiency.

### 6.3.3 Closures

Regulation uses seasonal closures of the entire fishery area, area closures within the season and time closures within the season. These closures help achieve both biological and economic goals. A variety of closure types are used.

- i. *Seasonal closures:* The Exmouth Gulf fishery is generally closed between December and April, whilst the Shark Bay fishery is closed November to March. This allows the small juvenile prawn stocks to grow during the annual recruitment period.
- ii. *Permanent area closures:* Parts of Exmouth Gulf and Shark Bay are permanently closed to trawling to stop fishing in areas where prawns are mostly small and to preserve seagrass and other sensitive habitats that are essential nursery areas for prawns and other species.
- iii. *Within-season area closures:* There are a complex series of fishery openings and closures as a result of the compartmentalisation of the fishing grounds, which are designed to allow fishing of the prawns as they reach optimal market size. The timing of these openings can vary annually due to the results of pre-season surveys. The actual area trawled in Exmouth Gulf is approximately 40 percent of the licensed area, while only 20 percent of licensed fishing area is fished in Shark Bay.
- iv. *Time-of-day closures:* King and tiger prawns are predominantly nocturnal and therefore trawling is generally only permitted between 1700 and 0800 hrs. Trawling for prawns during the day (except for banana prawns for which specific permission may be granted in Exmouth Gulf) is often unproductive as the prawns burrow in the sediment.
- v. *Moon closures:* There are several complete 24-hour closures over the period of the full moon, to increase economic efficiency by stopping fishing in low catch rate periods and to protect moulting soft-shelled prawns.

### 6.3.4 Roster (Rotational) Fishing

At the start of the fishing season in 1983, 21 boats were licensed to fish with otter trawls. On 20 January four boats commenced fishing in Area A only as there was no formal fishing season. From 2 March, size and abundance surveys were done in Area C until the prawn size was deemed fishable (i.e. would provide optimal yield) by the staff of the Research and Industry department. Roster fishing commenced on March 30 using seven boats only. Areas B and C were fished on a daily basis until the catch rates fell to the level that required fishing to cease. During roster fishing periods, research officers monitored fishing on a daily basis for catch and effort information. Also during the roster period the remaining boats fished Area A. The main objective focus to limit fishing effort so that Research Division could monitor the tiger prawn biomass to ensure fishing ceased when a level was reached that returned industry to fishing at reasonable economic levels and to introduce long-term sustainable fishing practices. Areas B and C were closed to fishing either at a predetermined catch rate threshold or 1 August each year, which ever came first) to avoid recruitment over-fishing. Breeding surveys monitoring tiger prawn stock abundance and female spawning condition were also undertaken.

A similar pattern of fishing operations was undertaken in 1984 to 1983. The first legislated season opening and closing dates, 1 February to 16 November 16 were implemented, and roster fishing was again part of the strategy from 25 March 25 until 25 June. Two non-fishing periods were established so that Research Division could determine the catch and effort rates at which to close the fishery. Night-time fishing only was also implemented (1800–0800) to reduce inefficient effort.

In 1985, 19 boats actively fished in Exmouth Gulf and roster fishing was modified so that half the fleet fished each night on a 9 and 10 boat system. Full fleet fishing occurred from 17 to 31 May. Because the fleet was monitored to determine catch rates, two additional fishing periods were permitted during June and July until the catch rate minimum was reached and Areas B and C closed on 17 July. The opening date was later in 1985 than in 1984 (15 February) and the fishery opened progressively later each year until the preferred opening date of 2 April 2 was attained in 1989.

The 1986 fishing season started 1 March with the full fleet fishing in all areas: no roster fishing was undertaken from then on. From 1984 recruitment and spawning surveys were implemented and continue today so that the Research Division can provide a prediction of the tiger prawn catch, management the prawn size and maintain and measure breeding stock levels each year.

In 1985, an industry-funded buyback reduced the number of boats from 23 to 19. Roster fishing ceased at the end of 1985, in conjunction with the introduction of a closed area in the tiger prawn spawning grounds that had a catch-rate threshold level cut off, or a mandatory closure on 1 August. Moon phase closures were implemented in 1985 for three days around the full moon. In 1986, gear restrictions (maximum of 15 fathoms [27 m] head rope per boat in twin gear rig) were implemented and the nursery area was further extended. The overall fishing season was shortened progressively until, by 1989, the season was opened from 2 April to mid November with partial within-season area closures to reduce capture of small prawns. A ban on daylight trawling was introduced in 1986 to further reduce fishing effort on tiger prawns.

### 6.3.5 Licence fees and cost recovery process and timetable

The cost recovery process commenced in 1995/96 and was a staged approach over seven years. Table 1 outlines the stages of the process. The Development and Better Interest Fund (DBIF) is imposed on each fishery to provide monies to address selected/urgent issues in any fishery within the state. The fisherman's contribution is based on the gross value of production (GVP) of the fishery for the two prior years. For example, the 2007-08 fees will be calculated using the 2007-08 cost recovery budget estimates and

TABLE 1  
Staged phases of cost recovery for Exmouth Gulf and Shark Bay prawn fisheries

| Year    | Cash costs | DBIF levy<br>(% of GVP) | Capital Costs | Employee Entitlements |
|---------|------------|-------------------------|---------------|-----------------------|
| 1995/96 | Yes (85%)  | + 0.41                  | + no          | + no                  |
| 1996/97 | Yes (85%)  | + 0.49                  | + no          | + no                  |
| 1997/98 | Yes (95%)  | +0.65                   | + no          | + no                  |
| 1998/99 | Yes (100%) | +0.65                   | + no          | + no                  |
| 1999/00 | Yes (100%) | +0.65                   | + no          | + no                  |
| 2000/01 | Yes (100%) | +0.65                   | + yes (100%)  | + no                  |
| 2001/02 | Yes (100%) | +0.65                   | + yes (100%)  | + yes (100%)          |

the GVP from 2005-06 calendar years. How this money is spent is determined by the Minister but departments can request allotments.

There has been full cost recovery (i.e. for research, management and compliance costs) since 2001/02 for both cash and capital costs as well as the DBIF levy and employee entitlements. The level of service provided is determined through consultation with representatives of the industry and quarterly reports and they receive quarterly reports summarizing activities and expenditures for management, compliance and research.

Licence fees are calculated on actual activity and expenditure (including capital costs and employee entitlements) over a three-year rolling average and the licence fee for the Exmouth Gulf prawn fishery has been between A\$31 000 and A\$34 000 and for Shark Bay prawn fishery between A\$34 000 and A\$42 000AUD for 2004/05 to 2006/07. The costing also uses 'unders and overs' so there are no refunds or additional licence fees in any one year.

### 6.3.6 Compliance

Compliance activities have included at-sea and aerial patrols to enforce closed seasons, closed areas and operational rules. In more recent times, compliance activities in the fishery have been based on a risk-based approach, which has included input from industry. As a result of the risk assessments, key compliance strategies now include pre-season briefings of skippers (introduced by Research Division DOF in the early 1980s), pre-season inspection of the trawl fleet and at-sea inspections. The Department's satellite-based vessel monitoring system (VMS) was introduced into the Exmouth Gulf and the Shark Bay prawn fisheries in 2000 and has improved compliance integrity by monitoring vessel location and speed, thus increasing real time compliance with formal closures. The implementation of VMS has the potential to expand the scope for management and to assist the Research Division with in-season, real-time, adaptive management measures.

Compliance levels in the Exmouth Gulf are excellent with few infringements recorded, especially since the single operator has strict internal controls to monitor compliance amongst its own fleet. This includes the use of the 'Smart prawn' system that monitors boat movements and catches during each fishing night and can detect transgressions into industry-initiated 'closed areas'.

## 7. ANNUAL MANAGEMENT PROCESS

### 7.1 Seasonal arrangements

Arrangements are developed in consultation with industry during the season and are based on ensuring sustainability and fishing in the most profitable manner. These arrangements are usually ratified three or four months before the season commences to allow the regulatory notices to be gazetted regarding season opening dates and any other proposed regulations. Table 2 provides a list of season arrangements for 2007 that was given to all skippers and licence holders.

TABLE 2

**Exmouth Gulf 2007 Season Fishing Arrangements – opening, closing dates and moon closure periods**

|  |   |
|--|---|
| Recruitment survey (Last quarter 12 March).  | 10–11–12 March.                               |
| Recruitment survey (first quarter 26 March).   | 25–26–27 March survey                         |
| Recruitment survey, last quarter 11 April.   | 10–11–12 April.                               |
| Survey area A. All Survey results discussed with industry to determine the extent of area fished in area A and B.  | 13 April                                      |
| Season open, areas A, B, C and D open to fishing.  | 16 April (last quarter 12 April)              |
| Survey area A  | 24 April (First quarter 24 April)             |
| <b>Moon closure:</b> full moon 2 May.  | Moon closure days to be nominated             |
| <b>Moon closure:</b> full moon 1 June.   | Moon closure days to be nominated.            |
| Monitor tiger prawn catch during June and July within areas B and C to ensure catch rate is above threshold level. | June and July                                 |
| Area C survey may be required to determine tiger prawn size structure and catch rate (kg/hr).                      | June and July                                 |
| <b>Moon closure:</b> full moon 30 June.  | Moon closure days to be nominated.            |
| <b>Moon closure:</b> full moon 30 July   | Moon closure days to be nominated.            |
| 1800 hrs. Areas B and C, cease fishing. Fishing Areas A and D.   | 1 August.                                     |
| Spawning stock survey. Last quarter 6 August.  | 5 to 8 Aug inclusive (4 nights).              |
| <b>Moon closure:</b> full moon 28 August.  | Moon closure days to be nominated             |
| Spawning stock survey. Last quarter 4 September. Area B re-opening subject to survey data.                         | 3 to 6 September inclusive (4 nights).        |
| <b>Fishing area B and C:</b> subject to survey data.   | September/October.                            |
| <b>Moon closure:</b> full moon 27 September.   | Moon closure days to be nominated.            |
| Spawning stock survey. Last quarter 3 October.   | 2 to 5 October inclusive (4 nights).          |
| <b>Moon closure:</b> full moon 26 October.   | Moon closure days to be nominated.            |
| Fishing areas B and C to the catch rate to the lower threshold level based on 6 fathom boats adjusted catch rate.  | After confirmation of survey catch rate data. |
| Season closed.   | 0800 24 November 2007.                        |

## 7.2 Principles determining opening and closing dates for the 2007 Fishing Season in the Exmouth Gulf Prawn Managed Fishery

The proposed date for the opening of the fishing season is 16 April 2007. Prior to the season opening, recruitment surveys of areas B and C will have been completed in March and early April prior to the opening date. It is proposed to have a field-based consultative process whereby industry and Research Division, decide on the extent of area to be fished within areas A, B, C and D when fishing commences utilizing all survey information. Fishing will cease 0800 hrs 24 November 2007. The proposal provides 197 fishing nights for the season. This is taking into account a minimum four-night moon closure period each month around the full moon.

Once the Chief Executive Officer (CEO), Department of Fisheries, has signed off the season notice, the micro fishing arrangements (maximizing size of prawns for commercial marketing, and fleet efficiency) for area openings, closures and moon closure periods will be by consultation between Research Division and industry. In turn Research will provide the moon closure dates to the VMS section for validation. Research shall provide, in writing, advice when the tiger prawn spawning area is to be closed or re-opened by notice to the Policy Officer for approval by the CEO, Department of Fisheries (when appropriate). Industry have the flexibility to nominate the number of non-fish nights (moon closure period) during each month, so that the number of non-fish nights may vary around the moon but the total number of non-fish nights allocated for moon closures during the season (minimum of 28 nights for the 2007 fishing season) shall be taken. The maximum number of nights fishing each season should not exceed 200 nights (based on historical data) except when it is proven that excess stock is available to fish. Non-fish nights shall include nights not fished due to strong wind warnings. When the target of 28 nights moon closure or non-fish nights are reached then it will not be necessary to inform the VMS section of remaining

moon closures. However, Research Division would continue to inform the VMS section regarding moon closure periods and nights not fished due to adverse weather conditions.

For the flexible non-fish periods to be workable, a set of guidelines needs to be in place to satisfy sustainability requirements.

- All licence holders agree on the timing and number of nights closed around each full moon during the season. If no agreement can be reached then by default a four-day moon, or longer if deemed necessary by Research Division, closure period around the full moon will take effect and continue for the remainder of the season. The closure will be declared, by notice in writing, signed by the Chief Executive Officer, Department of Fisheries to give effect to the proposed fishing arrangements to permit or prohibit fishing for prawns or any part of it (Clause 10(1) of the Exmouth Gulf prawn managed Fishery Plan).
- The catch rate of tiger prawns will be monitored on a daily basis in area B and C for the purpose of closing the areas B and C when the threshold level is reached.
- When the catch rate threshold level for tiger prawns of 19 kg/hr (based on quad gear 4.5 fathoms nets average catch rate) over 2 consecutive nights is reached prior to the mandatory closure date of August 1, then fishing shall cease in areas B and C. The 19 kg/hr catch rate will be adjusted based on boats towing 6 fathom nets during the 2007 season after trials comparing catch rates from the boat towing 4.5 fathom nets and boats towing 6 fathom nets.
- Areas B and C are closed on 1 August regardless of the tiger prawn catch rate level.
- Spawning stock surveys will be carried out during August, September and October using the standard survey pattern.
- If the catch rate of tiger prawns is above the threshold level after the September survey then a decision will be made after consultation between industry and research whether to re-open areas B and C to fishing.
- From November or a specified earlier date, fishing may take place in area B with a lower catch rate threshold level of 14 kg/hr or amended catch rate based on boats towing 6 fathom nets.

The end of season closure date has been proposed as 24 November 2007. It should be noted that generally in this fishery, during November, as new king prawn recruits move into the trawl grounds the prawn size composition becomes smaller. When the king prawns size composition reaches approximately, on average 23 to 25 per pound, or if 50% or greater of the daily catches are 21-30 and 31 + count per pound (particularly if the catch rate of king prawns is low) consideration should be given to close the fishery if this occurs prior to the promulgated closure. This decision is to be made in consultation with the Exmouth Gulf Prawn Licence holders and Department of Fisheries, Research Division.

## 8. CO-OPERATIVE MANAGEMENT

The annual cycle of management is dynamic and multi-faceted, with industry participation in the decision-making process. This begins with the initial draft of 'season arrangements' that is provided by the Research Division to the two licensees three months prior to the proposed commencement of the season. This draft contains all the mandatory sustainability requirements embedded within the arrangements. Opening and closing dates vary each year and depend upon environmental conditions, moon phase and the results of standardised pre-season surveys. The licensees provide input and suggestions on changes that suit their marketing or other operational requirements. The CEO of the Department of Fisheries statutorily sets the maximum fishing days (200 days) for the season and broad-based sustainability closures. Industry, in close consultation with the Research Division, works within that framework to maximise the

economic return from the prawn resource. The timing and the extent of area fished at the commencement of the season allow the harvesting of the current season's recruits and large 2+ residual prawns not caught in the previous season. Within the main fishing period, there are subsidiary openings and closings to increase size, quality and market value, while protecting stocks from recruitment overfishing. Moon closures increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

During the season, industry is proactive in determining 'real-time' harvesting strategies to optimise economic efficiency. They initiate area openings to optimize size and value of the prawns and area closures when small or suboptimal quality prawns are encountered. In recent years, they have also stopped fishing for the season based on size (for king prawns) and catch-rate levels, on their own initiative. This is possible as sustainability issues are already addressed through the more formal management arrangements.

The MG Kailis Group (owner of 15 permits in Exmouth) has installed a 'Smartcatch System' on their boats, whereby nightly trawl activity and catches are downloaded to the company database on a daily basis. This information can then be summarised and evaluated by the shore 'managers'. A local processing facility is owned by the company, which provides daily grading information for the previous nights' catches. This enables quick determination as to whether optimal-sized prawns are being caught. Once the information has been evaluated, industry can initiate changes to harvesting strategies or can request small scale 'surveys' to confirm prawn size and abundance in areas. This may result in changes to 'industry closure lines' that can be implemented within 24 hours. In the last two years, this process has been driven by industry 'managers' on site in Exmouth Gulf. Close communication is maintained with, and notification of changes are provided to, the Research Division. In Shark Bay, the fleet now also uses 'real-time' management through surveys with Research Division staff on board to verify size and abundance, which can lead to changes in 'industry closures' at short notice. Feedback from skippers often provides information to initiate area closures when small prawns are found.

The Research Division (DOF) also collects daily catch and effort information via logbooks for every trawl. Currently, this is in paper format but in the future the data transfers will be electronic. This information, in addition to the annual recruitment and spawning surveys, allows for annual stock assessments for each target species.

## 9. DISCUSSION

The comprehensive management plan and related legislation are performing well. The management plan delegates day-to-day operational management to the CEO of the Department of Fisheries. The fisheries are managed in a dynamic and consultative/cooperative manner whereby the CEO ensures an overall sustainability framework through a statutory Determination of broad openings and closures (outside the permanent Nursery Closures). Having the base management arrangements in legislation provides a high degree of stability. This allows the incorporation of industry-initiated management scenarios into the formalised management practises. Through close consultation between the Research Division and the licensees, real-time management uses in-season vessel surveys of "industry agreed" closed areas to target prawns at premium market sizes and to maintain higher catch rates. This process achieves maximum economic return for licensees and best use of the available prawn resource. The process for achieving management changes are well understood by the stakeholders and the system is flexible enough that the management process can respond quickly to change. In recent years, licensees in Exmouth Gulf have actively taken a role in initiating day-to-day changes to industry closure lines to optimise size and value of the prawns caught.

Without fleet reduction and the subsequent flexible management approach, economic returns would be much lower today. But, attempts to manage trawling efficiency have not kept pace with rising costs and falling prawn prices. The industry is again at a crossroad over declining profitability and requires further management changes to reduce catching costs. Licensees in both fisheries are considering further steps to maintain profitability, including removal of additional licences from each fishery. Fortunately, the record of cooperation between government and industry positions this industry to implement these kinds of strategies.

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