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Status of the West Coast Prawn *Penaeus (Melicertus) latisulcatus* Fishery in 2015

C. L. Beckmann and G. E. Hooper

SARDI Publication No. F2007/000772-8
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SARDI Aquatics Sciences
PO Box 120 Henley Beach SA 5022

July 2016

Fishery Status Report to PIRSA Fisheries and Aquaculture

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

SOUTH AUSTRALIA

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South Australian Research and Development Institute
SARDI Aquatic Sciences
2 Hamra Avenue
West Beach SA 5024

Telephone: (08) 8207 5400
Facsimile: (08) 8207 5406
http://www.pir.sa.gov.au/research

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Author(s):	C. L. Beckmann and G. E. Hooper
Reviewer(s):	L. McLeay and A. Linnane
Approved by:	S. Mayfield Science Leader - Fisheries
Signed:	
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EXECUTIVE SUMMARY

This report assesses the current status of the West Coast Prawn Fishery (WCPF) through analysis of data collected by several long-term monitoring programs. The harvest strategy for the WCPF does not contain performance indicators (PIs) linked to a definition of stock status. Consequently, this assessment uses a 'weight-of-evidence' method to determine stock status. The primary measures used to determine stock status in the WCPF are from fishery-dependent data relating to commercial catch, and average catch rates obtained from fishery-independent surveys (FIS').

Total catch for the WCPF in 2015 was 191 t, a 31% increase compared to 2014 and the highest catch since 1996 (216 t). Effort remained stable at 1,874 hours which was equivalent to 63 vessel nights. The commercial catch rate was 102 kg.h^{-1} in 2015. This was a 31% increase compared to 2014 (78 kg.h^{-1}) and the highest on record. In 2015, the majority of the catch was harvested from Venus Bay (171 t) followed by Ceduna (13.6 t) and Coffin Bay (7 t). Commercial catch rates were the highest on record in Venus Bay (110 kg.h^{-1}) and Ceduna (74 kg.h^{-1}), however, in Coffin Bay catch rates declined to 51 kg.h^{-1}, the lowest observed since 2009 (49 kg.h^{-1}).

The FIS catch rate (for all regions and months surveyed) was the highest on record at 85±6 kg.h^{-1}, a 26% increase from 2014 (68±7 kg.h^{-1}). This trend was driven by high FIS catch rates in Venus Bay and Ceduna. The FIS catch rate of recruits remained stable during March in Ceduna (102±13 recruits.h^{-1}). This was a 21% increase compared to 2013 (84±9 recruits.h^{-1}), but below the historical high of 141±38 recruits.h^{-1} observed in 2007.

On the weight-of-evidence, the commercial catch and survey catch rates indicate that the WCPF biomass is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (that is, the stock is not recruitment overfished) and that fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished. Therefore, using the national framework for stock status reporting (Flood *et al*., 2012), the WCPF stock is classified as '**sustainable**'.

1. INTRODUCTION

1.1. Overview

This fishery status report for the West Coast Prawn Fishery (WCPF) is generally updated annually as part of the South Australian Research and Development Institute (SARDI) Aquatic Sciences ongoing assessment program for South Australian prawn fisheries. This report updates the fishery status report for 2014 (Beckmann and Hooper, 2015) and analyses data from the 2015 fishing year. The aim of the report is to provide a brief synopsis of information available for the WCPF and assess the current status of the resource.

1.2. Description of the fishery

1.2.1. *Access*

The WCPF is a demersal otter trawl fishery that targets western king prawn, *Penaeus (Melicertus) latisulcatus* (Kishinouye, 1896), in continental shelf waters of the eastern Great Australian Bight (Figure 1.1). The fishery operates in coastal bays that have summer water temperatures comparable to those of Spencer Gulf and Gulf St Vincent where western king prawns are targeted by the Spencer Gulf and Gulf St Vincent Prawn Fisheries. Commercial fishing usually takes place from February to December from the last quarter of the moon through to the first quarter of the moon. Fishery-independent surveys (FIS') are conducted in November, March and June, and determine the fishing strategies for subsequent fishing periods. Recreational catches of western king prawns are low as prawns can only be taken using hand held nets in waters >10 m in depth. Levels of Aboriginal traditional catch and illegal fishing are considered negligible.

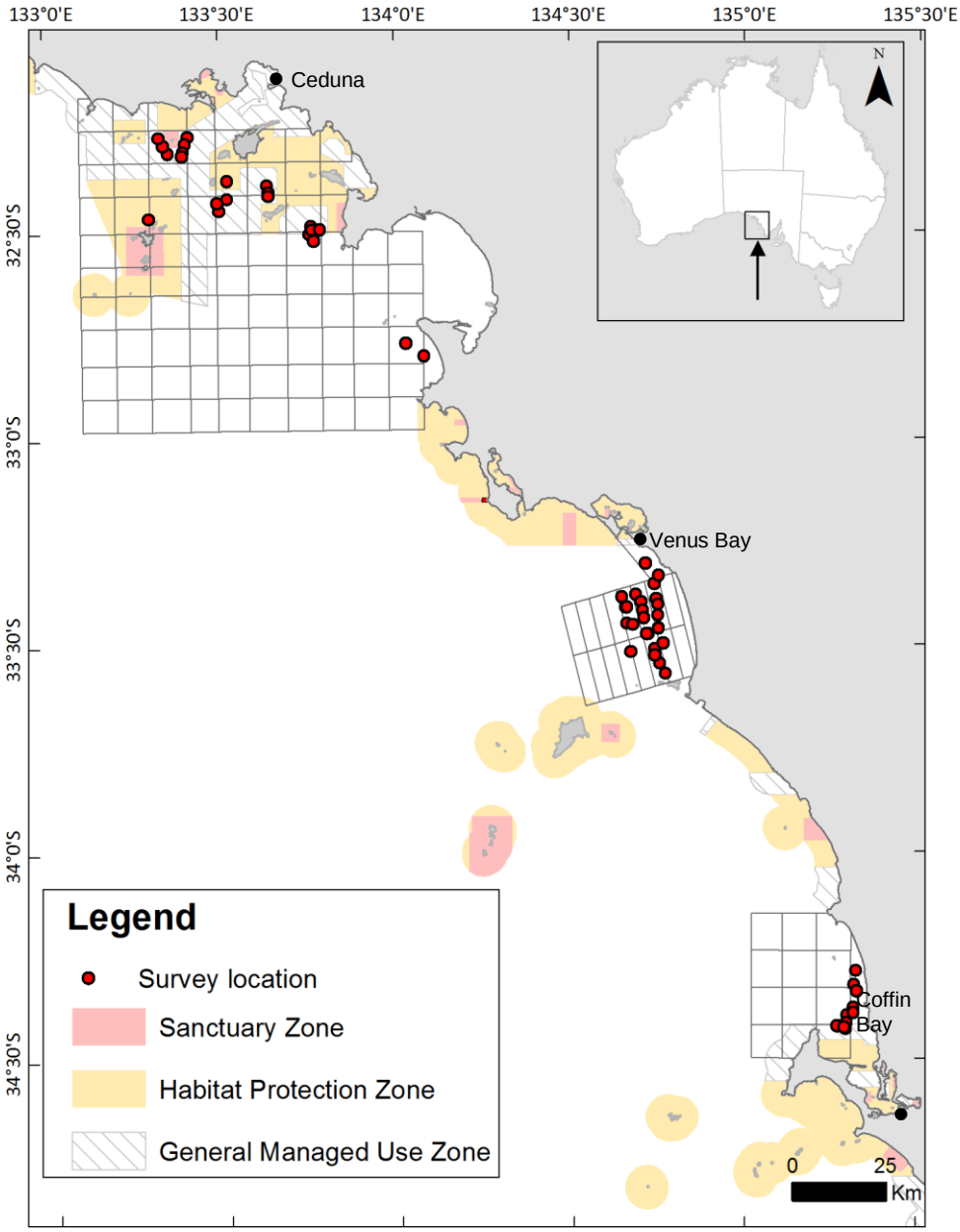

Figure 1.1 West Coast Prawn fishery zones and restrictions.

1.2.2. *Management arrangements*

The WCPF is managed by the South Australian State Government's Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture in accordance with the legislative framework provided within the *Fisheries Management Act 2007* and *Fisheries Management (General) Regulations 2007* and the *Fisheries Management (Prawn Fisheries) Regulations 2006.*

Management arrangements in the WCPF have evolved since the fishery began in the late 1960s (Table 1.1). Currently, the WCPF is a limited entry fishery with three licenced

operators. Trawling is prohibited during daylight hours and in waters <10 m in depth. Effort is restricted through a range of input controls (i.e. spatial and temporal closures, vessel size and power, and configuration of trawl gear, including type and number of nets towed, maximum headline length and minimum mesh size; Table 1.2).

The current management policy (PIRSA 2010) states that a suite of performance indicators (PIs) and reference levels need to be developed that reflect the current management arrangements for the fishery. Currently, there are no defined reference levels or PIs in the management policy; therefore, a 'weight–o- evidence' approach has been used to assess stock status for the WCPF.

A more detailed description of the management arrangements and harvest strategy for the fishery are provided in PIRSA (2010).

Table 1.1 Major management milestones for the West Coast Prawn Fishery.

Date	Management milestone
1968	Licence limitation. Trawling prohibited in waters of <10 metres. Commercial recording of catch and effort introduced
1969	*Prawn Resources Regulations 1969* established. West Coast divided into three zones
1976	West Coast Zone C fishery operators offered Spencer Gulf Zone D licences.
1979	Licences capped at 3
1984	*Fisheries Scheme of Management Regulations 198*4 introduced
1991	*Fisheries Scheme of Management Regulations 1991* introduced
1995	*Fisheries Scheme of Management Regulations 1995* introduced
1998	First management plan implemented
2006	*Fisheries Scheme of Management Regulations 2006* introduced
2007	Second management plan implemented. *Fisheries Management Act 2007* introduced.
2010	Third management plan implemented.
2014	Management Policy due to be updated

Table 1.2 Current management arrangements.

Prawn fishery management	Specification
Permitted prawn species harvested	*Penaeus (Melicertus) latisulcatus*
Permitted by-product species harvested	*Ibacus* spp. (slipper lobsters), *Sepioteuthis australis* (southern calamary), *Nototodarus gouldi,* (arrow squid), *Octopus* spp., Pectinidae (scallop).
Limited entry	Yes
Number of licences	3
Corporate ownership of licences	Yes
Licence transferability	Yes
Minimum depth trawled	10 m
Method of capture	Demersal otter trawl
Trawl net configuration	Single or double
Maximum total headline length	29.26 m
Minimum mesh size	4.5 cm
Maximum length of vessel	22 m
Maximum engine capacity	336 kW
Catch and effort data	Daily logbook submitted monthly
Catch and disposal records	Daily CDR records
Recreational fishery	Depth >10 m, hand nets only
Recreational licence	Not required

1.3. Biology of the western king prawn

1.3.1. *Distribution*

The western king prawn *P.latisulcatus* is distributed throughout the Indo-west Pacific (Grey *et al.*, 1983). Its distribution in South Australia is unique, as it is at its lowest temperature range, restricted to waters of Spencer Gulf, Gulf St Vincent and along the West Coast, including the commercially fished areas of Venus Bay, Coffin Bay and Ceduna.

The western king prawn is a benthic species that prefers sandy areas to seagrass or vegetated habitats (Tanner and Deakin, 2001). Both juvenile and adult prawns show a strong diel behavioral pattern of daytime burial and nocturnal activity (Rasheed and Bull, 1992; Primavera and Lebata, 2000). Strong lunar and seasonal differences in activity have also been reported, where prawn activity (and catchability) is greater during the dark phase of the lunar cycle and warmer months (Penn, 1976; Penn *et al.*, 1988). Abundance of the western king prawn within the gulfs and estuaries is influenced by salinity, where higher abundances are associated with high salinities (Potter *et al.*, 1991; Sang and Fotedar, 2004).

1.3.2. *Reproductive Biology*

In the WCPF, adult prawns aggregate, mature, mate and spawn in deep water (>10 m) between September and March, with a peak in November-December (Wallner, 1985). A minimum temperature of 17°C is required for western king prawn to spawn in Western Australia (Penn, 1980). This temperature range for spawning of western king prawn (17–25°C) generally occurs from November to May in the main spawning area off Venus Bay. In addition to multiple spawning events within a season, females are likely to spawn for multiple seasons based on the observation of a large proportion of females in different size cohorts being reproductively active during the spawning season (Penn, 1980).

1.3.3. *Early Life History*

The life cycle of the western king prawn consists of two phases: 1) an offshore phase, where spawning of adults, and drift and growth of larvae occurs; and 2) an inshore phase, where settlement of post-larvae and growth through to the juvenile stage occurs. Following hatching of the egg, prawn larvae undergo four main stages of metamorphosis (i.e. nauplii, zoea, mysis and post-larvae).

Temperature, salinity and food availability are generally considered to have the most influence on larval growth and survival in penaeid prawns (Preston, 1985; Carrick, 2003;

Jackson and Burford, 2003). Roberts *et al.* (2012) determined duration and survival of western king prawn larvae reared at different temperatures. Wallner (1985) showed that post-larvae were present in the water column between December and March in fished regions of the West Coast.

1.3.4. *Oceanographic influences*

Following spawning, prawn larvae are advected north-west (via inshore currents) from Venus Bay to nursery areas in Ceduna between February and May (Carrick, 2008; Figure 1.1). Settlement patterns of prawns in the WCPF are influenced by currents which flow north-west to south-east in the winter and south-east to north-west in summer, as well as wind-driven coastal upwelling events in the summer (Middleton and Platov, 2003). El Niño–Southern Oscillation (ENSO) events are associated with weaker Leeuwin Current flow and enhanced upwelling events (Middleton and Bye, 2007; Middleton *et al.,* 2007). Specifically, El Niño driven changes in current patterns (low sea level height and cold water) are thought to reduce larval survival by decreasing water temperatures, impact larval supply to nursery areas through unfavourable advection patterns and change the spatial distribution of the spawning stock by causing spawners to move offshore or away from trawl grounds (Carrick, 2008).

1.3.5. *Age Structure*

Wallner (1985) estimated daily instantaneous rates of natural mortality of prawns on the West Coast to be between 0.001 (inshore populations) and 0.014 (offshore populations). These values are consistent with other natural mortality values for this species in Spencer Gulf (0.003 to 0.005; King, 1977), Gulf St Vincent (0.003; Kangas and Jackson, 1997) and Western Australia (0.002 to 0.005; Penn, 1976).

Natural mortality (*M*) of juvenile prawns was determined in Spencer Gulf from June to November between 1992 and 1994 (*M*=0.05/week; Carrick, 2003). Natural mortality for juvenile *M. latisulcatus* in Spencer Gulf prawn nurseries was found to be lower than that for other prawn species (Carrick, 1996).

1.3.6. *Stock Structure*

Research undertaken by the South Australian Museum and SARDI (cited in Carrick, 2003) using rDNA demonstrated significant genetic differences in haplotype frequency between South Australian and Western Australian populations of western king prawns. Richardson (1982) examined the gene and genotype frequencies of western king prawns

from Investigator Strait and Gulf St Vincent using electrophoretic techniques, and found no evidence of genetic isolation of the two stocks.

1.4. Research Program

The current research program conducted by SARDI Aquatic Sciences comprises four components that include: (i) a daily logbook program; (ii) catch and effort information; (iii) Three FIS' per year in November (Venus Bay, Coffin Bay and Ceduna), March (Venus Bay and Ceduna), and June (Venus Bay); and (iv) an annual report that assesses the status of the fishery against the PIs suggested in the *Management Policy* (PIRSA, 2010).

There have been several projects that have focused on addressing key knowledge gaps in our understanding of western king prawns in the west coast region. They have focussed on understanding the key factors which affect prawn recruitment and implications to harvesting prawn stocks (FRDC 1991/3; Carrick, 1996), modelling prawn movement and spatial dynamics (FRDC 1999/142; Carrick and Ostendorf, 2005), and understanding the impacts of environmental variability on sustainability, fishery dynamics and economic performance (FRDC project: Carrick, 2008) .

Previous stock assessment and stock status reports also provide detailed biological information and catch history which have been used to assess the status of the fishery (Wallner 1985; Carrick and McShane 1998; Carrick and Williams, 2000; 2001; Boxshall, 2001; Svane, 2003; Svane and Barnett, 2004; 2005; Dixon *et al*., 2005; Dixon and Roberts, 2006; Roberts, 2007; Hooper *et al*., 2009; 2010; 2011; Gorman *et al*., 2012; Beckmann *et al*., 2014; Beckmann and Hooper, 2015).

1.5. Determination of stock status

The current management policy (PIRSA 2010) states that a suite of performance indicators (PIs) and reference levels need to be developed that reflect the current management arrangements for the fishery. Currently, there are no defined reference levels or PIs in the management policy; therefore, a 'weight-of–evidence' approach is used to assess stock status. The primary indicators used to assess stock status in the WCPF are total catch, estimated from fishery-dependent data, and average catch rates estimated from FIS' conducted in March, June and November.

A national stock status classification system was recently developed to enable consistent assessment of key Australian fish stocks (Flood *et al.*, 2014). It considers whether the current level of fishing pressure is adequately controlled to ensure that stock abundance is not reduced to a point where the production of juveniles is significantly compromised. The system combines information on both the current stock size and level of catch into

a single classification for each stock against defined biological reference points. Each stock is then classified as ‘sustainable’, ‘transitional-recovering’, ‘transitional-depleting’, ‘overfished’, ‘environmentally limited’, or ‘undefined’ (Table 1.3). PIRSA has adopted this classification system to determine the status of all South Australian fish stocks.

Table 1.3 Stock status terminology (Flood *et al*., 2014).

	Stock status	Description	Potential implications for management of the stock
	Sustainable	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished	Appropriate management is in place
↑	Transitional–recovering	Recovering stock—biomass is recruitment overfished, but management measures are in place to promote stock recovery, and recovery is occurring	Appropriate management is in place, and the stock biomass is recovering
↓	Transitional–depleting	Deteriorating stock—biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished	Management is needed to reduce fishing pressure and ensure that the biomass does not deplete to an overfished state
	Overfished	Spawning stock biomass has been reduced through catch, so that average recruitment levels are significantly reduced (i.e. recruitment overfished). Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect
	Environmentally limited	Spawning stock biomass has been reduced to the point where average recruitment levels are significantly reduced, primarily as a result of substantial environmental changes/impacts, or disease outbreaks (i.e. the stock is not recruitment overfished). Fisheries management has responded appropriately to the environmental change in productivity	Appropriate management is in place
	Undefined	Not enough information exists to determine stock status	Data required to assess stock status are needed

2. METHODS

2.1. Fishery-independent surveys

FIS' using industry vessels (with observers) have been undertaken in most years since 1989. Survey dates were chosen to correspond with the new (dark) moon. At each shot location (Figure 1.1), survey vessels trawl along a pre-determined path for 30 minutes. The distance trawled at each location is dependent on trawl speed (3–5 knots) and influenced by vessel power, tide and weather conditions. Data collected for each shot location include the total catch, catch of small prawns (20+ grade), number of nets used, trawl duration, tide direction, and number of prawns in a 7 kg bucket (bucket count) as a rapid measure of prawn size. Estimates of mean prawn size (prawns per kg) are calculated from the bucket count with higher counts representing smaller prawns and lower counts representing larger prawns. A random sample of 100 prawns is also taken from each shot to obtain information on sex ratio and length-frequency (see Appendix A).

The mean catch rate of recruits per trawl-hour was determined for each survey in each region from 2006. 'Recruits' are defined for this purpose as prawns ≤32 mm CL for males and ≤34 mm CL for females. Nominal catch per unit effort (CPUE) was calculated by dividing catch by effort, and expressed in $kg.h^{-1}$. The mean CPUE (± standard error) is presented as an annual index (for all regions and months surveyed) and as a regional index (for each survey period).

In 2015, surveys were conducted at Venus Bay in March, June and October, Coffin Bay in November and Ceduna in March. A summary of the number of survey trawl shots within regions that comprise the fishery-independent dataset for the WCPF is provided in Appendix B.

2.2. Catch and effort statistics

SARDI maintains a comprehensive catch and effort database for the WCPF using data collected from the compulsory fishing logbook system. Fishery-dependent catch and effort data from normal fishing operations exclude catch and effort data collected during surveys. Data were obtained from two sources: annual data from 1968 to 1972 and monthly data from January 1973 to June 1980 from the South Australian Fishing Industry Council (SAFIC) annual reports; and daily logbook data from July 1980 to December 2015 (SARDI). Daily logbook data from July 1980 to November 1986 are presented although they are not fully validated (discrepancies in annual catch between daily logbooks and various summaries were <5 t in all years).

In this report, a 'fishing year' is defined as calendar year to reflect the temporal pattern of fishing effort within the fishery. Total and regional catch and effort data are presented for each fishing year as a total and by regions. As the main spawning period for western king prawns in the West Coast extends from December to March, catch is also presented for the early spawning period (November–December) compared to all other fishing months. Annual and regional nominal CPUE was calculated by dividing catch by effort, and expressed in $kg.h^{-1}$.

2.3. Quality assurance of data

All logbook data are entered and validated according to the quality assurance protocols identified for the WCPF in the SARDI information systems quality assurance and data integrity report (Vainickis, 2010). The data are stored in an Oracle database, backed up daily, with access restricted to SARDI Information Systems staff. Extracts from the database are provided to SARDI researchers on request.

Data are extracted from the databases using established protocols. Accuracy of the data extracted is checked by comparing pivot table summaries with previous data extractions. The analyses in this report were carried out independently for multiple years at a time to confirm they were accurate compared to the results of previous reports.

The results, their interpretation and conclusions provided in the reports are discussed with peers, PIRSA Fisheries and Aquaculture, and BCF licence holders. All co-authors review the report prior to the report being formally reviewed by at least two independent scientists at SARDI in accordance with the SARDI report review process.

3. RESULTS

3.1. Fishery-wide

Total catch for the WCPF in 2015 was 191 t, a 31% increase compared to 2014 (146 t) and the highest catch since 1996 (216 t) (Figure 3.1). The majority of this catch (141 t, 74%) was harvested during the non-spawning season (April-October) in Venus Bay. During early spawning (November–December) in 2015, 21 t was harvested from Ceduna and Coffin Bay and this was a 28% decrease compared to 2014. A further 30 t was harvested from Venus Bay during the late spawning period (January–March) in 2015; approximately four times the harvest during the same period in 2014 (7 t). Levels of effort remained comparable to levels recorded in 2014 with 1,874 hours fished over 63 vessel nights, and levels of effort generally reflected levels of catch.

In 2015, the commercial catch rate was 102 $kg.h^{-1}$, which was a 31% increase compared to 2014 (78 $kg.h^{-1}$), and the highest on record (Figure 3.1). The annual FIS catch rate was also the highest on record at 85±6 $kg.h^{-1}$ in 2015, a 26% increase compared to 2014 (68±7 $kg.h^{-1}$).

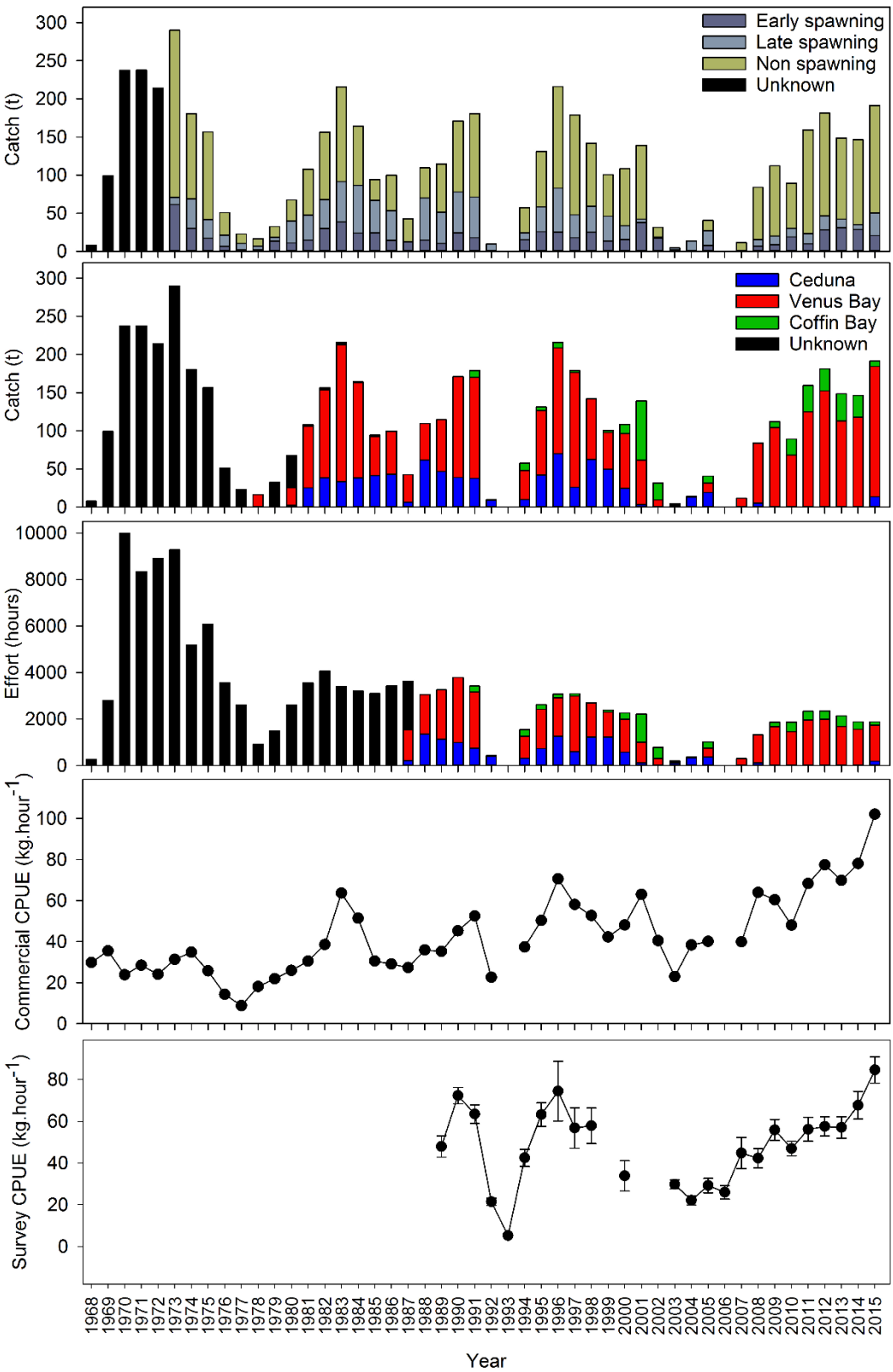

Figure 3.1 Summary of key outputs used to assess the status of the West Coast Prawn Fishery. From top; catch (t) during early spawning (November–December), late spawning (January–March) and non-spawning (April–October), regional catch (t), regional effort (hours), nominal commercial catch per unit effort (CPUE, $kg.h^{-1}$) and mean (±SE) nominal fishery-independent survey CPUE ($kg.h^{-1}$).

3.2. Venus Bay

In 2015, total catch for the Venus Bay region was 171 t, which was a 45% increase compared to 2014 (118 t) and the highest catch on record for this region (Figure 3.2). The majority of this catch (83%) was harvested during the non-spawning period (April-October). No catch has been harvested from Venus Bay during the early spawning period since 2008. During the late spawning period (January–March), 30 t was harvested from Venus Bay and this was approximately four times the harvest during the same period in 2014 (7 t). Levels of effort were similar to 2015 with 1,345 hours fished over 50 vessel nights.

The annual commercial catch rate was 110 kg.h^{-1}in Venus Bay in 2015, which was a 46% increase from 2014 (76 kg.h^{-1}) and the highest on record (Figure 3.2). The FIS catch rate was highest in March in Venus Bay at 114±15 kg.h^{-1}, which was a 38% increase compared to 2014 (83±18 kg.h^{-1}), and the highest March FIS catch rate recorded for this region. The FIS catch rate was 85±13 kg.h^{-1} in June in Venus Bay, which was a 24% increase compared to 2014 (69±10 kg.h^{-1}), and the highest value recorded since 1991 (86±13 kg.h^{-1}). In November, the FIS catch rate was 88±13 kg.h^{-1} Venus Bay, which was a 21% increase since 2014 (73±10 kg.h^{-1}) and the highest value recorded since 2007 (117±41 kg.h^{-1}).

The FIS catch rates of recruits recorded in all three FIS' in 2015 were lower than recorded in 2014 (Figure 3.2). The catch rate of recruits was highest in June with 45±17 recruits.h^{-1}, which was a 23% decrease compared to 2014 (59 ±11 recruits.h^{-1}) and the lowest value since 2013. Similarly, the catch rate of recruits decreased by 18% from 36±17 recruits.h^{-1} in March 2014 to 30±9 recruits.h^{-1} in March 2015. The catch rate of recruits in March was the lowest ever recorded. The catch rate of recruits in November has remained relatively stable since 2011 with 20±8 recruits.h^{-1} recorded in 2015.

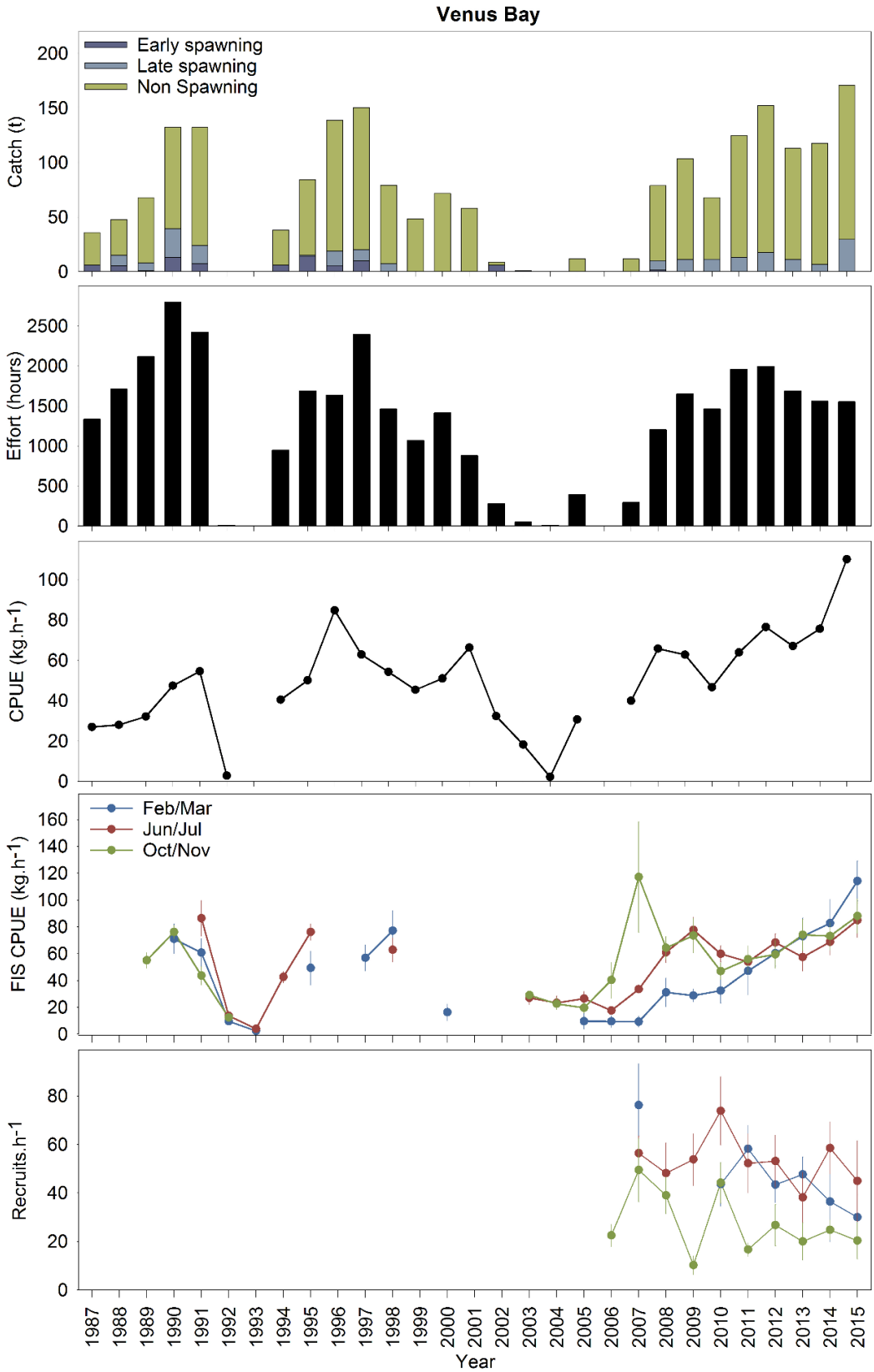

Figure 3.2 Summary of key outputs used to assess the stock status of the Venus Bay region of the West Coast Prawn Fishery. From top; catch (t) during early spawning (November–December), late spawning (January–March) and non-spawning (April–October), effort (hours), nominal commercial catch per unit effort (CPUE, kg.h^{-1}), mean (±SE) nominal fishery-independent survey (FIS) CPUE (kg.h^{-1}) by month sampled and mean (±SE) recruit CPUE (recruits.h^{-1}) by month sampled.

3.3. Coffin Bay

In 2015, total catch for the Coffin Bay region was 7 t. This was a 75% decrease compared to 2014 (29 t; Figure 3.3). Fishing only took place in Coffin Bay during November (early spawning season) in 2015. No catch has been harvested from Coffin Bay during the late spawning season (January–March) since 2002 (1 t) and significant levels of catch during the non-spawning period have only occurred in 2001 (39 t) and 2011 (24 t). Reduced catch was reflected in the low levels of effort in 2015, with 141 hours fished over 5 vessel nights, compared to 319 hours over 13 vessel nights in 2014.

In 2015, the annual commercial catch rate in Coffin bay was 51 $kg.h^{-1}$, which was a 43% decrease compared to 2014 (90 $kg.h^{-1}$) and the lowest recorded since 2009 (42 $kg.h^{-1}$; Figure 3.3). FIS' were conducted in November in Coffin Bay for the first time since 2009. The FIS catch rate was 58.5±9 $kg.h^{-1}$ in 2015, a 15% increase compared to 2009 (49.6±10.6 $kg.h^{-1}$).

The catch rate of recruits has been measured during only two previous November surveys in 2006 and 2008 (Figure 3.3). In 2015, the catch rate of recruits was 6±2 $recruits.h^{-1}$. This was a 4% increase compared to 2008 (6±1 $recruits.h^{-1}$) and an 89% decrease compared to 2006 (52±14 $recruits.h^{-1}$).

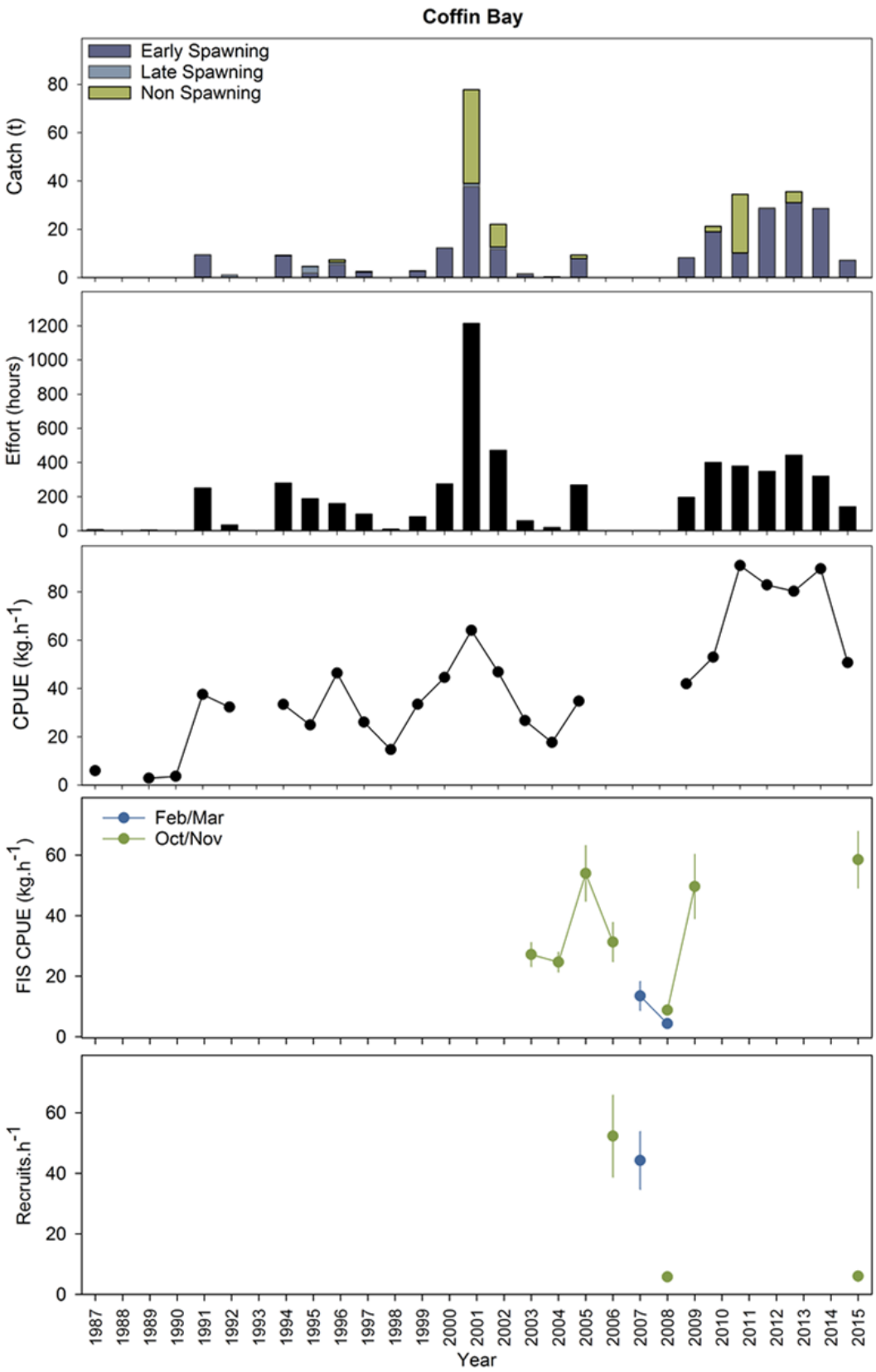

Figure 3.3 Summary of key outputs used to assess the status of the Coffin Bay region of the West Coast Prawn Fishery. From top; catch (t) during early spawning (November–December), late spawning (January–March) and non-spawning (April–October), effort (hours), nominal commercial CPUE (kg.h^{-1}), mean (±SE) nominal fishery-independent survey (FIS) CPUE (kg.h^{-1}) by month sampled and mean (±SE) recruit CPUE (recruits.h^{-1}) by month sampled.

3.4. Ceduna

In 2015, total catch for the Ceduna region was 13.6 t (Figure 3.4). This was the first time Ceduna has been fished since 2009 and was the highest catch recorded in Ceduna since 2005 (19.3 t). Similar to 2008 and 2009, fishing only took place in Ceduna during the early spawning period in 2015. No harvest has taken place during the late spawning period in Ceduna since 2005 (19 t) or during the non-spawning period since 2002 (0.2 t). In 2015, 184 hours were fished over 8 vessel nights. Levels of effort were the highest observed since 2005 when 353 hours were fished over 15 vessel nights.

In 2015, commercial catch rate in Ceduna was 74 $kg.h^{-1}$, this was approximately triple the catch rate observed in 2009 (25 $kg.h^{-1}$) and the highest on record (Figure 3.4). FIS' at Ceduna were undertaken in March 2015. The FIS catch rate was 80±14 $kg.h^{-1}$. This was a 128% increase compared to 2014 (35±7 $kg.h^{-1}$) and the highest March FIS catch rate recorded for this region. In March 2015, the catch rate of recruits was 102±13 $recruits.h^{-1}$, this was nearly identical to the 2014 result but low compared to historical levels.

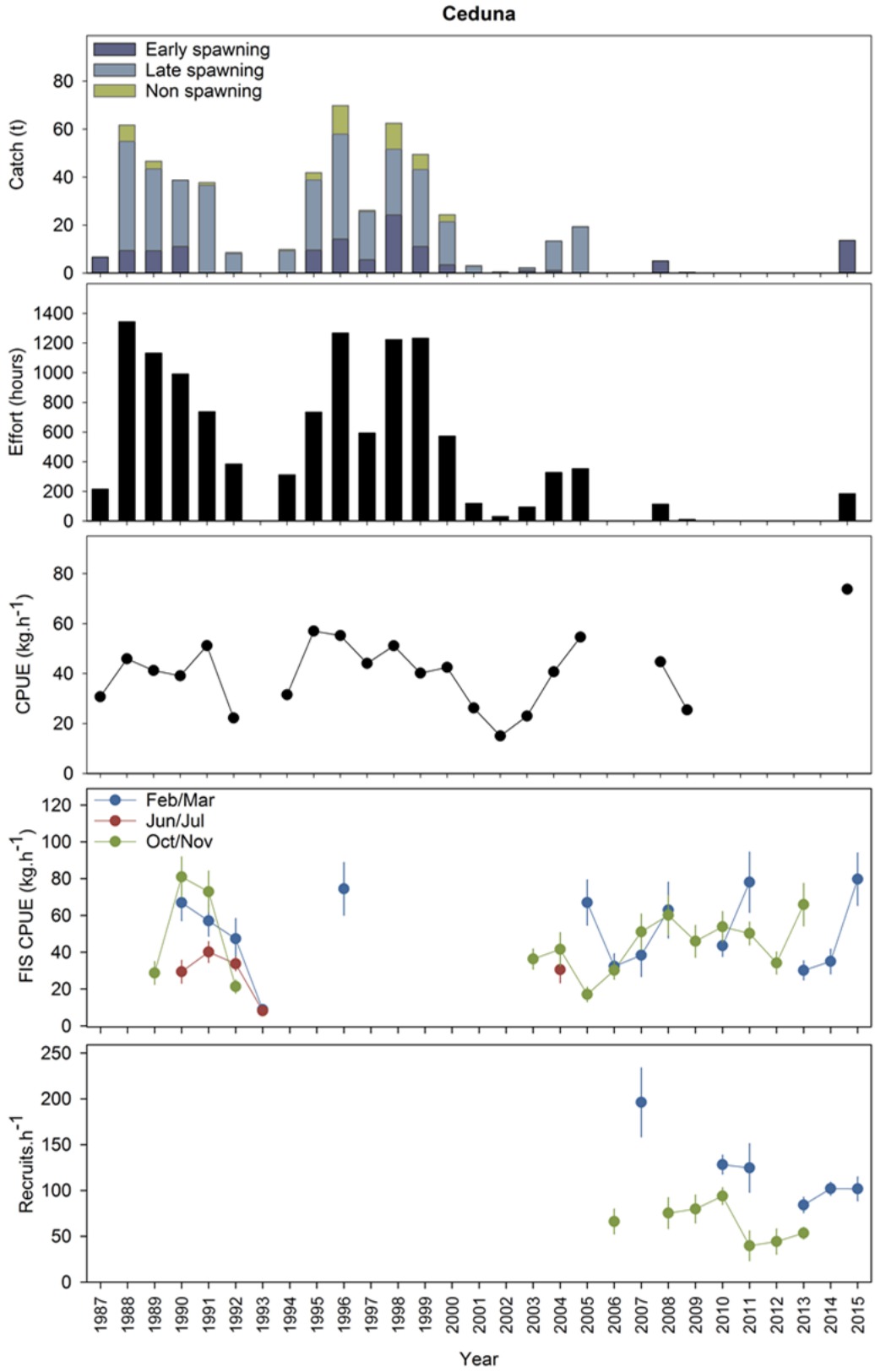

Figure 3.4 Summary of key outputs used to assess the status of the Ceduna region of the West Coast Prawn Fishery. From top; catch (t) during early spawning (November–December), late spawning (January–March) and non-spawning (April–October), effort (hours), nominal commercial catch per unit effort (CPUE, kg.h^{-1}), mean (±SE) nominal fishery-independent survey (FIS) catch rate (kg.h^{-1}) by month sampled and mean (±SE) recruit CPUE (recruits.h^{-1}) by month sampled.

4. SUMMARY

The harvest strategy for the WCPF (PIRSA, 2010) is the current tool for managing fishing effort and primarily uses spatial and temporal closures. While formal guidelines surrounding harvest strategy development are contained within the Management Policy for the fishery, PIs linked to decision rules have not yet been developed. In addition, the harvest strategy for the WCPF does not define when the stock is considered 'recruitment-overfished' and performance indicators (PIs) linked to a definition of stock status have not been developed for this fishery. Consequently, this assessment uses a 'weight-of-evidence' method to determine stock status.

The current Management Policy and harvest strategy for the fishery will be reviewed in 2016. In the lead up to this review, a workshop will be held in 2016/17 between SARDI, PIRSA and industry representatives to discuss the options for the collection of information on recruitment. Additional data on recruitment patterns could facilitate potential future studies investigating environmentally driven fluctuations in recruitment, particularly in relation to the El Niño-Southern Oscillation (ENSO). This is particularly relevant as the 2015–16 El Niño was the strongest recorded since 1950 (BOM, 2016). Frequent and prolonged El Niño events have been identified as important drivers in structuring recruitment in western South Australia (Carrick, 2008). The 2015–16 El Niño is now over and the ENSO outlook suggests that there is approximately a 50% chance of La Niña developing in 2016 (BOM, 2016). The onset of La Niña conditions is likely to result in warmer water temperatures in the eastern Great Australian Bight due to the enhanced eastward spread of the Leeuwin Current and these conditions have previously been associated with high recruitment (Carrick, 2008).

The primary measures used to determine stock status in the WCPF are commercial catch obtained from fishery-dependent data and average catch rates obtained from the FIS'. There are several key uncertainties associated with this assessment of stock status. These include:

1) FIS have not been conducted in a consistent manner across all regions (i.e. variation in survey timing among regions and variation in survey sites within regions).
2) Catch rates have not been standardised to account for the influence of factors which are unrelated to prawn abundance (i.e. temporal and spatial shifts in catch and effort and improvements in catching efficiency).

3) The spatial extent of the FIS may not adequately represent recruitment to the fishery due to spatial limitations, particularly in Ceduna during March where inshore recruitment areas have not been sampled.

Both fishery-dependent and fishery-independent data suggest that the fishery has been in a relatively stable position since 2011. During 2015, 191 t was harvested, which was the highest catch recorded since 1996 (216 t). A majority of the catch was harvested from Venus Bay (171 t), followed by Ceduna (13.6 t) and Coffin Bay (7 t). Commercial catch rates were the highest on record in Venus Bay (110 $kg.h^{-1}$) and Ceduna (74 $kg.h^{-1}$). However, in Coffin Bay in 2015, commercial catch rates declined to 51 $kg.h^{-1}$, the lowest observed since 2009 (49 $kg.h^{-1}$). This was likely a result of El Niño driven changes in current patterns influencing the spatial distribution of the stock. Despite this, the FIS catch rate (for all regions and months surveyed) in 2015 was also the highest on record at 85±6 $kg.h^{-1}$, a 26% increase from 2014 (68±7 $kg.h^{-1}$). This trend was driven by high FIS catch rates in Venus Bay and Ceduna. While FIS and commercial catch rates suggest that the relative biomass of adult prawns was amongst the highest on record, the catch rate of recruits during the 2015 FIS' remained low compared to historical values.

On the weight-of-evidence, the commercial catch and FIS catch rates indicate that the WCPF biomass is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (that is, the stock is not recruitment overfished) and that fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished. Therefore, using the national framework for stock status reporting (Flood *et al*., 2012), the WCPF stock is classified as '**sustainable**'.

5. REFERENCES

Beckmann, C. L. and Hooper, G. E. (2015). West Coast Prawn *Penaeus (Melicertus) latisulcatus* Fishery 2014. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000772-7. SARDI Research Report Series No. 853. 15pp.

Beckmann, C. L., Hooper, G. E. and Noell, C. J. (2014). West Coast Prawn *Penaeus* (*Melicertus*) *latisulcatus* Fishery 2012–13. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000772-6. SARDI Research Report Series No. 808. 76pp.

BOM (2016). *El Niño is over, but has left its mark across the world*, accessed 30 May 2016, http://www.bom.gov.au/climate/updates/articles/a018.shtml

Boxshall, S. (2001). West Coast Prawn. Fishery Assessment Report to PIRSA for the Prawn Fisheries Management Committee. South Australian Fisheries Assesment Series. 01/19.

Carrick, N. A. (1996). Key factors which affect prawn recruitment and implications to harvesting prawn stocks. Fisheries Research and Develoment Corporation, Project No. 1991/003. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Carrick, N. A. (2003). Spencer Gulf Prawn (*Melicertus latisulcatus*) Fishery. Fishery assessment report to PIRSA Fisheries. RD03/0079-2. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Carrick, N. A. (2008). Determining the impact of environmental variability on the sustainability, fishery dynamics and economic performance of the West Coast prawn fishery. FRDC Report 2005/082.

Carrick, N. A. & McShane, P. (1998). Spencer Gulf and West Coast prawns. South Australian Fisheries Assessment Series, Report No. 98/8. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Carrick, N. A. & Ostendorf, B. (2005). Modelling prawn movement and spatial dynamics in the Spenccer Gulf and West Coast Prawn Fisheries. Canberra, Australia.

Carrick, N. A. & Williams, H. (2000). Spencer Gulf and West Coast prawns. Fishery assesment report to PIRSA. South Australian Fisheries Assessment Series, Report No. 00/08. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Carrick, N. A. & Williams, H. (2001). Spencer Gulf and West Coast prawns. Fishery assesment report to PIRSA. South Australian Fisheries Assessment Series, Report No. 01/08 Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Dixon, C. D. & Roberts, S. D. (2006). West Coast Prawn (*Melicertus latisulcatus*) Fishery. SARDI Aquatic Sciences RO03/0076–4, SARDI Research Report Series No 122. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Dixon, C. D., Roberts, S. D. & Ward, T. M. (2005). West Coast Prawn (*Melicertus latisulcatus*) Fishery. SARDI publication no. RD03/0079–3. Adelaide, South Australia: SARDI Aquatic Sciences.

Flood, M., Stobutzki, I., Andrews, J., Ashby, C., Begg, G., Fletcher, R., Gardner, C., McDonald, B., Moore, A., Roelofs, A., Sainsbury, K., Saunters, T., Smith, T., Stewardson, C., Stewart, J., and Wise, B. (2014) Status of key Australian fish stock reports 2014. Fisheries Research and Development Corporation, Canberra.

Gorman, D., Hooper, G. E. & Dixon, C. D. (2012). West Coast Prawn *Penaeus* (*Melicertus*) *latisulcatus* Fishery 2011. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000772-5. SARDI Research Report Series No. 638. 22pp.

Grey D.L., Dall W. and Baker A. (1983) “A guide to the Australian penaeid Prawns”. Department of Primary Production, Northern Territory, Australia.

Hooper, G. E., Dixon, C. D. & Roberts, S. D. (2009). West Coast Prawn (*Melicertus latisulcatus*) Fishery 2008. SARDI Aquatic Sciences Publication No. F2007/000772-2, SARDI Research Report Series No. 367. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Hooper, G. E., Dixon, C. D. & Robertson, W. D. (2010). West Coast Prawn *Penaeus* (*Melicertus*) *latisulcatus* Fishery 2009. SARDI Publication No. F2007/000772-3. SARDI Research Report Series No. 450. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Hooper, G. E., Dixon, C. D. & Roberts, S. D. (2011). West Coast Prawn, *Penaeus* (*Melicerus*) *latisulcatus* Fishery, 2010. SARDI Publication No. F2007/000772-4. SARDI Research Report Series No. 563. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

Jackson, C. J. & Burford, M. A. (2003). The effects of temperature and salinity on growth and survival of larval shrimp *Penaeus semisulcatus* (Decapoda: Penaeoidea). *Journal of Crustacean Biology* **23**, 819-826.

Kangas, M. I. & Jackson, B. (1997). Gulf St Vincent Prawn Fishery. South Australian Fisheries Assessment Series, Report No. 99/05. Adelaide, South Australia: South Australian Research and Development Institute (Aquatic Sciences).

King, M. G. (1977). The biology of the western king prawn, *Penaeus latisulcatus* Kishinouye, and aspects of the fishery in South Australia. MSc Thesis, University of Adelaide.

Middleton, J. F. & Platov, G. (2003). The Mean Summertime Circulation along Australia's Southern Shelves: A Numerical Study. *J. Phys. Oceanogr.* **33**, 2270–2287.

Middleton, J. F. & Bye, A. T. (2007). A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland. *Progress in Oceanography* **75**, 1–41.

Middleton, J.F, Arthur. C., Van Ruth, P, Ward, T.M, McClean, J.L., Maltrud, M.E., Gill P., Levings A. and Middleton, S. (2007). El Niño effects and Upwelling off South Australia. *Journal of Physical Oceanography* **37**, 2458–2477.

Penn J.W. (1976) Tagging experiments with the western king prawn *Penaeus latisulcatus* Kishinouye. II. Estimation of population parameters. Aust. J. Mar. Freshwater Res. 27: 239–250.

Penn. J.W. (1980). Spawning and fecundity of the western king prawn, *Penaeus latisulcatus* Kishinouye, in Western Australian waters. *Australian Journal of Marine and Freshwater Research* **31**, 21–35.

Penn, J. W., Hall, N. G. & Caputi, N. (1988). Resource assessment and management perspectives of the penaeid prawn fisheries of Western Australia. In *Marine Invertebrate Fisheries: Their Assessment and Management* (Caddy, J. F., ed.), pp. 115-140. New York: John Wiley & Sons, Inc.

PIRSA (2010). Management policy for the commercial West Coast Prawn Fishery. p. 18: Primary Industries and Resources SA.

Preston, N. (1985). The combined effects of temperature and salinity on hatching success and the survival, growth, and development of the larval stages of *Metapenaeus bennettae* (Racek & Dall). *Journal of Experimental Marine Biology and Ecology* **85**, 57-74.

Primavera J.H. and Lebata M.J.H.L. (2000) Size and diel differences in activity patterns of *Metapenaeus ensis*, *Penaeus latisulcatus* and *P. merguiensis*. Mar. Fresh. Behav. Physiol. 33**:** 173–185.

Potter I.C., Manning R.J.G. and Loneragan N.R. (1991) Size, movements, distribution and gonadal stage of the western king prawn (*Penaeus latisulcatus*) in a temperate estuary and local marine waters. J. Zool., Lond. 223: 419–445.

Rasheed M.A. and Bull C.M. (1992) Behaviour of the Western king prawn, *Penaeus latisulcatus* Kishinouye: Effect of food dispersion and crowding. Aust. J. Mar. Freshwater Res. 43: 745–752.

Richardson, B. J. (1982). Geographical distribution of electrophoretically detected protein variation in Australian commercial fishes. III. Western king prawn, *Penaeus latisulcatus* Kishinouye. *Australian Journal of Marine and Freshwater research* **33**, 933-937.

Roberts, S. D. (2007). West Coast Prawn (*Melicertus latisulcatus)* Fishery Status Report. Fishery Status Report to PIRSA Fisheries. SARDI Aquatic Sciences Publication No. RD03/0076-5. SARDI Research Report Series No. 185.

Roberts, S.D., Dixon, C.D. & Andreacchio, L. (2012). Temperature dependent larval duration and survival of the western king prawn, *Penaeus (Melicertus) latisulcatus K*ishinouye, from Spencer Gulf, South Australia. *Journal of Experimental Marine Biology and Ecology* **411**, 14-22.

Sang H.M. and Fotedar R. (2004) Growth, survival, haemolymph osmolality and organosomatic indices of the western king prawn (Penaeus latisulcatus Kishinouye, 1896) reared at different salinities. Aquaculture 234: 601–614.

Svane, I. (2003). West Coast Prawn Fishery (*Melicertus latisulcatus*). Fishery assessement report to PIRSA.

Svane, I. & Barnett, J. (2004). West Coast Prawn Fishery (*Melicertus latisulcatus*). Fishery status report to PIRSA.

Svane, I. & Barnett, J. (2005). West Coast Prawn Fishery (*Melicertus latisulcatus*). Fishery status report to PIRSA.

Tanner J.E. and Deakin S. (2001) Active habitat selection for sand by juvenile western king prawns, *Melicertus latisulcatus* (Kishinouye). J. Exp. Mar. Biol. Ecol. 261: 199–209.

Wallner, B. (1985). An assessment of the South Australian West Coast western king prawns, *Penaeus latisulcatus* fishery. Adelaide, South Australia: Department of Fisheries, South Australia.

APPENDIX A: LENGTH FREQUENCY DATA

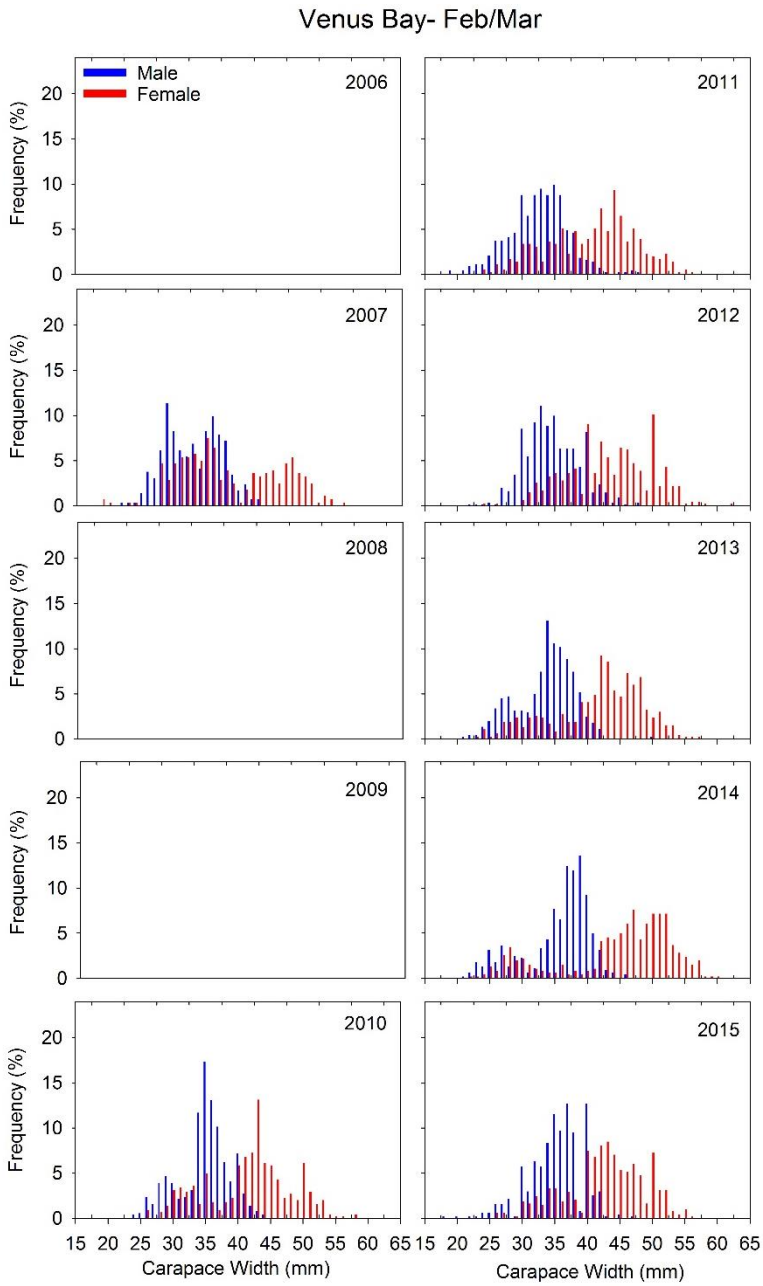

Figure A.1 Length frequency distributions (%) of male and female western king prawns from February/March fishery-independent surveys in Venus Bay.

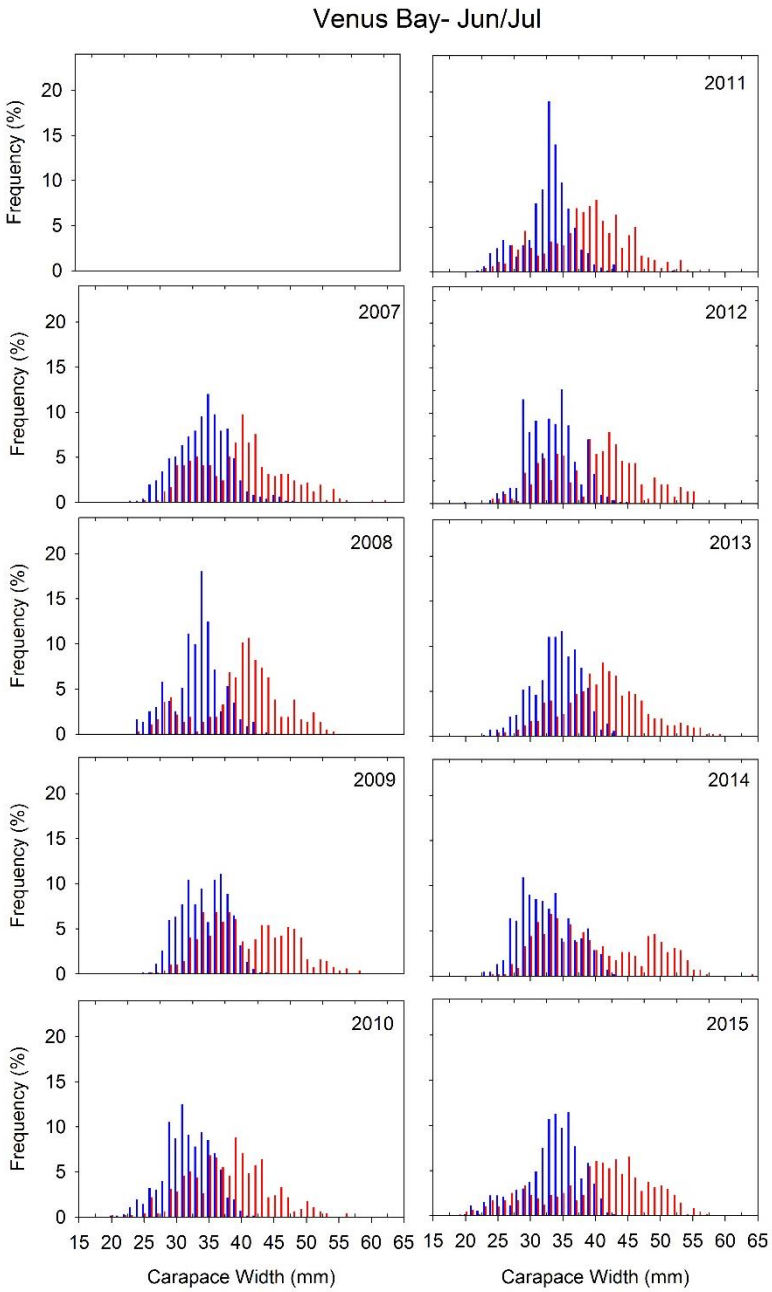

Figure A.2 Length frequency distributions (%) of male and female western king prawns from June/July fishery-independent surveys in Venus Bay.

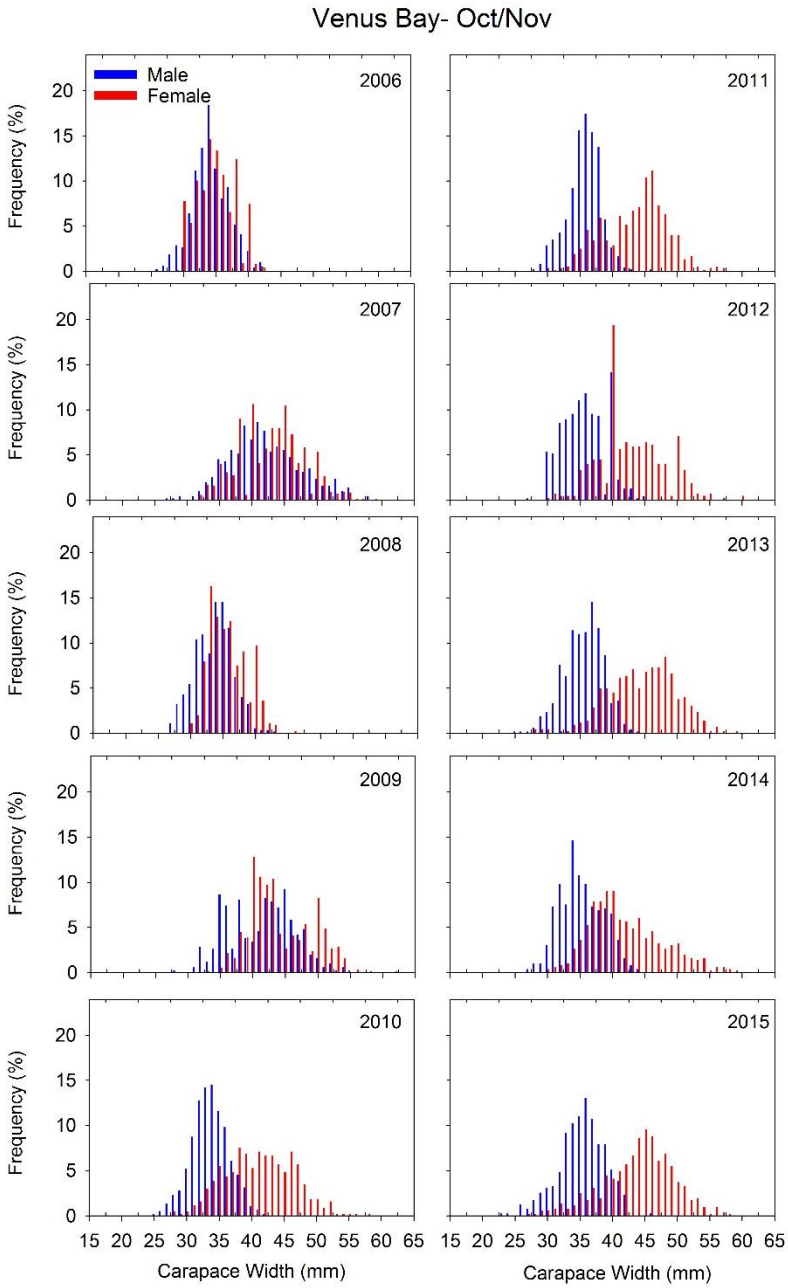

Figure A.3 Length frequency distributions (%) of male and female western king prawns from October/November fishery-independent surveys in Venus Bay.

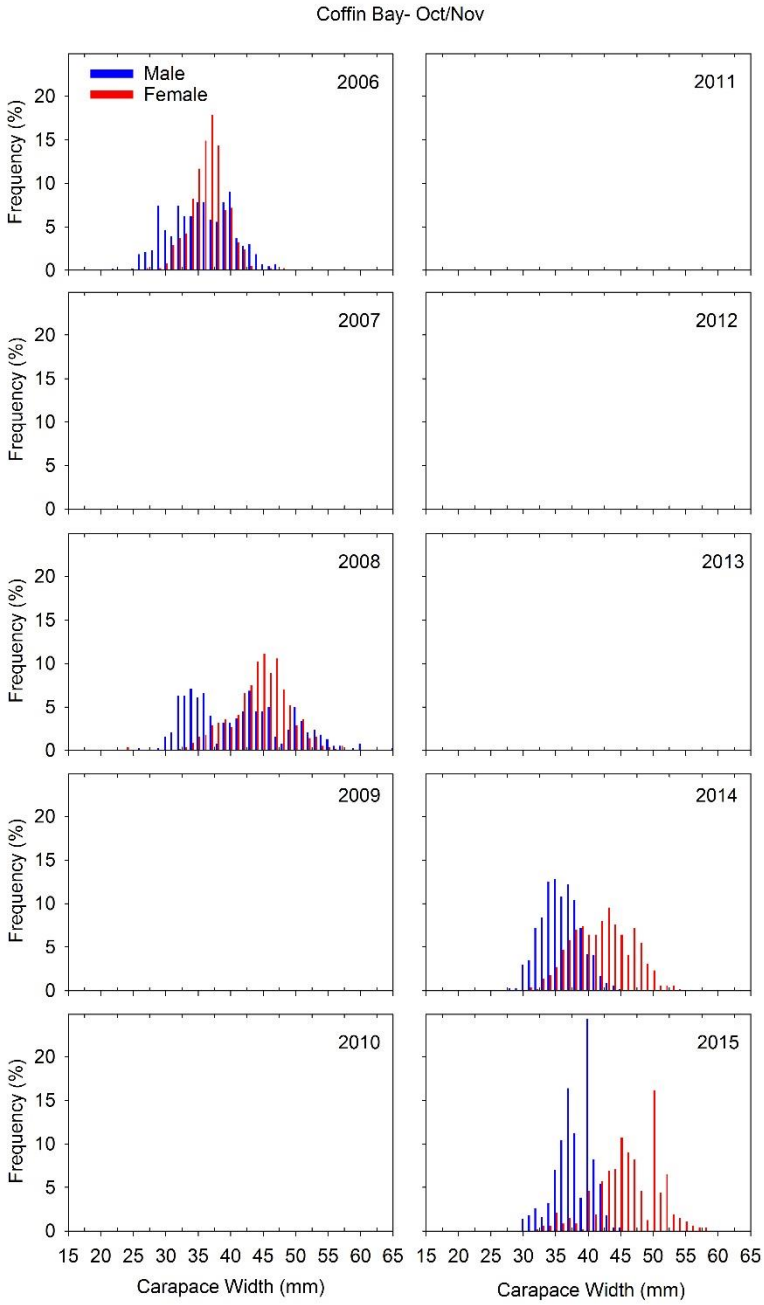

Figure A.4 Length frequency distributions (%) of male and female western king prawns from October/November fishery-independent surveys in Coffin Bay.

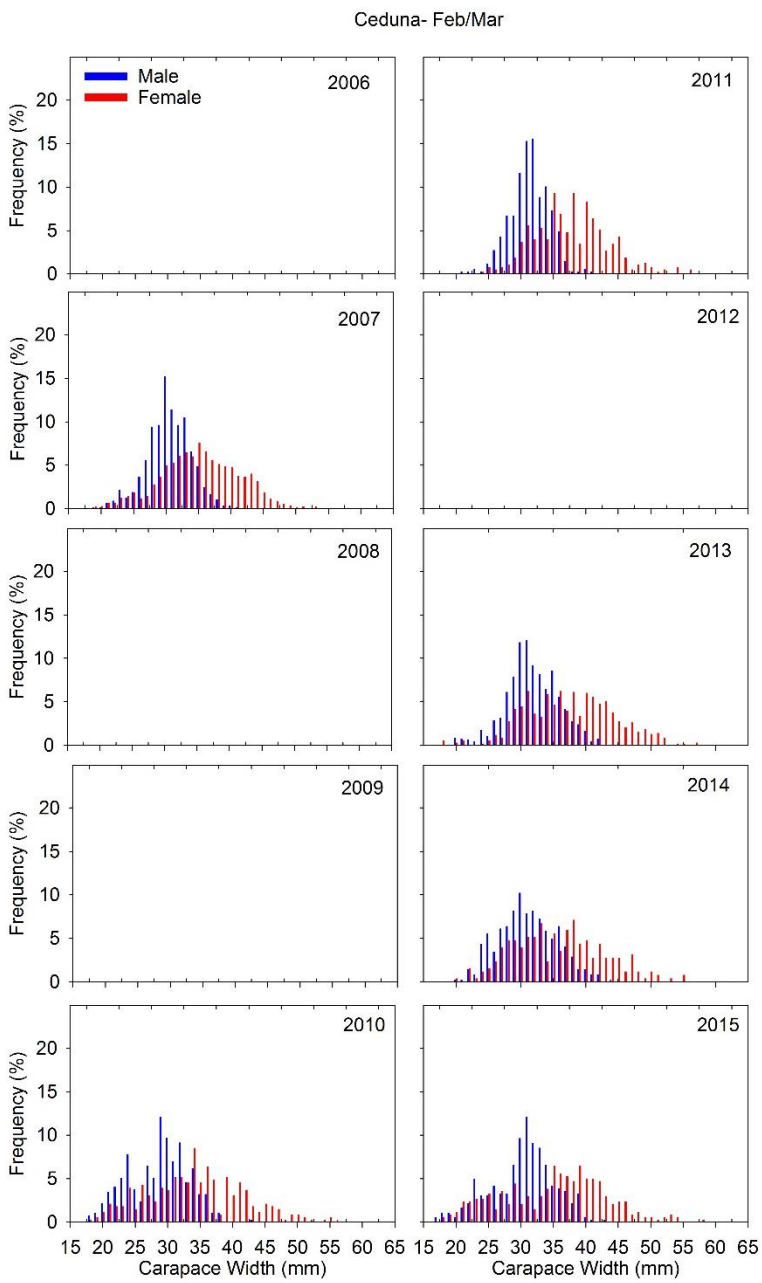

Figure A.5 Length frequency distributions (%) of male and female western king prawns from February/March fishery-independent surveys in Ceduna.

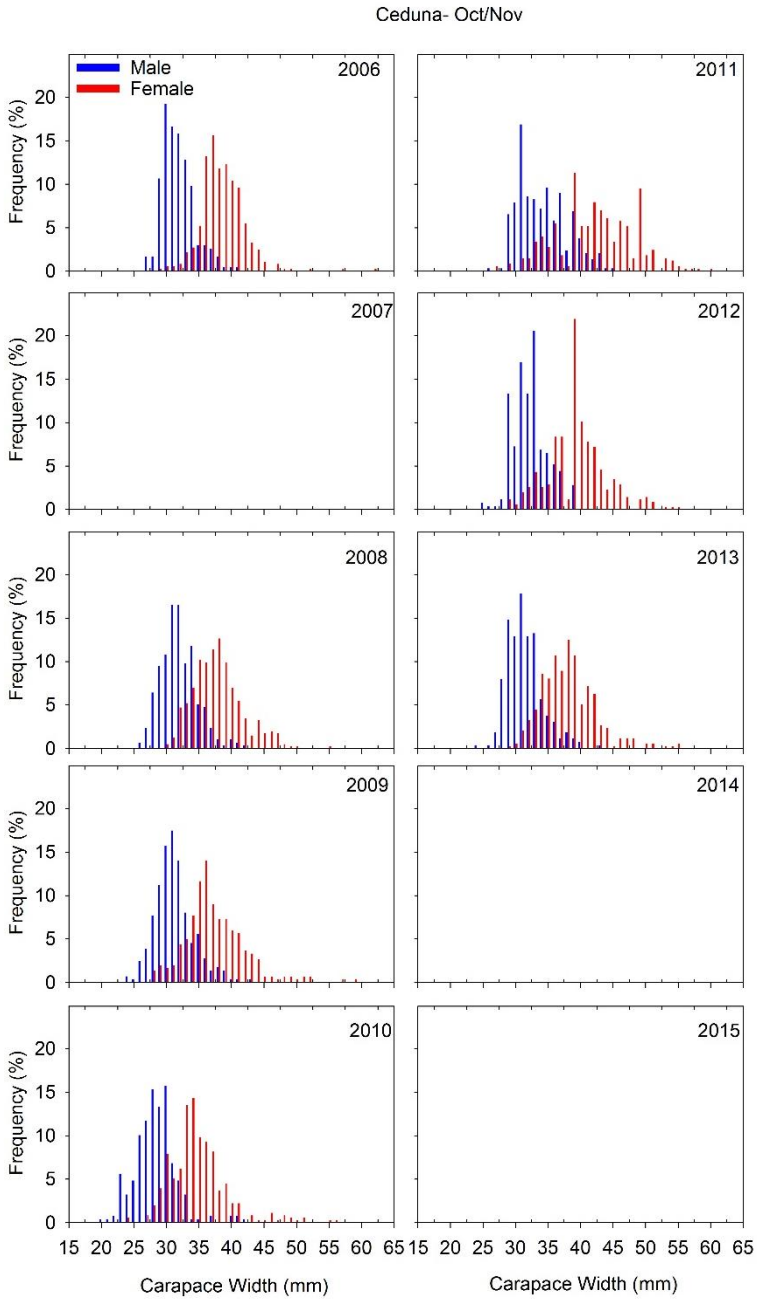

Figure A.6 Length frequency distributions (%) of male and female western king prawns from October/November fishery-independent surveys in Ceduna.

APPENDIX B: SURVEY DETAILS

Table B.1 Number of fishery-independent survey shots done in fishing regions of the West Coast Prawn Fishery from November 1989 to December 2014.

Year	Month	Ceduna	Coffin Bay	Venus Bay	Total
1989	Nov	7	-	19	26
1990	Feb	6	-	20	26
	Apr	6	-	20	26
	Jun	6	-	-	6
	Nov	7	-	20	27
1991	Feb	17	-	20	37
	Apr	17	-	20	37
	Jun	17	-	20	37
	Nov	16	-	11	27
1992	Feb	17	-	20	37
	Apr	17	-	20	37
	Jun	17	-	20	37
	Jul	9	-	12	21
	Oct	16	-	20	36
1993	Feb	17	-	20	37
	Apr		-	11	11
	Jun	17	-	20	37
1994	Jun	-	-	20	20
1995	Jan	16	-		16
	Feb		-	20	20
	Jul		-	26	26
1996	Feb	16	-	19	35
1997	Feb	-	-	22	22
1998	Mar	-	-	16	16
	Jun	-	-	18	18
2000	Feb	-	-	10	10
	Dec	-	-	9	9
2003	Jul		-	14	14
	Oct	9	10	10	29
	Nov	7	10	9	26
2004	Apr	-	-	13	13
	Jun	9	8	13	30
	Oct	9	9	11	29
2005	Feb	8	-	11	19
	Jun	-	-	14	14
	Nov	6	8	10	24
	Dec	7	-	-	7
2006	Feb	8	-	11	19
	Jun	-	-	13	13
	Nov	7	10	11	28

Year	Month	Ceduna	Coffin Bay	Venus Bay	Total
2007	Mar	14	8	11	33
	Aug	-	-	10	10
	Nov	6	-	10	16
2008	Mar	7	5	10	22
	Jun	-	-	8	8
	Oct	7	10	10	27
2009	Mar	-	-	10	10
	Jun	-	-	10	10
	Nov	6	10	10	36
2010	Mar	7	-	10	17
	Jun	-	-	10	10
	Nov	6	-	10	16
2011	Mar	7	-	10	17
	Jun	-	-	10	10
	Nov	6	-	10	16
2012	Mar	-	-	10	10
	Jun	-	-	9	9
	Nov	6	-	9	15
2013	Mar	13	-	9	22
	Jun	-	-	9	9
	Oct	6	-	9	15
2014	Mar	6	-	9	15
	Jun	-	-	9	9
	Oct	-	-	10	10
2015	Mar	7	-	10	17
	Jun	-	-	10	10
	Nov	-	10	9	19