Fisheries

Blue Crab (*Portunus armatus*) Fishery 2011/12

C. D. Dixon, C. J. Noell, G. E. Hooper and T. M. Ward

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SARDI Aquatic Sciences
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April 2013

Fishery Assessment Report to PIRSA Fisheries and Aquaculture

Government of South Australia

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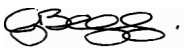
Signed: 

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EXECUTIVE SUMMARY

This fishery assessment report updates the 2010/11 report, providing an assessment of the current status of the South Australian Blue Crab Fishery (BCF) up to July 2012 for Spencer Gulf and October 2012 for Gulf St Vincent.

In 2011/12, 97.5% of the Total Allowable Commercial Catch (TACC) of the BCF was harvested, with Spencer Gulf and Gulf St Vincent pot fishing sectors harvesting 98.9% and 96.9% of their share of the TACC, respectively. The pot fishing sector currently holds >99% of the TACC, with some licence holders in the Marine Scalefish Fishery making up the remainder.

There are three performance indicators for the fishery, all of which provide a measure of relative abundance of legal-size or pre-recruit crabs: 1) survey catch per unit effort (CPUE) of legal-size crabs; 2) survey CPUE of pre-recruit crabs; and 3) commercial CPUE of legal-size crabs. The first two indicators, which are derived from fishery-independent surveys, are the most reliable indicators of stock status due to the consistent timing of the survey (i.e. during winter), standardised pot type and location and spatial coverage in each gulf. In contrast, the third performance indicator, which is derived from commercial catch and effort data, does not provide a reliable measure of the relative abundance of legal-size crabs because of the effects of changes in gear and vessel technology, fisher demographics, experience and behavior (e.g. second pot lifts) and temporal and regional distribution of catch and effort.

Data from fishery-independent surveys conducted in June 2012 indicate that the blue crab resource in Spencer Gulf remains in a strong position. Relative abundance of legal-size crabs derived from fishery-independent surveys was above the upper limit reference point. Relative abundance of pre-recruits from surveys was within the reference range (just below the upper limit reference point). The relative abundance of legal-size and pre-recruit crabs in the June 2012 survey were the highest and second highest recorded, respectively. Pot-sampling data indicate that pre-recruit abundance has been high and stable since 2008. In recent years the TACC has been fully caught with reducing effort. Evidence available suggests that the current Spencer Gulf TACC is sustainable. Using the national framework for stock status reporting, the blue crab resource in Spencer Gulf is classified as a sustainable stock.

The Gulf St Vincent fishery is currently in its weakest position since the introduction of quota. The relative abundance of pre-recruits from the July 2012 survey was below the lower limit reference point. Although the relative abundance of legal-size crabs was just above the lower limit reference point, survey CPUE for both legal-size and pre-recruit crabs has generally declined since 2006, and in

2012 were the lowest and second lowest recorded, respectively. In 2011/12 the Gulf St Vincent catch was taken from more fishing blocks than any previous year. Pot-sampling data indicate that the relative abundance of pre-recruits was low in all months fished during the 2011/12 season. Pot-sampling for the first few months of the 2012/13 season (July to September 2012) does not provide any evidence of improvement since 2011/12. This was the fourth consecutive year the entire TACC was not caught. The current TACC has not constrained catches in recent years. Using the national framework for stock status reporting, the Gulf St Vincent resource is classified as a transitional-depleting stock.

1. INTRODUCTION

1.1. Overview

This report is the eighth version that has been updated annually since 2004 as part of the SARDI Aquatic Sciences' ongoing assessment program for the South Australian Blue Crab Fishery (BCF) (Svane and Hooper 2004; Currie and Hooper 2006; Currie *et al.* 2007; Dixon *et al.* 2008; Dixon and Hooper 2009, 2010, 2011; Rodgers *et al.* 2012). The report aims to: 1) synthesise information for the BCF in each of the Spencer Gulf and Gulf St Vincent regions; 2) assess the current status of the blue crab resource and consider the uncertainty associated with each assessment; 3) comment on the current biological performance indicators and reference points for the fishery; and 4) identify future research needs.

The first report on the BCF was published in 1987 by the South Australian Department of Fisheries (Grove-Jones 1987). The fishery was later reviewed in 1994 by Baker and Kumar (1994). SARDI completed the first fishery assessment report for the BCF in 1998 (Kumar *et al.* 1998) based predominately on summaries of catch and effort information. These brief reports were then published annually until 2003 (Kumar *et al.* 1999a, 1999b; Boxshall *et al.* 2000, 2001; Hooper and Svane 2003).

Since 2004, this report has documented the biology and management of the BCF in South Australia, presented analyses of commercial logbook and fishery-independent survey data, and provided assessment against the performance indicators of the management plan for the fishery (current version: PIRSA 2012). Since 2008, the report has presented information and conclusions for each gulf separately and also included information gathered from the fishery-dependent pot-sampling program. The 2010 report was the first to provide explicit spatial information, at the fishing block scale, for commercial catch and effort data.

The fishery assessment report has evolved since 2004 to be the major report that is published annually that documents, analyses and interprets the available data and assesses the BCF against the performance indicators identified in the Management Plan for the fishery. It formally provides the information required to make decisions in accordance with the total allowable commercial catch (TACC) decision rules provided in the harvest strategy of the 'Management Plan for the South Australian Commercial Blue Crab Fishery' (PIRSA 2012, 'the Management Plan'). The report is prepared for Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture, and presented to PIRSA and industry each year to inform the TACC decision and supporting research program (in line with the strategic research plan in the Management Plan) for the following season.

Additional research conducted for the BCF includes an independent review of the research program (Scandol and Kennelly 2001) and a review of blue crab biology in South Australia (Svane and Cheshire 2005).

1.2. History of the Fishery

1.2.1. Commercial fishery

The blue swimmer crab, *Portunus armatus* (previously *P. pelagicus*, Lai *et al.* 2010), was first harvested as by-product in South Australian prawn and marine scalefish fisheries in the 1970s. In 1981, an experimental trawl fishery with four licensed fishers was established in northern Spencer Gulf. This approach was later abandoned and in 1983 six experimental pot fishing permits were offered to licence holders in the Marine Scalefish Fishery. In 1985/86, the number of experimental licences was increased to 12, i.e. four in the West Coast, six in Spencer Gulf, and two in Gulf St. Vincent. In 1986, the West Coast fishery declined and the four licence holders surrendered their entitlements. Also during 1986, the sale of blue swimmer crab as by-product from the prawn fishery was prohibited.

In June 1996 management arrangements for a separate commercial blue crab fishery in South Australia were established. A management strategy and research program was implemented to support the development of a sustainable fishery. In 1997, PIRSA proposed a three-year developmental strategy where the capacity for expansion of the fishery was to be determined through a research program and commercial fishing.

The BCF is based on the capture of a single species, *Portunus armatus,* although other crab species may also be landed. The fishery comprises two fishing zones for the purpose of setting the TACC or 'quota' (which applies from 1 July to 30 June), i.e. Spencer Gulf and Gulf St Vincent fishing zones (Figure 1.1). There is a single TACC for the BCF, with separate quota units for each fishing zone. Almost all of the TACC (99%) is allocated among the BCF licence holders (also referred to as 'pot fishers'), with the remainder allocated to some MSF licence holders. The *Fisheries Management (General) Regulations 2007* state that blue swimmer crab may also be taken from State waters within three nautical miles of the coast west of longitude 135°E, although this 'West Coast' region of South Australia is not subject to quota management arrangements.

Commercial pot fishers generally haul their gear once or twice every 24 hours using specifically designed crab pots covered with netting. Marine scalefish fishers use either hoop or drop nets

hauled every 20-30 minutes. Crabs can be stored live in tanks, iced down uncooked, or cooked before being landed at port.

Most of the commercial catch is marketed in Australia, primarily in the Sydney and Melbourne fish markets. In the 2010/11 financial year, 638 tonnes of blue swimmer crab valued at approximately $4.94M were harvested from South Australian State waters (Knight and Tsolos 2012). This value includes commercial quantities of blue crabs taken from the West Coast, which is not part of the TACC for the BCF.

1.2.2. Recreational fishery

PIRSA conducted the most recent State-wide assessment of recreational fishing in South Australia, from November 2007 to October 2008 (Jones 2009). Retained catch of blue crab was estimated at 1,144,837 individuals for this period, with an estimated weight of 283.7 t. This represents 29.8% of the total annual catch if added to the commercial catch of 2007/08 (Jones 2009). Of the recreational catch, 48% was caught from Spencer Gulf, 46% from Gulf St Vincent and Kangaroo Island, and 6% from the West Coast.

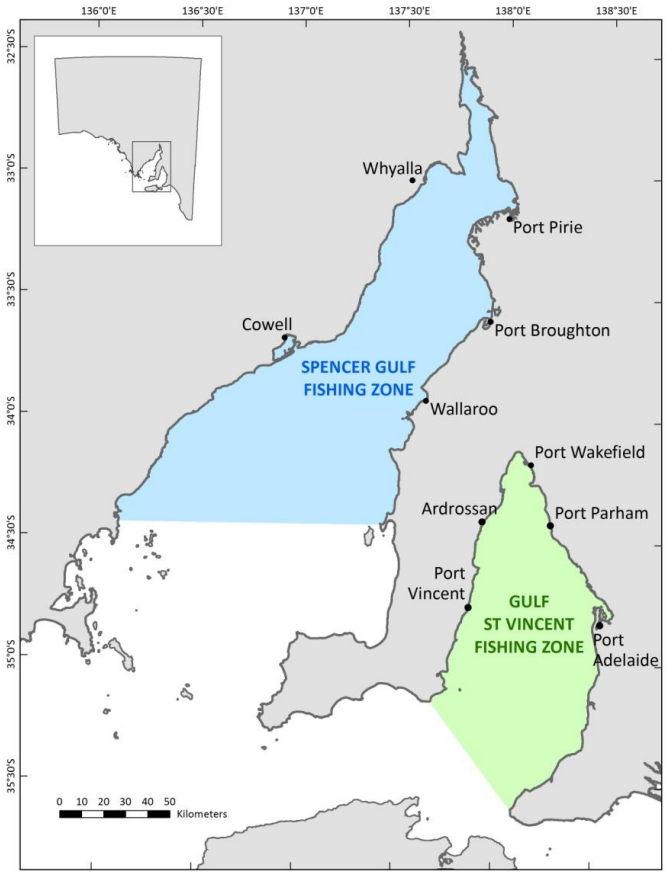


Figure 1.1. The location of Spencer Gulf and Gulf St Vincent fishing zones of the South Australian Blue Crab Fishery.

Two other recreational fishing surveys were undertaken in South Australia prior to the 2007/08 survey. A National Recreational and Indigenous Fishing Survey (Henry and Lyle 2003) was conducted between May 2000 and April 2001. The annual catch taken by recreational fishers in South Australia was estimated at 389.8 t, which, when combined with the commercial catch during 2000/2001, represents 37.5% of the total catch. Also, McGlennon and Kinloch (1997) estimated a recreational catch of 161.2 t per year, of which 115.8 t was taken in Gulf St Vincent and 45.4 t in Spencer Gulf. This estimate was derived from a boat survey conducted in 1994/95 in Gulf St Vincent and 1995/96 in Spencer Gulf and West Coast, and does not include the recreational shore-based fishery, thus making it difficult to compare with the more comprehensive surveys of 2000/01 and 2007/08.

1.3. Management

1.3.1. Legislation

As with all of South Australia's fisheries and aquatic resources, the *Fisheries Management Act 2007* ('the Act') and relevant subordinate regulations provide the statutory framework for management of the South Australian blue crab resource. The schemes of management for the fishery are prescribed in the *Fisheries Management (Blue Crab Fishery) Regulations 1998* and the *Fisheries Management (Marine Scale Fisheries) Regulations 2006*, while general regulations pertaining to commercial and recreational take of blue crabs from State waters are described in the *Fisheries Management (General) Regulations 2007*.

1.3.2. Management history

Several fishing sectors have had historic access to the blue crab resource in South Australia, including marine scale fishers and prawn trawlers. The BCF was established in 1996, with formalised management arrangements that included pot restrictions, formation of two fishing zones (Spencer Gulf and Gulf St Vincent) and a single TACC with quota units allocated separately for each zone. Quota is transferable between the pot fishers of the BCF and eligible marine scalefish licence holders.

Since the introduction of a TACC in the BCF in 1996/97, there has been a transfer of fishing effort from the MSF to the pot fishing sector (Figure 1.2), with the number of MSF licences holding blue crab quota steadily decreasing from 29 to three. When quota was first introduced, there were four licensed pot fishers in the Spencer Gulf and two in the Gulf St Vincent. Additional licences were added in 2001/02 (Spencer Gulf), 2002/03 and 2007/08 (Gulf St Vincent) to make up the current

numbers of five and four licences for the Spencer Gulf and Gulf St Vincent pot fishing sectors, respectively.

1.3.3. Current management arrangements

The TACC was initially set by PIRSA at 520 t for the 1996/97 fishing season. Over the next four seasons the TACC gradually increased to 626.8 t in 2000/01, where it has remained.

Blue swimmer crabs are undersize if the carapace width, measured from the anterior base of the first spine, is less than 11 cm. All licensed and unlicensed persons are prohibited from retaining egg-bearing females. All licensed fishers are prohibited from taking blue crabs during closed seasons for the commercial fishing sectors (Spencer Gulf: 21 Dec to 19 Feb; Gulf St Vincent: 1 Nov to 15 Jan). Recreational fishers are restricted to a bag limit of 40 crabs (blue crabs and/or sand crabs combined) per person per day and a boat limit of 120 crabs per day.

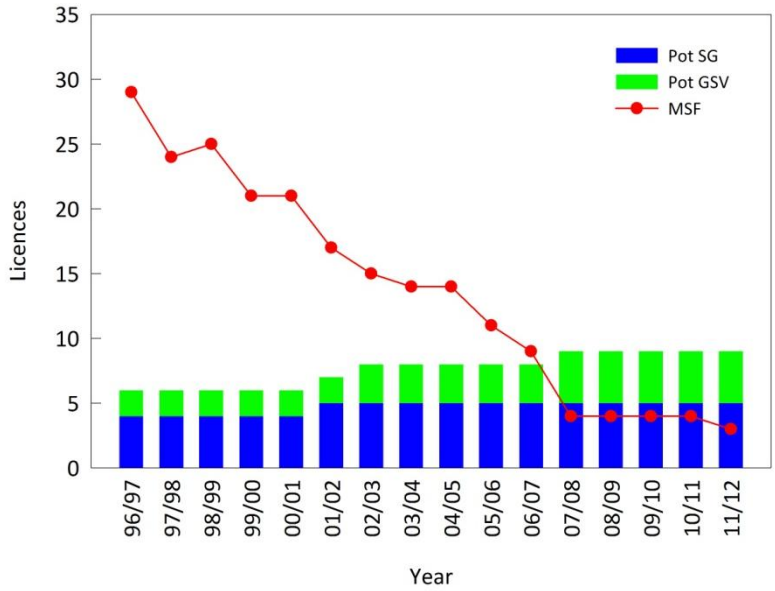


Figure 1.2. Number of licences in the Blue Crab Fishery since 1996/97.

1.3.4. Management Plan

The Management Plan (PIRSA 2012) was recently prepared by the Fisheries Council of South Australia as required under the Act.

The four primary goals for the BCF as provided in the Management Plan are:

1. Ensure the blue swimmer crab resource is harvested within ecologically sustainable limits;

2. Allocate access to the blue swimmer crab resource to achieve optimum utilisation and equitable distribution to the benefit of the community;
3. Minimise impacts on the ecosystem; and
4. Cost-effective and participative management of the fishery.

An important component of the Management Plan is the harvest strategy. The harvest strategy for the BCF is designed to implement a precautionary approach to managing the fishery and to set the TACC at a level that aims to ensure stock sustainability, as well as certainty and stability for the industry, which relate to Goals 1 and 2 (and associated objectives) of the Management Plan.

Key biological performance indicators and limit reference points have been established to guide the annual TACC decision-making process (Table 1.1). Harvest decision rules stipulate that if the lower limit reference point for any performance indicator is not achieved, PIRSA Fisheries and Aquaculture and the relevant co-management body will review the TACC and consider the possibility of a decrease from the baseline TACC of 626.8 tonnes. This is deemed to be an appropriately precautionary response in the Management Plan that reflects the current level of understanding about the species, fishery production and dynamics, and the limitations of existing fishery data. One of the aims of this report is to assess the performance of the fishery in terms of the performance indicators and limit reference points specified in the Management Plan.

Table 1.1. Key biological performance indicators and limit reference points for the South Australian Blue Crab Fishery. Abbreviation: CPUE, catch per unit effort.

Gulf	Data source	Performance indicator	Reference range	
			lower	upper
SG	Fishery-independent survey	CPUE of legal-size crabs (legal-size crabs/pot lift)	5	8
	Fishery-independent survey	CPUE of pre-recruits (pre-recruits/pot lift)	2	9
	Commercial catch and effort	CPUE of legal-size crabs (kg/pot lift)	2	4
GSV	Fishery-independent survey	CPUE of legal-size crabs (legal-size crabs/pot lift)	1.5	4
	Fishery-independent survey	CPUE of pre-recruits (pre-recruits/pot lift)	1.5	8.5
	Commercial catch and effort	CPUE of legal-size crabs (kg/pot lift)	2	4

The Management Plan provides a strategic direction for management of the fishery over the next five years. In addition to providing details of the current harvest strategy, it emphasises the need to build scientific knowledge through improvements in the quality of both fishery-dependent and fishery-independent information, with the view of developing a future harvest strategy that comprises more robust fishery performance indicators and limit reference points that are explicitly linked to TACC decisions. Explicit TACC decision rules in the future will provide greater certainty to

the industry, fishery managers, other fishing sectors and the broader community on how the fishery will be sustainably managed under the quota management system.

1.4. Biology of the blue swimmer crab

1.4.1. Description

The blue swimmer crab, *Portunus armatus* (Lai *et al.* 2010) is a true crab (Brachyura) belonging to the family Portunidae. Blue swimmer crabs have five pairs of legs (i.e. a decapod). The first pair are chelae or claws, the following three pairs are walking legs and the last pair are modified as swimming paddles. The carapace is rough in texture, broad and has a prominent projection/spine on each side. They are active swimmers, but bury in the sediment while resting, with only eyes, antennae and gill chamber openings uncovered. Males are blue and have larger claws than females, which are green-brown in colour (Figure 1.3). A detailed description of this species is provided by Stephenson (1972).

Figure 1.3. Differences in coloration and claw size between male (top) and female (bottom) blue swimmer crabs (*Portunus armatus*).

1.4.2. Distribution and stock structure

Portunus armatus is distributed throughout the coastal waters of the tropical regions of the western Indian Ocean and the eastern Pacific Ocean (Kailola *et al.* 1993). In the relatively colder, temperate

parts of Australia, the life cycle has evolved to increase growth and reproduction during the warmer part of the year when water temperatures increase to those similar in tropical regions. Activity reduces during the colder winter months.

Portunus armatus occurs in a wide range of algal and seagrass habitats, and on both sandy and muddy substrata, from the intertidal zone to a depth of at least 50 m (Williams 1982; Edgar 1990). In coastal waters, smaller crabs are generally found in shallow waters less than 1 m, while adults are found in deeper waters. Juvenile crabs occur in mangrove creeks and mud flats for eight to twelve months, by which time they attain a size of 80 to 100 mm carapace width. Within South Australia, there is a distinct seasonal pattern of adult crab movements into shallow inshore waters during the warmer months of September to April and to deeper offshore waters during the colder months of May to August (Smith, 1982).

Using allozyme markers, Bryars and Adams (1999) determined that the populations of *P. armatus* within Spencer Gulf, Gulf St Vincent and the West Coast regions of South Australia represented separate sub-populations with a limited gene flow. They also found that inter-regional larval dispersal is restricted, and each sub-population must be dependent on its own larval supply.

In a study using microsatellite markers, Chaplin *et al.* (2001) found that the assemblages of *P. armatus* in different embayments in South Australia often constitute genetically different meta-populations, which suggests that the level of migration between these populations is probably limited and likely to be determined by local factors.

1.4.3. Reproductive biology

Male and female *P. armatus* generally reach sexual maturity at carapace widths of 70 and 90 mm, respectively, when they are approximately one-year old. The male and female will form a pre-corpula for eight to ten days before ecdysis of the female. After female ecdysis, when the female is soft-shelled, copulation takes place over a six to eight-hour period (Meagher, 1971).

The spawning season lasts for three to four months over the summer/autumn period. The duration of the growing season varies among individuals because those settling in early summer have a longer growing season than those settling in mid to late summer. In South Australian waters, crabs close to the minimum legal size (110 mm) are approximately 14 to 18 months old, sexually mature, and females have produced at least two batches of eggs within one season (Kumar *et al.* 2000, 2003).

Development of the ovaries appears to be triggered by rising water temperature in spring. During copulation, the spermatophore is transferred to the female spermatheca. The eggs are subsequently

fertilised on extrusion (Smith, 1982). Van Engel (1958) found that the sperm in the female spermatheca of another portunid, the Chesapeake blue crab (*Callinectes sapidus*), could remain viable for at least 12 months. This is likely to also be the case for *P. armatus*. Egg extrusion is independent of the timing of copulation.

Ovarian development can be classified by five visually distinguishable stages (see Sumpton *et al.* 1994, and Figure 1.4):

Stage I: Gonad immature, white or translucent;
Stage II: Gonad maturing, light yellow/orange, not extending into hepatic region;
Stage III: Gonad maturing, yellow/orange, not extending into hepatic region;
Stage IV: Gonad mature, dark yellow/orange, extending into hepatic region; and
Stage V: Ovigerous, female bearing fully matured eggs (pale to dark yellow/grey), carried externally.

Stage IV of ovarian development was observed in late October to November in conjunction with rising seawater temperatures (Kumar *et al.* 2000). In samples collected during November, 80% of crabs were Stage III or Stage IV, of which more than 40% were in advanced Stage IV.

In tropical waters, female blue swimmer crabs carry eggs throughout the year, however, seasonal variation in the number of egg-bearing females can be observed (Kumar *et al.* 2000). During embryonic development (Stage V), the colour of the eggs changes from yellow to a dark grey (Figure 1.4).

In South Australia, egg-bearing females are observed throughout the year but peak in late spring. Commercial logbook data from July 1997 to June 2005 indicate that high proportions of berried females appear in the catch in October in Gulf St Vincent and November in Spencer Gulf (Figure 1.5). This pattern was consistent between years.

Fecundity is calculated as the number of eggs carried externally by the female. Kumar *et al.* (2003) found that the fecundity of female crabs was size-dependent, increasing up to a carapace width of 134 mm and decreasing thereafter. Fecundity increased by 83.9% from 105 mm to 125 mm, implying that a single large female could produce as many eggs as two small females. Kumar *et al.* (2000) found that a female blue crab can produce between 650,000 to 1,760,000 eggs per spawning.

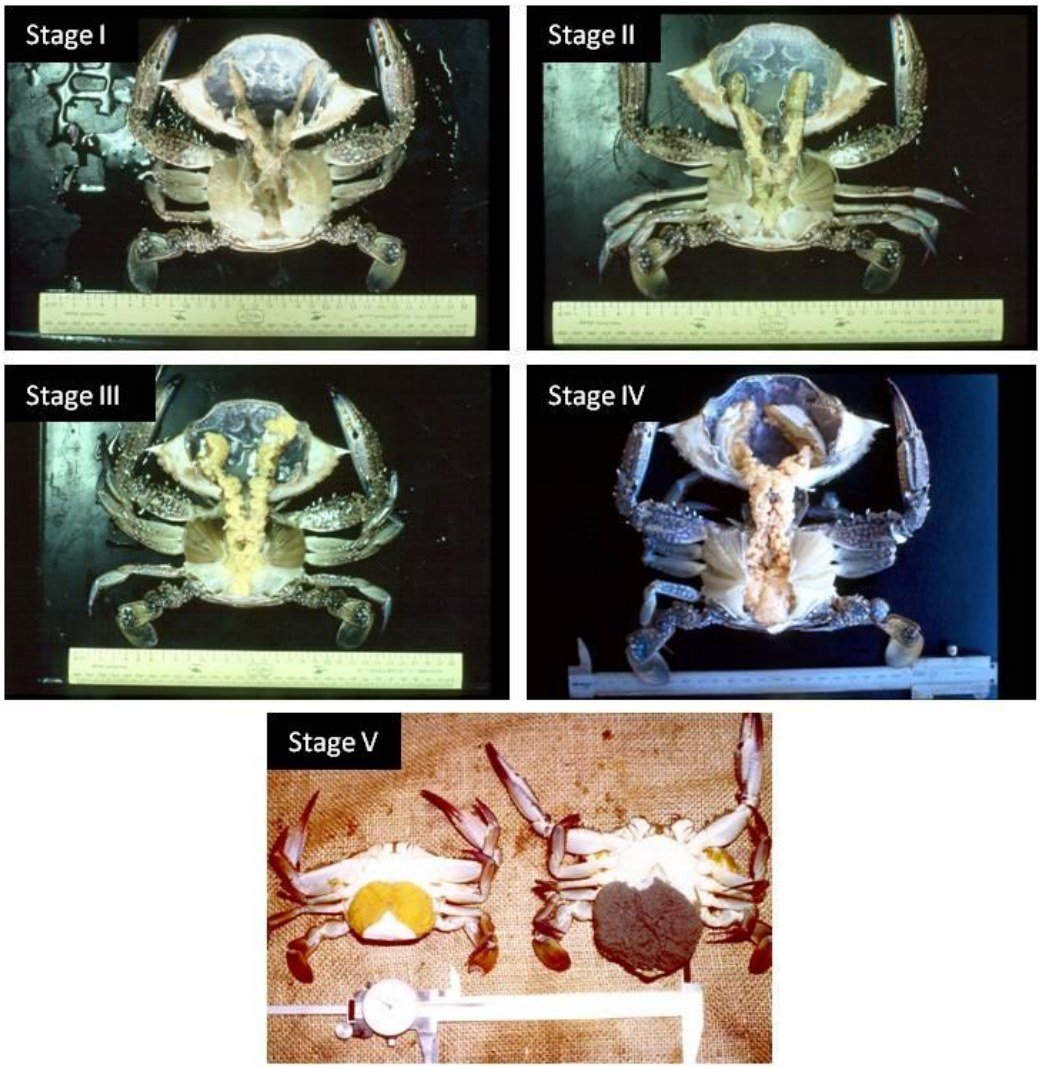


Figure 1.4. The five ovarian stages of the blue swimmer crab (from Kumar *et al.* 2000).

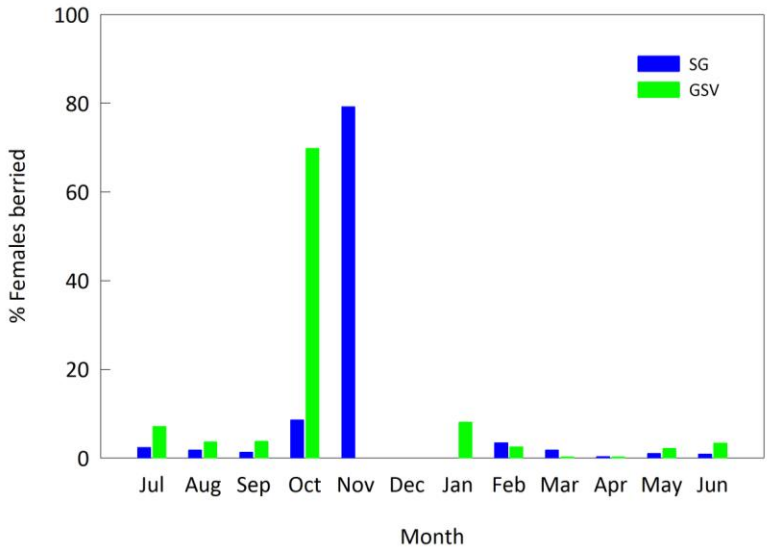


Figure 1.5. Monthly mean percentage of berried female blue crabs in commercial catches from each gulf from 1997/98 to 2004/05.

Portunus armatus can spawn more than one batch of eggs in a season. Eight to ten days after spawning the first batch of eggs, the female may ovulate and fertilise a second batch (Meagher, 1971). On examination of berried females, some carried developing oocytes at Stages II and III in the ovary while also carrying an external egg mass (Kumar *et al.* 2003). Although blue crabs are capable of producing more than one batch of eggs in a season, successive ovulations do not always occur (Meagher, 1971).

1.4.4. Length-weight relationship

The relationships between carapace width (mm) and weight (g) for male and female blue crabs from Spencer Gulf and Gulf St Vincent were determined for a sample of 582 individuals of size range 52-149 mm (SARDI unpublished data 2009) and was described by the power curve: weight = $a \times$ carapace width^b. The length to weight relationship differed between the sexes but was consistent among gulfs (Figure 1.6). In each gulf, male blue crabs grew to a larger total weight for a given carapace width.

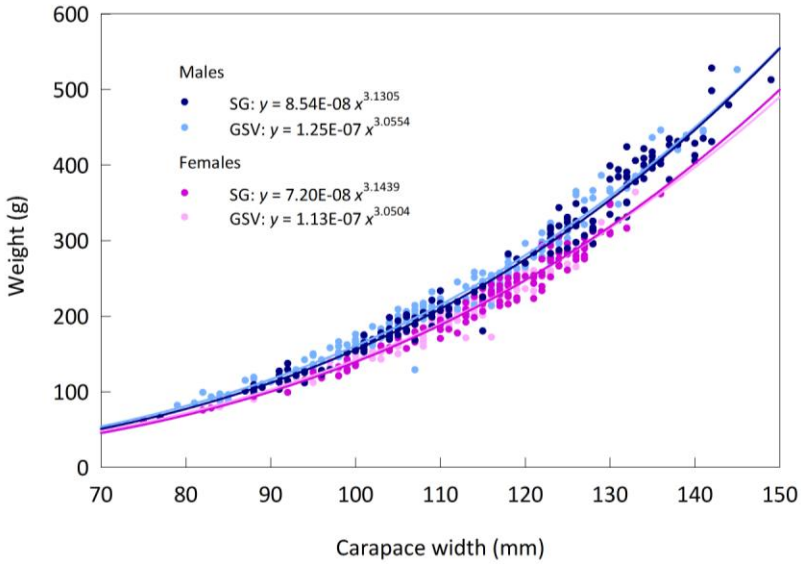


Figure 1.6. Length-weight relationships of male and female blue crabs from Spencer Gulf and Gulf St Vincent.

1.4.5. Parasites

The parasites of some decapod crustaceans are known to cause sterilisation of their host, and can therefore have an important impact on the population of infested species (Gaddes and Sumpton 2004). The barnacle, *Sacculina granifera,* is a known parasitic castrator of *P. armatus*, and can have a marked effect on gonad development and growth in Australian populations (Shields and Wood 1993). Levels of parasitism in South Australian blue crab populations have yet to be examined.

2. METHODS

2.1. Overview

The assessment of the BCF is based on three different information sources: 1) fishery-independent survey data; 2) fishery-dependent commercial logbook data; and 3) fishery-dependent pot-sampling data. This fishery assessment report updates the 2010/11 report, providing an assessment of the current status of the BCF up to July 2012 for Spencer Gulf and October 2012 for Gulf St Vincent.

Fishery-independent surveys are considered the most reliable source of information for assessment due to the relatively consistent timing of the survey (i.e. during winter), the standardised sampling approach in terms of pot type and location (which avoids some of the biases associated with targeted fishing of commercial operations), and their representativeness of crab populations in each gulf. They provide a snapshot of the catch per unit effort (CPUE) as an index of biomass across the full extent of the fishery at the end/beginning of the quota season (June/July).

Two of the three key biological performance indicators are determined from surveys: 1) survey CPUE of pre-recruits (pre-recruits/pot lift); and 2) survey CPUE of legal-size crabs (legal-size crabs/pot lift). The primary uncertainty in the interpretation of survey CPUE of pre-recruits results from differences in the timing of surveys relative to the timing of peak recruitment to the fishery. Other uncertainties may include the operation of some licences by different fishers between and within years and extrinsic factors such as weather and water temperature.

Commercial logbook data provide useful measures of relative abundance of both legal-size and pre-recruit crabs, as well as information on the sex ratio of the catch. The commercial CPUE of legal-size crabs (kg/pot lift) is the third key biological performance indicator. The main uncertainty associated with logbook data regards the interpretation of commercial CPUE data which may be influenced by changes in fisher demographics and experience, temporal and regional shifts in the distribution of catch and effort, changes in the frequency of second pot lifts, differences in gear types and vessel technology, selectivity of commercial pots, and crab behaviour (i.e. catchability).

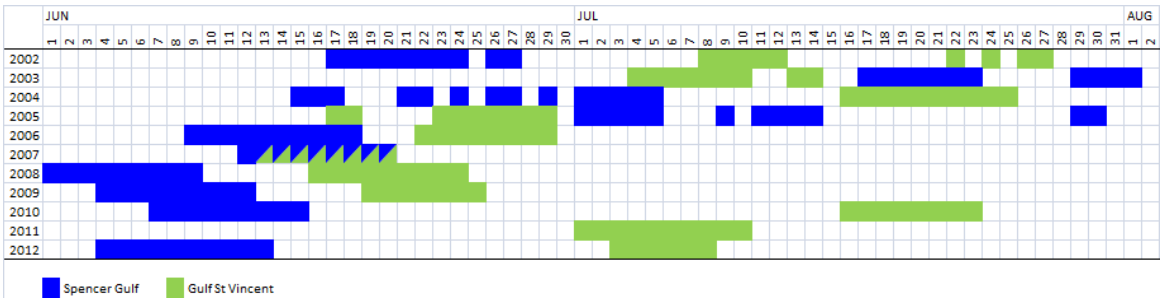
The fishery-dependent pot-sampling program began in 2006 and involves the recording of catch data from one small-mesh pot (i.e. smaller escape gaps) each fishing day. This provides useful supplementary information on the relative abundance of pre-recruits and the sex ratio of the population. The pot-sampling program avoids the biases associated with commercial large-mesh pots, however, the current frequency of sampling is considered low, especially since there are only a few operators in the fishery.

The assessment of the fishery presented in this report is based on measures of relative abundance of legal size and pre-recruit crabs from these three sources in a hierarchical manner, with particular attention given to the performance indicators and reference points specified in the Management Plan. Data are analysed and presented for each gulf separately using the same methods presented in the remainder of this section.

2.2. Fishery-independent survey data

Fishery-independent surveys for the BCF have been conducted during June/July on an annual basis since 2002 (Table 2.1). The primary aim of fishery-independent surveys is to determine measures of relative abundance and size composition of blue crabs in Spencer Gulf and Gulf St Vincent during winter, when juvenile crabs generally recruit to the fishery. This also coincides with the end/beginning of the quota season.

Table 2.1. Dates on which fishery-independent surveys were conducted in Spencer Gulf and Gulf St Vincent from 2002 to 2012.



Although fishery-independent surveys in both gulfs have been consistently undertaken during the winter months of June/July, there has been some variability during these periods (Table 2.1). In Spencer Gulf, most fishery-independent surveys were conducted in June and early July, except for 2003, when the survey was conducted in late July to early August, and 2005, when the survey was extended throughout July. In Gulf St Vincent, fishery-independent surveys were conducted in July from 2002 to 2004, in June from 2005 to 2010, and then returned to July thereafter.

In accordance with the Management Plan, in the event that the 10-year average survey CPUE of pre-recruits is exceeded for either gulf, PIRSA Fisheries and Aquaculture and the South Australian Blue Crab Pot Fishers' Association (SABCPFA) may consider omitting the survey in that gulf the following year. As a result of high CPUE of legal-size and pre-recruit crabs in Spencer Gulf recorded in the 2010 survey, the decision was made to not conduct a survey in 2011.

The area of fishery-independent surveys encompasses waters with depths ranging from 3 to 22 m northwards of a line from Wallaroo to Cowell in Spencer Gulf and northwards of line from Glenelg to

Port Vincent in Gulf St Vincent (Figure 2.1). Sampling sites were determined based on fisher knowledge and historical catch and effort data. From these recommendations, four sites were selected in each fishing block to be surveyed.

Fewer pot lifts were done during 2002 than in subsequent years. Prior to the 2008 survey, the location of survey sites was modified by SARDI, PIRSA and industry to provide a more accurate representation of the blue crab abundance in each gulf. These changes included: removal of all sites from some fishing blocks, addition of new sites within previously unsurveyed fishing blocks, and movement of sites within fishing blocks. A summary of the changes to survey sites for Spencer Gulf and Gulf St Vincent is provided in Figure 2.1.

Survey CPUE, calculated as the number of legal-size crabs/pot lift or pre-recruits/pot lift (small-mesh pots only) for each survey, is used as a measure of relative abundance. Unless stated otherwise, survey CPUE data presented in this report refer to sites that have not changed since 2002 (i.e. 'standardised pot lifts').

At each site, both commercial crab pots (Figure 2.2) and small-mesh pots (Figure 2.3) were set and hauled on a daily basis, except for Gulf St Vincent, where only small-mesh pots were used for the 2012 survey. Commercial pots have a diameter of 1.2-1.4 m, a height of 50 cm, and are covered with a 90-mm mesh. Small-mesh pots, designed specifically for fishery-independent surveys, have a diameter of 1.4 m, a height of 50 cm, and a mesh size of 55 mm. At each survey site, five sets of gear were deployed along a line, each set comprising one commercial pot (except for Gulf St Vincent in 2012) and one small-mesh pot. Each set of gear was spaced 150 m apart and, where both pot types were used, each pot was separated by 40 m of rope. Pots were baited with fresh Australian salmon, sardines or striped trumpeter, and were hauled from dawn each day.

A global positioning system (GPS) was used to locate the gear, and depth was recorded for each site. Blue crabs were measured for carapace width (mm) using Vernier calipers, and details of sex (male or female) and condition (dead, soft, berried) were recorded. Data on by-catch species were collected during the survey, however, these are not presented in this report. An assessment of by-catch data from 2002 to 2006 was presented in Currie *et al.* (2007).

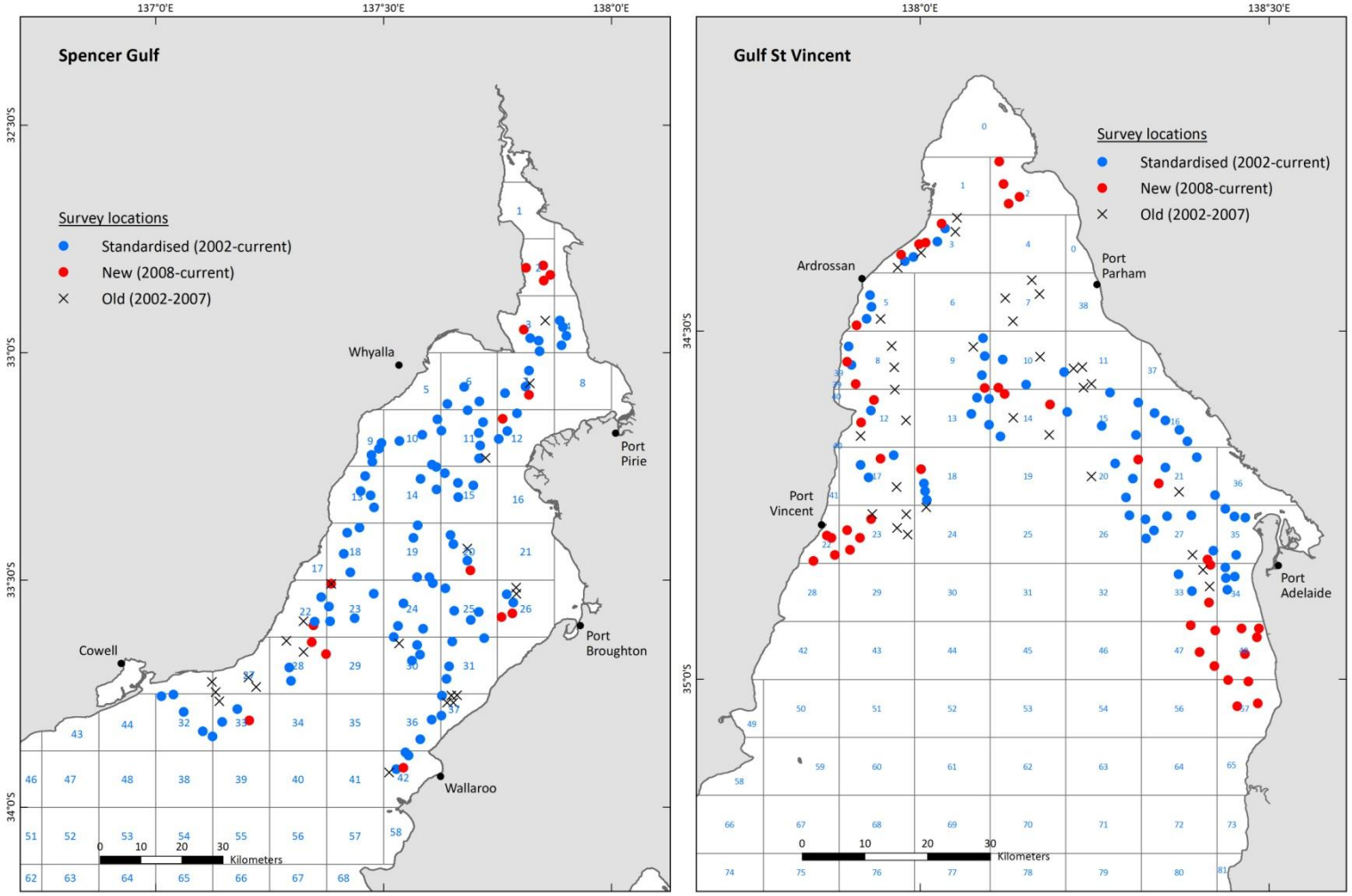


Figure 2.1. Commercial fishing blocks (squares) and survey locations in Spencer Gulf and Gulf St Vincent of the Blue Crab Fishery.

Figure 2.2. Commercial crab pot (mesh size of 90 mm).

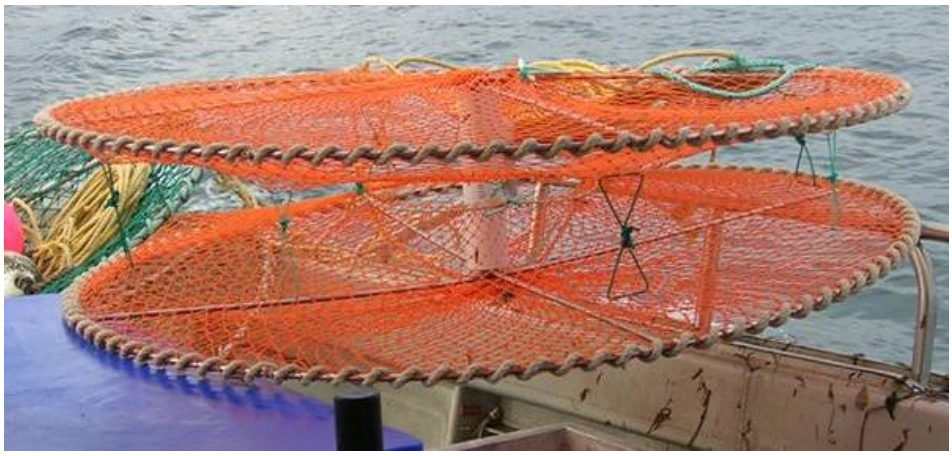


Figure 2.3. Small-mesh crab pot used for surveys (mesh size of 55 mm).

2.3. Fishery-dependent data

2.3.1. Commercial logbooks

SARDI maintains a comprehensive catch and effort database for the BCF using data from the compulsory fishing logbook system. Each gulf is divided into a series of fishing blocks. Data recorded in commercial logbooks by licensed fishers include fishing block, depth, catch, effort, sex and number of crabs. Additional data recorded in logbooks include information on second pot lifts where pot fishers may lift and reset their gear twice in the one day. Under these circumstances, soak time for the first pot lift is generally 18–20 hours and 4–6 hours for the second pot lift. Logbooks also provide for recording the numbers of undersized crabs (pre-recruits) and berried females. These data were first collated for the 1996/97 fishing season. Historical data from the fishery were recorded into the 'GARFIS' catch and effort database of the South Australian Fisheries Department from 1983/84.

Commercial logbook data on total catch and effort include Spencer Gulf and Gulf St Vincent pot fishing sectors and the marine scalefish sector. Currently, the number of MSF participants precludes independent, non-confidential assessment of the data and thus MSF catch and effort are presented only in the Fishery Overview (Section 3) of this report. Detailed analyses on the Spencer Gulf and Gulf St Vincent pot fishing sectors since the introduction of quota (1996/97) are provided in Sections 4 and 5, respectively.

Spatial distribution of the annual catch includes examination of the number of blocks fished and the magnitude of catches within those blocks. When considering the spatial distribution of the catch in cases where pots were set over more than one fishing block, an equal distribution of catch between blocks was assumed for the analysis.

For analyses and presentation of commercial logbook data throughout this report, effort data (and calculated CPUE) is expressed in boat days or pot lifts. Catch, effort and CPUE data are presented at annual and monthly scales, and as a series of maps showing the distribution of catch and CPUE. As juvenile crabs generally recruit to the fishery each year during winter, the CPUE of pre-recruits is determined from commercial pot lifts during June and July each year to provide a recruitment index to supplement the more reliable survey CPUE measure.

Information on sex ratio was obtained from the daily catch weight by sex where provided. When calculating monthly and annual catches of each sex, several assumptions were necessary to deal with missing data:

1. When male catch weight was not provided (but female was) or male + female weight did not sum to the total, estimates of female weight and total weight were assumed correct;
2. When neither male nor female catch weight was provided (but total was), two scenarios were determined: 1) assume that all catch was male (minimum % female) and 2) assume that days of missing data comprised the same percentage of females as other days for that month where female data were available; and
3. When calculating monthly catches, where neither male nor female catch weight was provided (but total was) for that entire month, the proportion of females in the catch was assumed from other comparable data.

2.3.2. Pot-sampling

The pot-sampling program collects CPUE data on pre-recruits (pre-recruits/pot lift) from small-mesh pots and size composition of blue crabs throughout the fishing season to inform on recruitment strength and sex ratio.

Pot-sampling data have been collected since May 2006 in Spencer Gulf and since July 2006 in Gulf St Vincent. Sampling was voluntarily undertaken from one small-mesh pot (or up to two small-mesh pots since 2010/11) and one commercial pot each fishing day. Since May 2008, data have been collected from small-mesh pots only in each gulf. Data collected in the pot-sampling program include date, licence number, fishing block, GPS coordinates of pot locations, depth, water temperature, and the sex and size of individual crabs. All results of the pot-sampling program are presented by calendar year (only from 2008 onwards) to ensure that pre-recruits sampled in June/July in any one year are examined together, thus providing a consistent and informative analysis of seasonal trends.

3. FISHERY OVERVIEW

3.1. Total catch and effort

Catches of blue crabs were first recorded in 1983/84, when 26.9 t of crabs were harvested over a total of 530 boat days (Figure 3.1), most of which was harvested by the MSF. Over the following twelve years catches progressively increased, particularly for the Spencer Gulf and Gulf St Vincent pot fishing sectors of the BCF, reaching a historical high of 651.3 t in 1995/96. The introduction of quota in the following season resulted in a 29% reduction in total catch to 462.4 t. The total catch generally increased up to 2007/08 when the entire TACC was caught, but has remained below the TACC since that time.

Over the past twelve years the TACC has been set at 626.8 t. The total catch during 2011/12 was 611.25 t (97.5% of the TACC), with almost all this catch harvested by the Spencer Gulf and Gulf St Vincent pot fishing sectors (i.e. >99%). Prior to the introduction of quota, trends in effort generally followed trends in commercial catch, reaching a historical high of 3,419 boat days in 1995/96. The introduction of quota during 1996/97 saw effort drop to 2,213 boat days, but later increasing to a post-TACC maximum of 2,458 boat days in 1999/00. Since then, effort has decreased, with the 1,150 days fished during 2011/12 being less than half that expended during 1999/00. This decline in effort was attributed mostly to the transfer of quota from the MSF to the pot fishing sectors of the BCF and the introduction of multiple pot lifts per day.

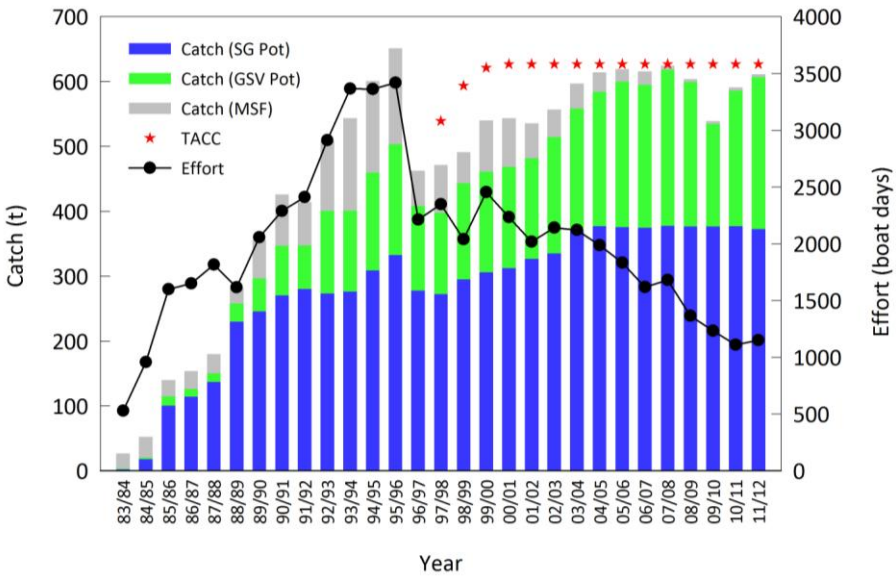


Figure 3.1. Commercial catch (t), effort (boat days) and TACC (t) for the Blue Crab Fishery (including the Spencer Gulf and Gulf St Vincent pot fishing sectors, and the Marine Scalefish Fishery) from 1983/84 to 2011/12.

4. SPENCER GULF POT FISHING SECTOR

4.1. Fishery-independent surveys

4.1.1. Relative abundance of legal-size crabs

Relative abundance of legal-size crabs has increased substantially over time, with survey CPUE since 2009 being almost twice that observed in 2005 (Figure 4.1). The survey CPUE of legal-size crabs in 2012 was the highest recorded (9.3 legal-size crabs/pot lift).

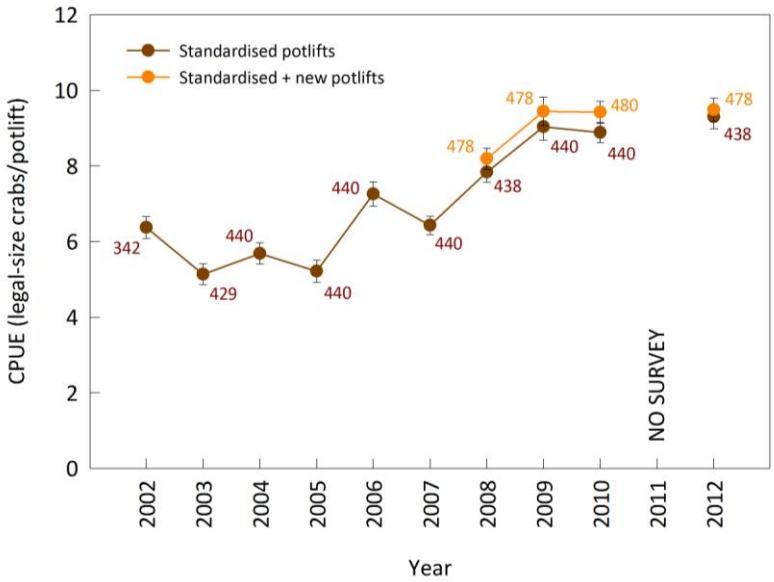


Figure 4.1. Mean (±SE) survey CPUE of legal-size crabs (legal-size crabs/pot lift) for standardised pot lifts (2002-current) and standardised + new pot lifts (2008-current) in Spencer Gulf during June/July from 2002 to 2012. Labels indicate the number of pot lifts.

4.1.2. Relative abundance of pre-recruits

Relative abundance of pre-recruits was highly variable between 2002 and 2012 (Figure 4.2). The survey CPUE for pre-recruits generally declined from 2002 (6.9 pre-recruits/pot lift) to 2005 (2.3 pre-recruits/pot lift), and then increased sharply to its highest level in 2007 (10.1 pre-recruits/pot lift) before consecutive declines in 2008 and 2009 (to 3.0 pre-recruits/pot lift). More recently, survey CPUE was relatively high in 2010 and 2012 (range: 7.9-8.7 pre-recruits/pot lift) (no survey was conducted for Spencer Gulf in 2011).

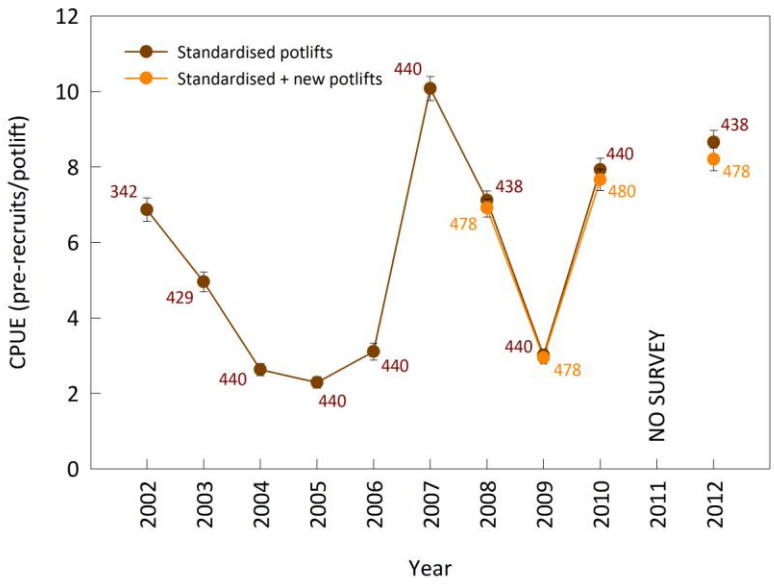


Figure 4.2. Mean (±SE) survey CPUE of pre-recruits (pre-recruits/pot lift) for standardised pot lifts (2002-current) and standardised + new pot lifts (2008-current) in Spencer Gulf during June/July from 2002 to 2012. Labels indicate the number of pot lifts.

4.1.3. Spatial distribution of legal-size crabs

Legal-size crabs were broadly distributed throughout the surveyed region in most years (Figure 4.3). A very high survey CPUE (>10 legal-size crabs/pot lift) was observed most consistently in block 3 in upper Spencer Gulf (in 9 of 10 years), and sporadically in several other blocks throughout the survey period (blocks 4, 7, 11, 12, 14, 15, 18, 23, 24, 26, 28, 30, 31, 36 and 42). In 2012, very high survey CPUE of pre-recruits was observed in the south-eastern blocks 30, 36 and 42 for the first time. Survey CPUE for legal-size crabs was low (<2 legal-size crabs/pot lift) on the western shoreline in blocks 9, 13, 22 and 33. There appeared to be a shift in the distribution of legal-size crabs in recent years, with high survey CPUE levels occurring in an increasing number of blocks between Port Broughton and Wallaroo (blocks 25, 26, 30, 31, 36 and 42).

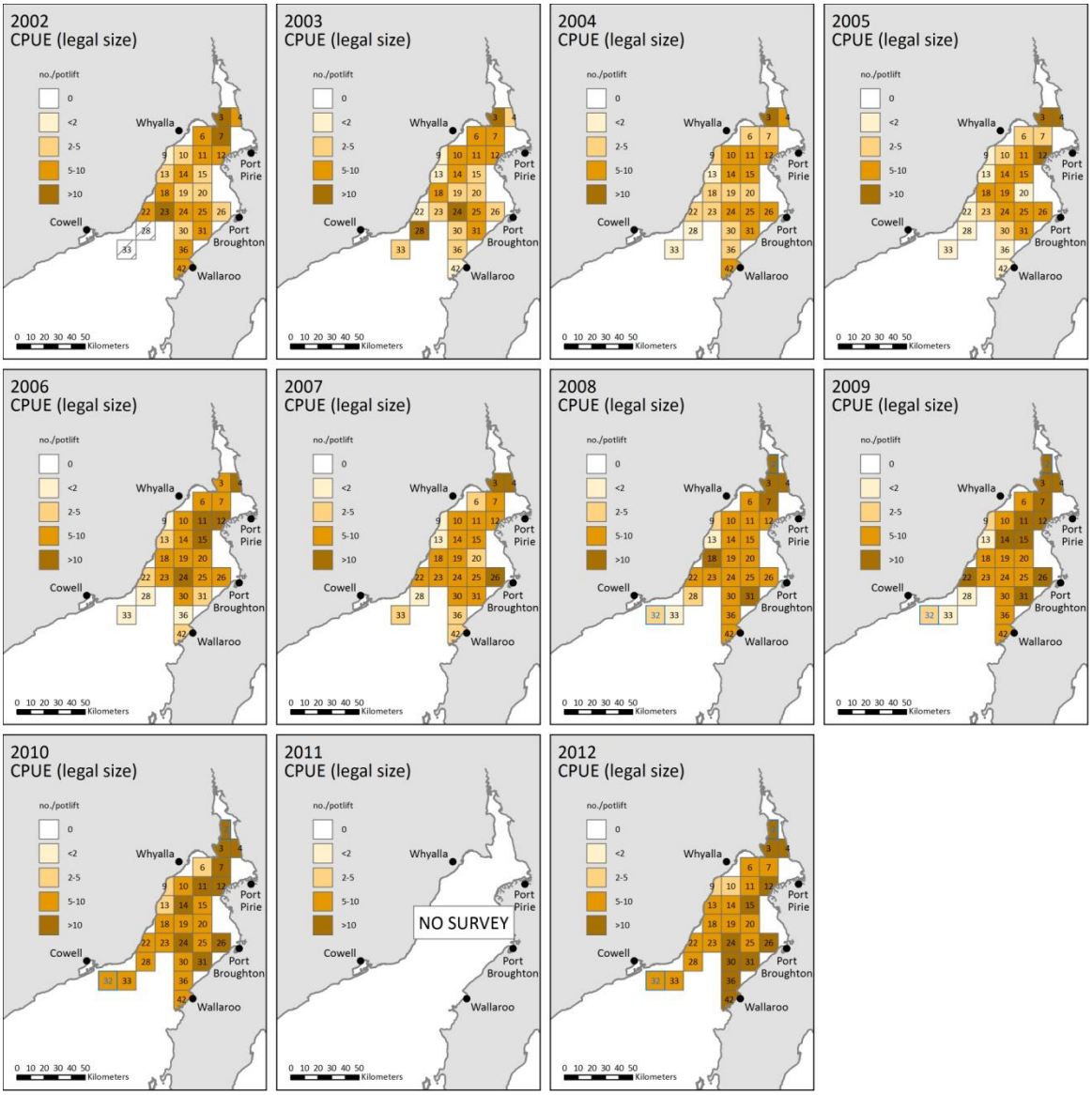


Figure 4.3. Spatial distribution of survey CPUE of legal-size crabs (legal-size crabs/pot lift) from standardised pot lifts in Spencer Gulf during June/July from 2002 to 2012. Note: 2008 to 2012 maps include new blocks surveyed (2 and 32).

4.1.4. Spatial distribution of pre-recruits

Relative abundance of pre-recruits varied substantially among blocks and between years (Figure 4.4). Nevertheless, pre-recruits were broadly distributed throughout the surveyed region and there was a general trend of decreasing CPUE from north to south during most years with the exception of 2010, when the survey CPUE of pre-recruits was highest in several southern blocks, and 2012 when CPUE of pre-recruits was highest on the eastern side of Spencer Gulf in central and southern blocks.

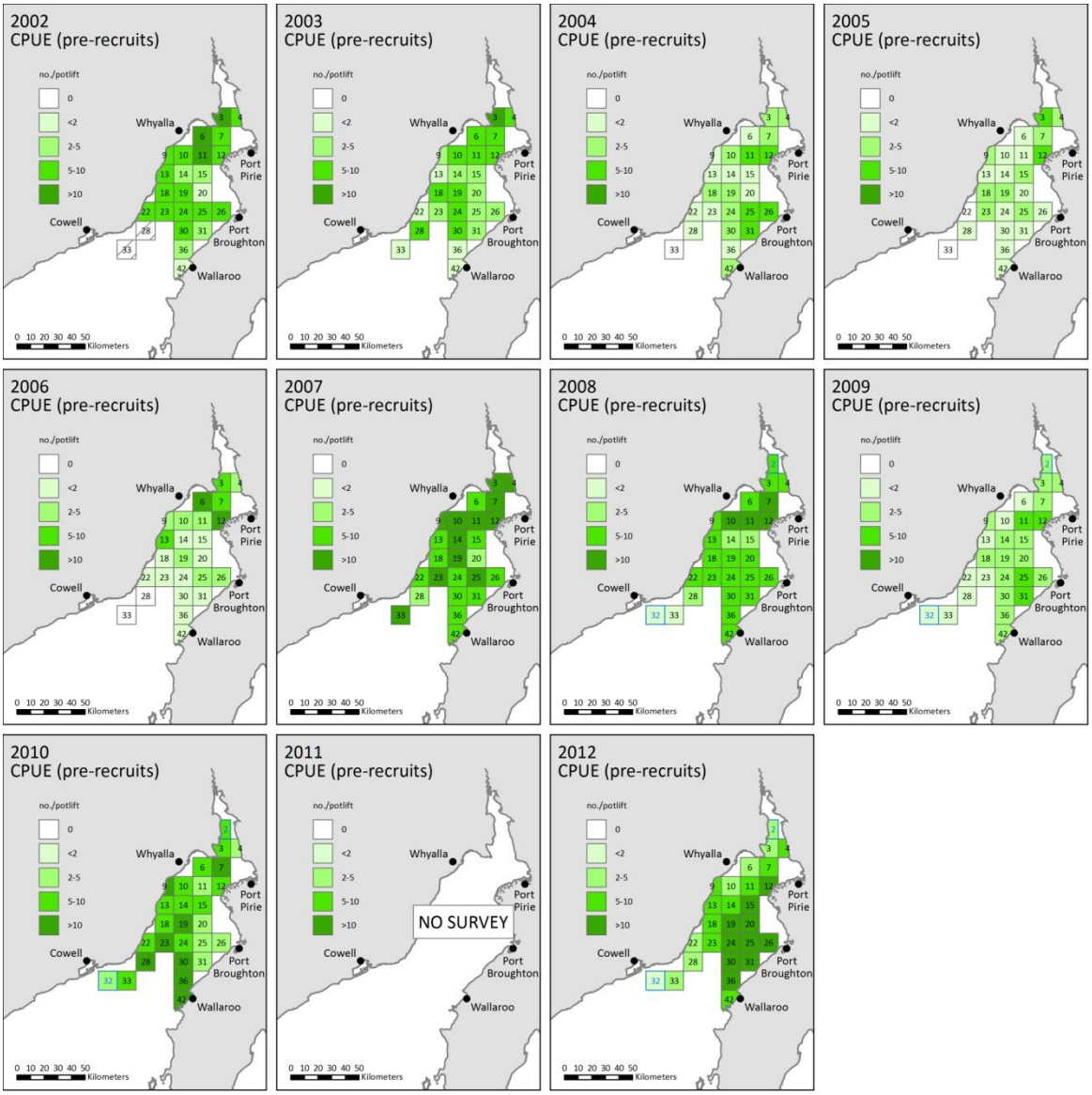


Figure 4.4. Spatial distribution of survey CPUE of pre-recruits (pre-recruits/pot lift) from standardised pot lifts in Spencer Gulf during June/July from 2002 to 2012. Note: 2008 to 2012 maps include new blocks surveyed (2 and 32).

4.1.5. Crab size

The size distribution of the surveyed population varied substantially among years (Figure 4.5). The modal size of crabs was 100–109 mm carapace width (undersize, or pre-recruits) in 2002 and 2007, 110–119 mm (legal-size crabs) in 2003, 2004, 2008, 2009 and 2012, and 120–129 mm in 2005, 2006 and 2010. During 2006, there was also a relatively high abundance of very small pre-recruits (<79 mm), with an apparent bi-modal distribution suggesting a large recruitment event. Further evidence of this recruitment was apparent in the following year, with high proportions of the 2007 sample at 90–109 mm, including the size mode at 100-109 mm. The size structure in 2012 was very similar to 2008. Overall, there is a good representation of all size classes across the years.

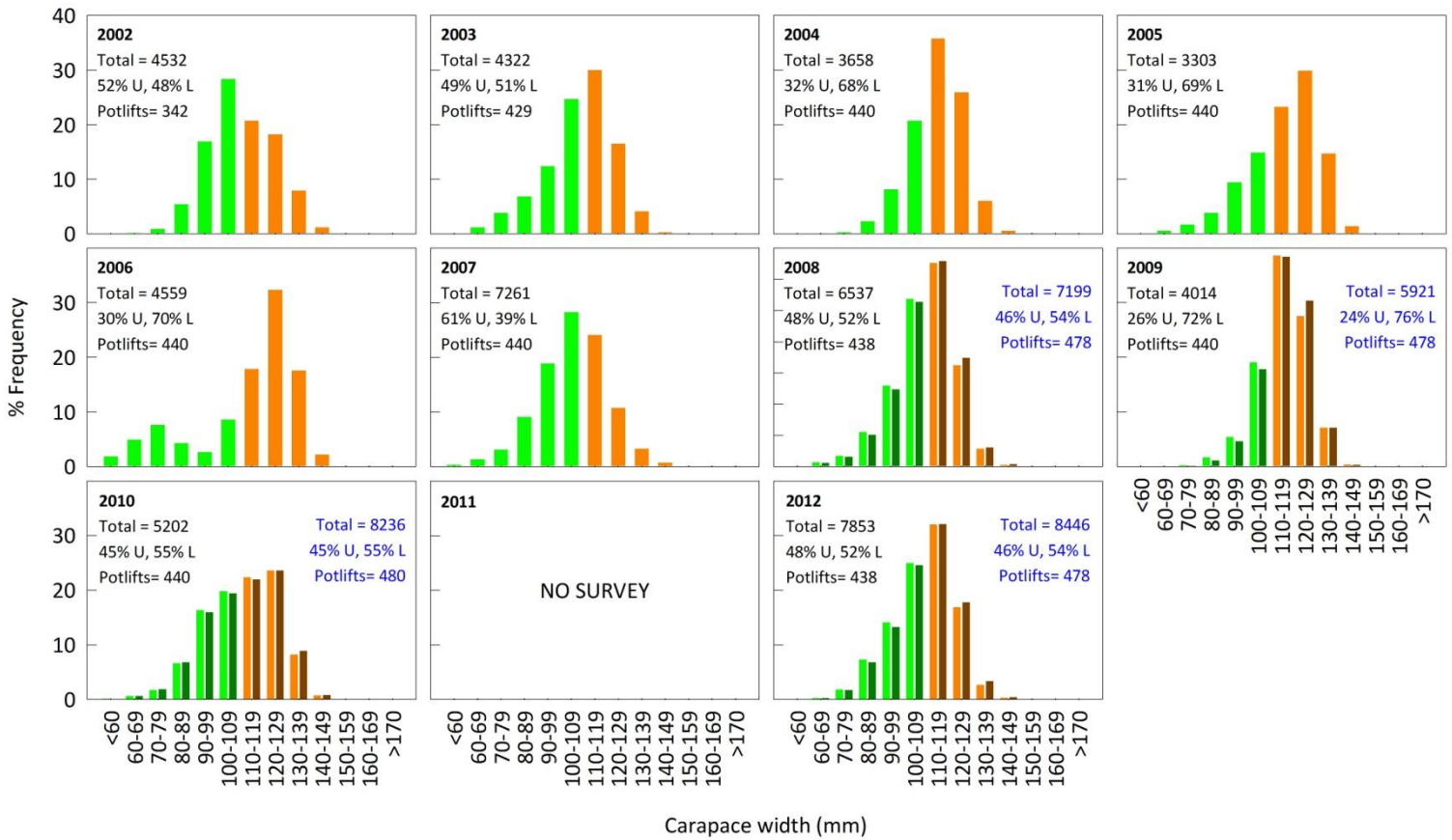


Figure 4.5. Size-frequency distribution of crabs caught during fishery-independent surveys conducted in Spencer Gulf during June/July from 2002 to 2012. Green and orange bars represent pre-recruits and legal-size crabs, respectively, caught using standardised pot lifts (2002-current), while darker bars (and blue text) represent those caught using standardised + new pot lifts (2008-current).

4.2. Commercial logbook data

4.2.1. Catch and effort

4.2.1.1. Annual trends

The Spencer Gulf pot fishing sector held 377 t (60%) of the 626.8 t TACC for 2011/12 (source: PIRSA Fisheries and Aquaculture), most of which (372.7 t, 99%) was landed. Catch from this sector has been stable since 2003/04 at a level ~38% higher than 1997/98 (272.4 t, Figure 4.6).

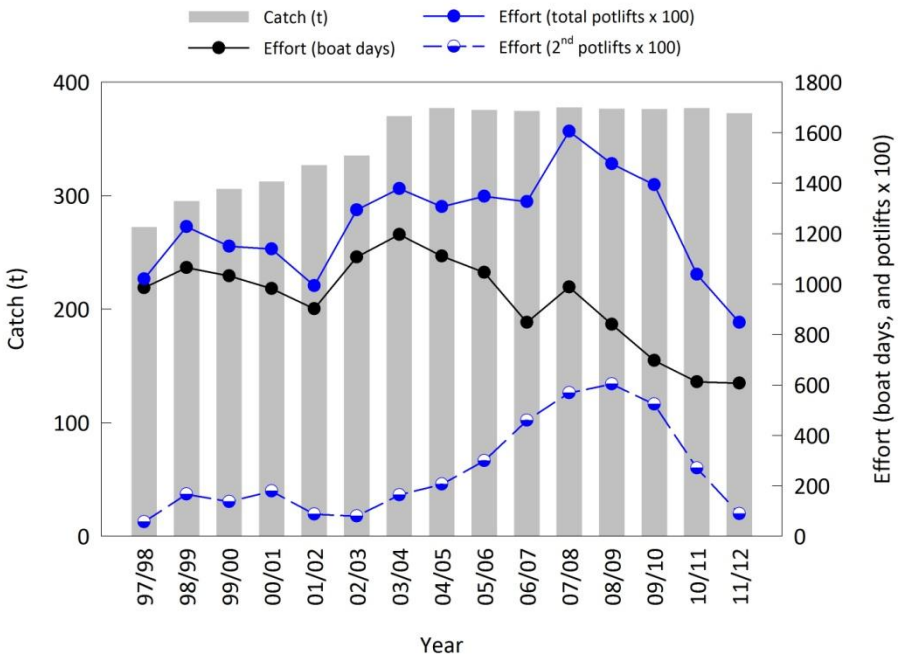


Figure 4.6. Total catch (t) and effort (in boat days, total pot lifts and second pot lifts) for the Spencer Gulf pot fishing sector from 1997/98 to 2011/12.

Following the introduction of quota in 1996/97, the number of boat days remained relatively constant over the 5-year period 1997/98 to 2001/02 with an average of 993 days fished (Figure 4.6). Boat days increased in 2002/03 and 2003/04 after a new licence was issued in February 2002, and have declined since (with the exception of 2007/08). In 2011/12, the number of boat days (607 boat days) was slightly less than the previous historic low of 2010/11 (612 boat days) following the introduction of quota.

The number of total pot lifts was relatively constant from 2002/03 to 2006/07, increased sharply in 2007/08 to 160,555 pot lifts (the highest recorded) and then reduced substantially over the next four seasons. In 2011/12, total pot lift effort (84,756 pot lifts) was 18% lower than the previous season, was the lowest level recorded and was almost half the number of total pot lifts in 2007/08.

The number of second pot lifts was at a low level (<18,000 pot lifts) from 1997/98 to 2003/04, increased substantially until 2008/09 (at 60,398 pot lifts) and has declined thereafter, returning to a low level in 2011/12. The number of second pot lifts in 2011/12 (8,983 pot lifts) was only one-third of those in the previous year (2010/11: 27,118 pot lifts). Relative to total number of pot lifts, the proportion of second pot lifts decreased from 38% to 11% in 2009/10 and 2011/12, respectively.

4.2.1.2. Spatial distribution of the annual catch

Following the introduction of quota in 1996/97, the number of blocks fished in Spencer Gulf was low for the 4-year period 1997/98 to 2000/01 (≤20 blocks) (Figure 4.7). Since 2001/02, the total number of blocks fished increased and generally ranged between 27 and 33 (2007/08 was exceptionally high at 39 blocks fished). Most of this increase and variation in number of blocks fished is attributed to the number of blocks with low total catches (<5 t), as the number of blocks with moderate (5-20 t) and high (>20 t) total catches have been relatively stable. These trends in total number of blocks fished and blocks with catches of less than 5 t is reflective of: 1) the overall increase in quota harvested by the Spencer Gulf pot fishing sector; and 2) the exploratory patterns of fishing new areas.

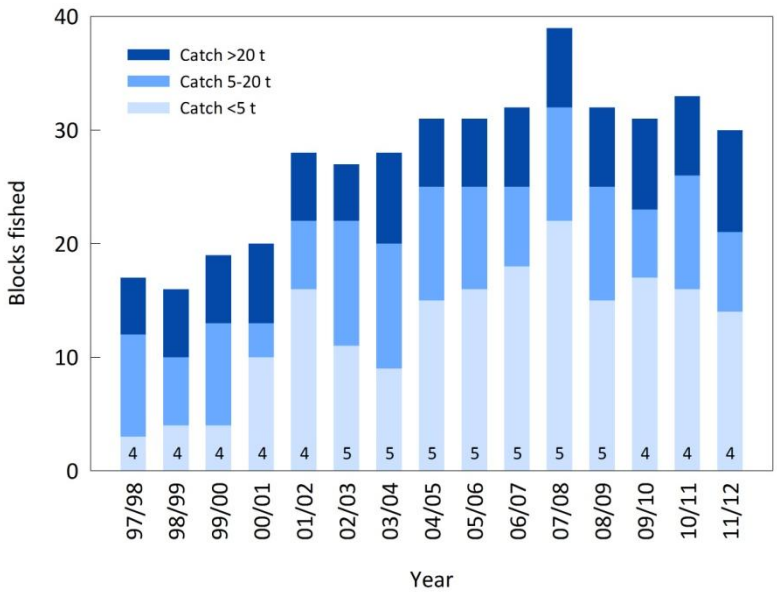


Figure 4.7. The number of blocks fished in the Spencer Gulf pot fishing sector from 1997/98 to 2011/12 with catches of <5 t, 5-20 t and >20 t. Labels indicate the number of licences fishing.

The spatial distribution of catch has varied considerably since the introduction of quota, with the exception of consistently high catches in four blocks aligned in a north-south direction in upper Spencer Gulf (blocks 2, 3, 7 and 12; Figure 4.8). Initially, catches were restricted to several blocks in upper Spencer Gulf, but over time there has been a gradual spread of catches further south. During 2011/12, the distribution of catches was similar to those of the previous four seasons (2007/08 to 2010/11).

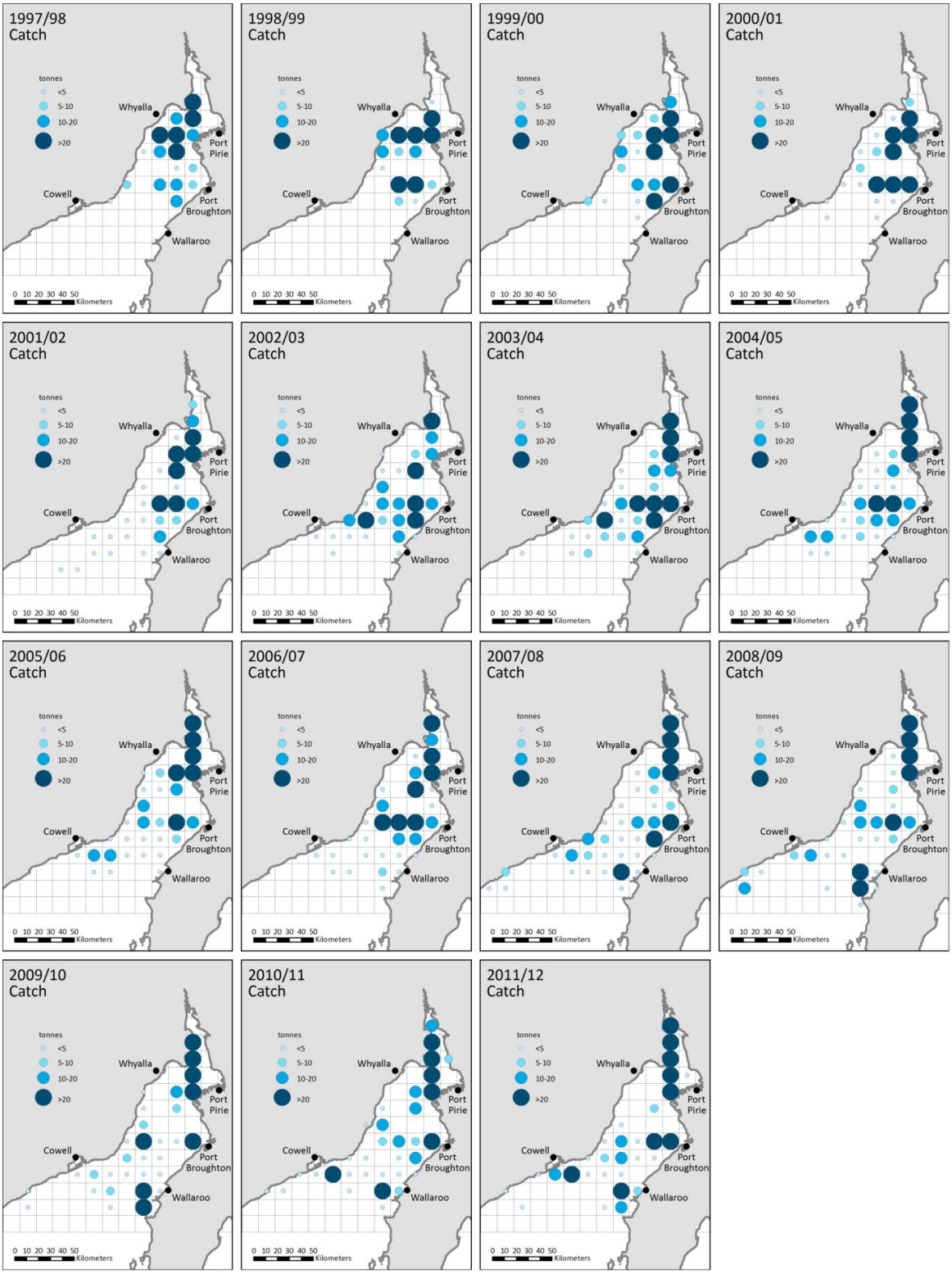


Figure 4.8. Spatial distribution of commercial catch by the Spencer Gulf pot fishing sector from 1997/98 to 2011/12.

4.2.1.3. Monthly catch and effort

Commercial pot fishing in Spencer Gulf occurs throughout the year, except for the closed season from 21 December to 19 February. Trends in monthly effort generally reflected trends in monthly catch. From 1999/2000 to 2005/06, monthly catch and effort showed similar trends among years (Figure 4.9), with catch and effort often highest in March/April and lowest in June. Since 2006/07 (and including 2011/12), there has been an apparent shift in this trend, with catch and effort generally higher between July and November (winter and spring) and lower between February and June. For 2011/12, the highest catch was recorded in November (58 t) and the lowest catch in March (20 t).

4.2.2. Catch per unit effort

4.2.2.1. Mean annual CPUE

The mean commercial CPUE for 2010/11 and 2011/12 were the highest recorded (3.75 and 4.37 kg/pot lift, respectively; Figure 4.10). These increases in CPUE are likely to at least be partly attributed to an increase in effective effort of a proportion of the fleet following substantial gear modifications in the last two seasons. Therefore, is not known the extent to which these increases in commercial CPUE reflect an actual increase in relative abundance over this period.

4.2.2.2. Spatial distribution of mean annual CPUE

The spatial distribution of commercial CPUE was highly variable among fishing blocks within years in Spencer Gulf from 1999/2000 to 2010/11, however, in 2011/12 a high CPUE (>3 kg pot lift) was recorded in 29 of the 30 blocks fished throughout the gulf (Figure 4.11). In other years, there were few consistent trends in the distribution of fishing blocks with high commercial CPUE. The lower number of blocks with high CPUE from 2007/08 to 2009/10 likely reflects the increase in number of second pot lifts during this period. The almost ubiquitous high commercial CPUE throughout Spencer Gulf during 2011/12 and, to a lesser extent 2010/11, likely reflects increases in effective effort and relative abundance (also shown in survey results) in the fishery.

4.2.2.3. Mean annual CPUE for first and second pot lifts

Mean commercial CPUE for first pot lifts was greater than that for the second pot lifts in all years except 2009/10 (Figure 4.12). Mean commercial CPUE for first pot lifts has increased substantially in the last two years, primarily due to gear modifications within the fleet.

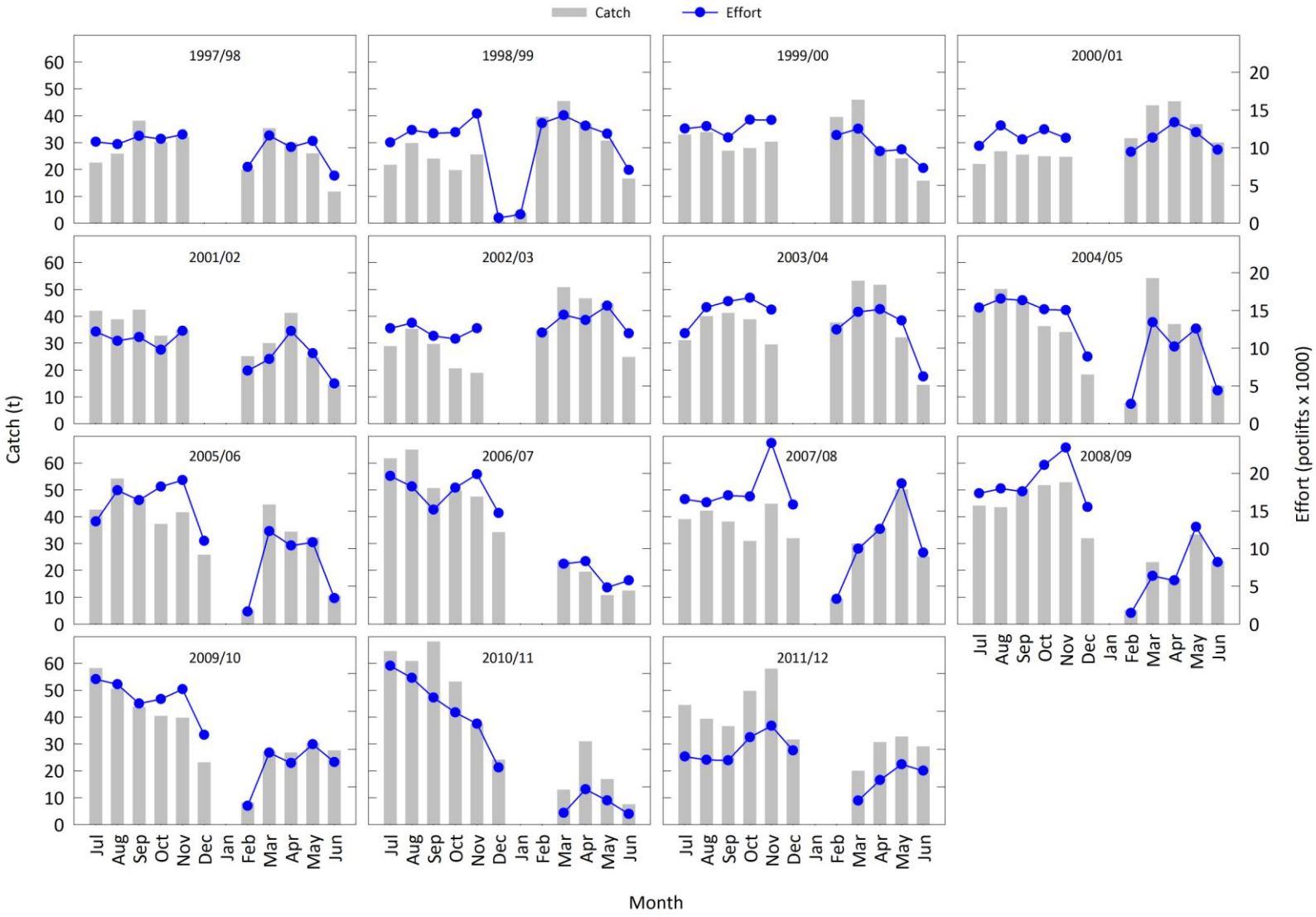


Figure 4.9. Monthly catch (t) and effort (pot lifts x 1000) for the Spencer Gulf pot fishing sector from 1997/98 to 2011/12.

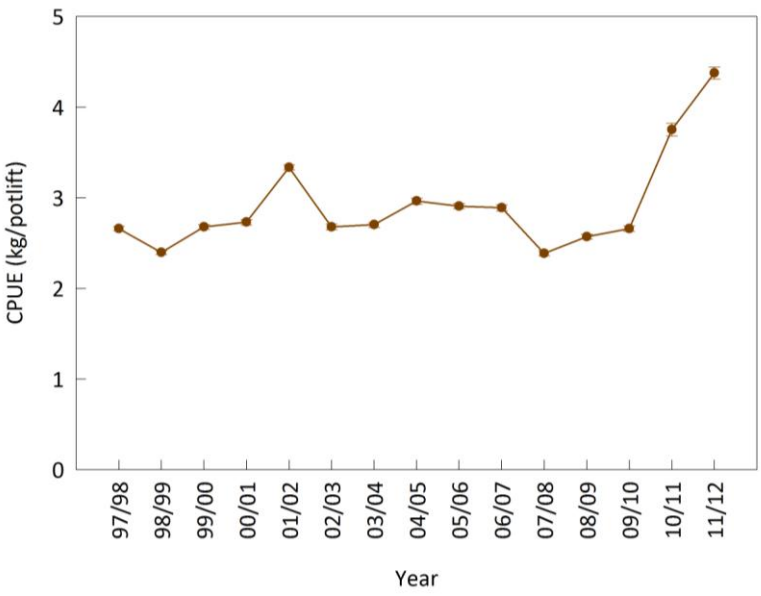


Figure 4.10. Mean (±SE) commercial CPUE (kg/pot lift) in the Spencer Gulf pot fishing sector from 1997/98 to 2011/12. Note: some error bars are obscured by the data points.

4.2.2.4. Mean monthly CPUE

Monthly patterns in commercial CPUE were highly variable in Spencer Gulf (Figure 4.13). Generally, commercial CPUE was high during the start of the quota period (July) and declined until the closure (December). In most years, CPUE increased immediately after the closure (January), was highest during February or March and then gradually declined until the end of the quota year (June). The 2009/10 season produced an unusual pattern as peak CPUE was in June. In the last two seasons, commercial CPUE has peaked in March at rates >6 kg/pot lift, the highest monthly CPUE recorded for the fishery. Again, this is partly a result of gear modifications within the fleet.

4.2.2.5. Mean daily CPUE

Mean commercial daily CPUE has increased considerably since the introduction of quota (Figure 4.14). The greatest increases have occurred since 2002/03 which coincides with an increase in number of second pot lifts and, more recently, with gear modifications of the fleet. The increase in standard errors in recent years indicates that the increases in daily catch are also more variable. The commercial daily CPUE of 614 kg/boat day in 2011/12 was the second highest recorded for the fishery (the highest being 616 kg/boat day in 2010/11).

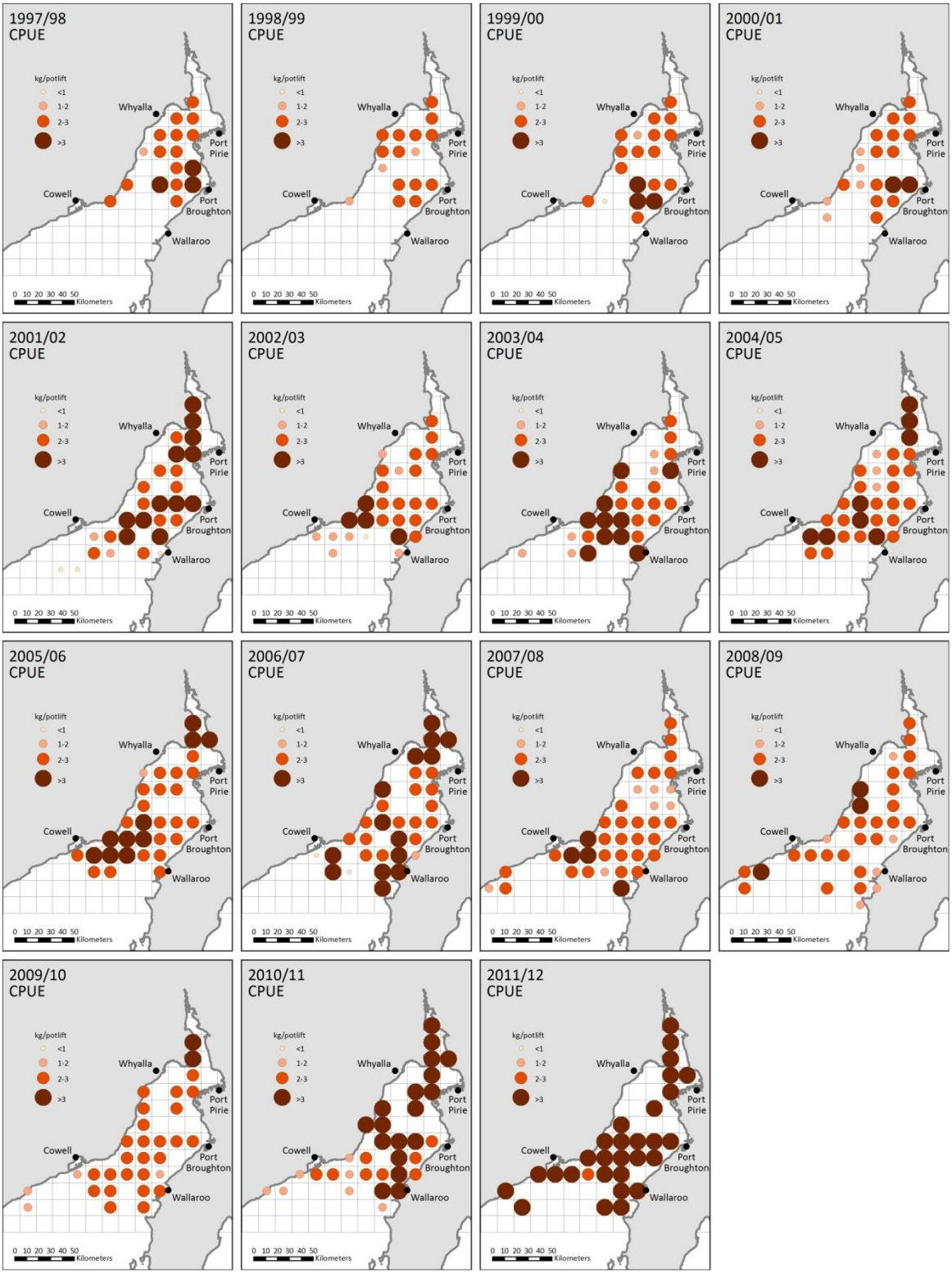


Figure 4.11. Spatial distribution of commercial CPUE for the Spencer Gulf pot fishing sector from 1997/98 to 2011/12.

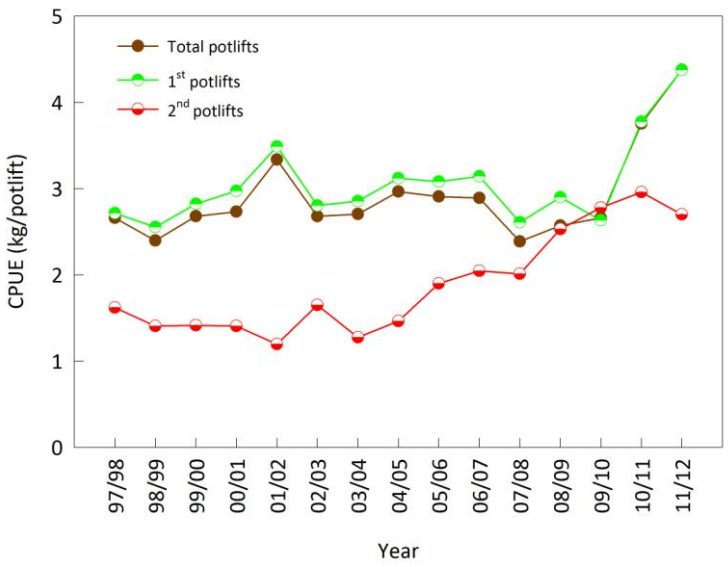


Figure 4.12. Mean commercial CPUE (kg/pot lift) in the Spencer Gulf pot fishing sector for first pot lifts, second pot lifts and total pot lifts from 1997/98 to 2011/12.

4.2.3. Pre-recruits

For June/July, the commercial CPUE of pre-recruits in Spencer Gulf was highly variable among years, ranging between 0.7 and 7.0 pre-recruits/pot lift in 2012 and 1998, respectively (Figure 4.15). The low CPUE of pre-recruits caught in commercial pots in 2012 is likely to be partly attributable to recent improvements in the size selectivity of commercial pots.

4.2.4. Sex ratio

Annual catches are predominantly comprised of male crabs by weight (Figure 4.16). Under the assumptions that missing data on sex in daily catch records were: 1) all male (lower female estimate); and 2) an equal proportion to available data for each month (upper female estimate), the percentage of female crabs in the total annual catch between 1997/98 and 2011/12 ranged from: 1) 4-18% (mean 10%); and 2) 4-38% (mean 20%). Additional data on proportion of each sex in total catch provided by one fisher indicated that females comprised 49% and 31% of their catch in 2010/11 and 2011/12, respectively. This was well above the estimated range for available logbook data in each year (12-38% and 5-10%, respectively), suggesting that the proportion of females harvested can vary considerably among fishers.

Generally, catches of female crabs were highest between July and November in Spencer Gulf (Figure 4.17). Few female crabs were retained during February, March and April in any year. Differences in proportion of females in the catch suggest that the timing of capture exerts a strong influence over the proportion of females harvested annually.

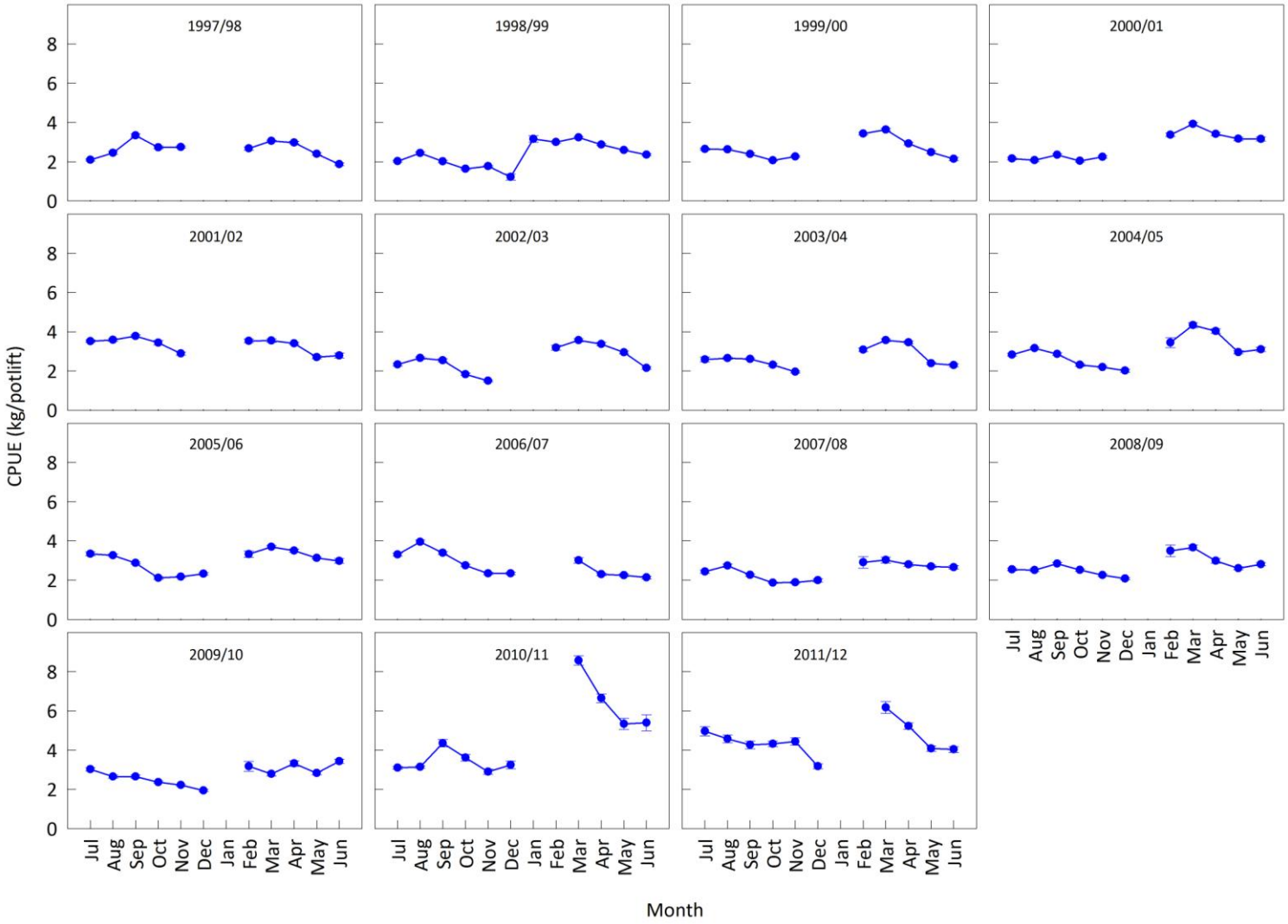


Figure 4.13. Mean (±SE) monthly commercial CPUE (kg/pot lift) for the Spencer Gulf pot fishing sector from 1997/98 to 2011/12. Note: some error bars are obscured by the data points.

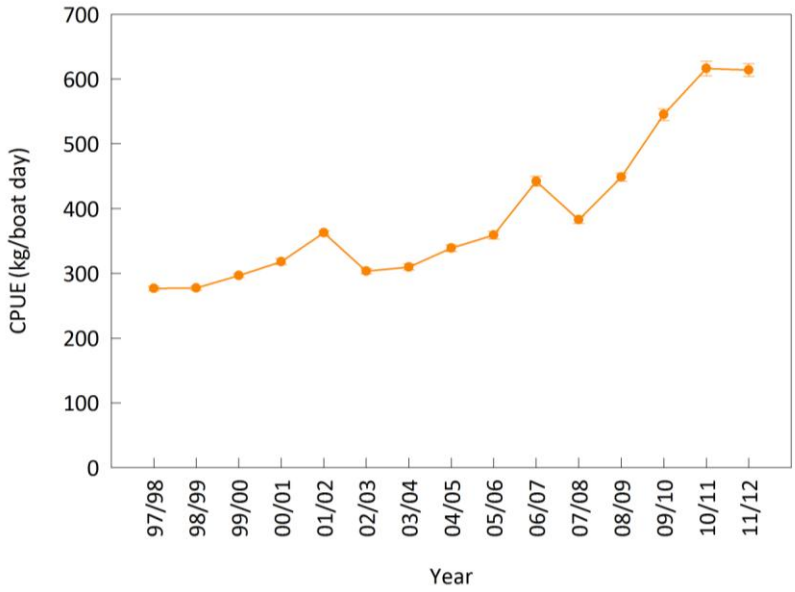


Figure 4.14. Mean (±SE) commercial daily CPUE (kg/boat day) for the Spencer Gulf pot fishing sector from 1997/98 to 2011/12. Note: some error bars are obscured by the data points.

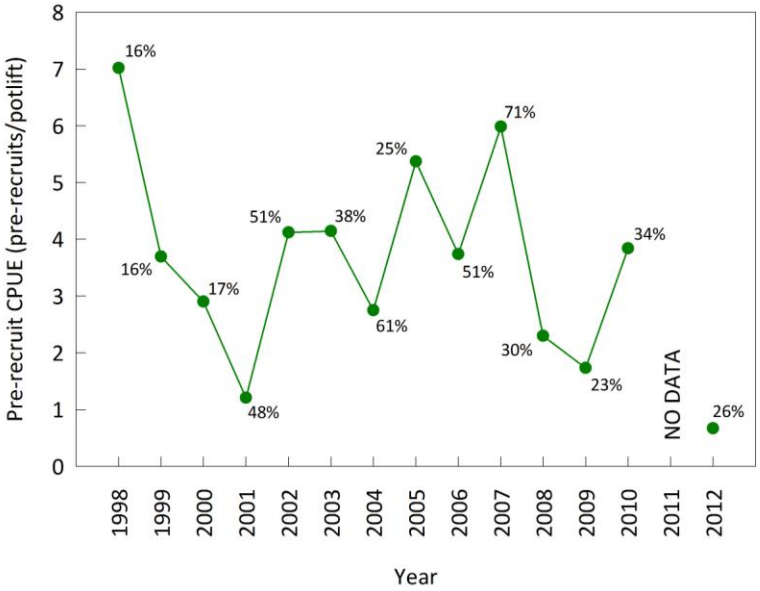


Figure 4.15. Mean commercial CPUE for pre-recruits (pre-recruits/pot lift) in Spencer Gulf during June/July from 1998 to 2012. Labels indicate the % of days when pre-recruit data were recorded in logbooks. No data on pre-recruits were recorded in 2011.

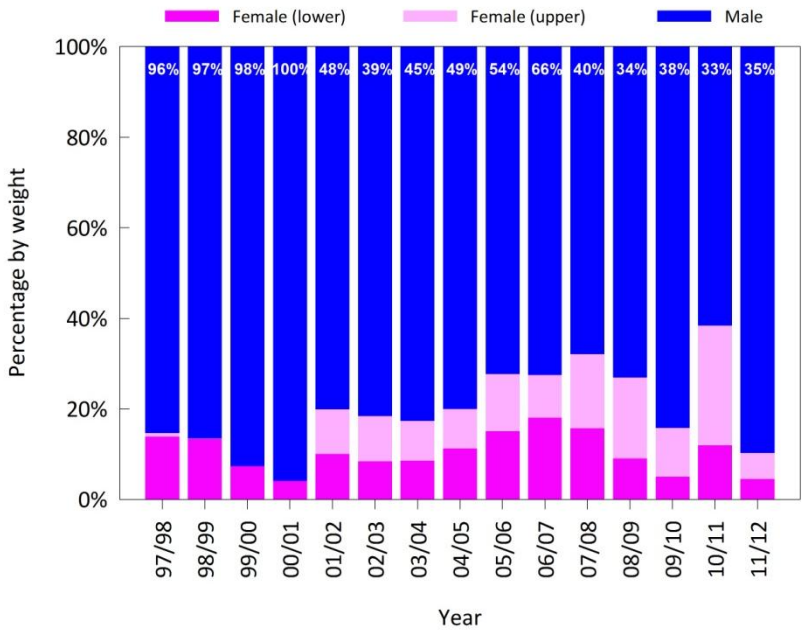


Figure 4.16. The percentage of female (pink bars, upper and lower ranges) and male (blue bars) crabs by weight in Spencer Gulf from commercial logbook data from 1997/98 to 2011/12. Labels indicate the percentage of the total catch upon which estimates were based.

4.3. Pot-sampling data

Pot-sampling data collected since May 2006 provide supplementary information (to fishery-independent surveys and commercial logbook data) on CPUE of pre-recruits and sex ratio. Fishers are required to provide data from one small-mesh pot per fishing day. The data collected prior to 2008 were excluded from analysis in this report due to the limited number of boat day samples (Table 4.1).

Table 4.1. Statistics on pot-sampling data collected from 2006 to 2012.

Statistic	2006	2007	2008	2009	2010	2011	2012
No. of active licences*	5	5	5	5	4	4	4
No. of licences providing data	3	3	4	4	4	3	4
No. of boat days during the sampling period	989	859	971	696	734	526	497
No. (and % of total) of boat days sampled	41 (4%)	39 (5%)	434 (45%)	523 (75%)	490 (67%)	128 (24%)	195 (39%)
No. (and % of total fished) of blocks sampled	6 (21%)	18 (55%)	28 (72%)	20 (69%)	25 (69%)	7 (30%)	20 (71%)
No. of crabs measured	845	1303	8526	8750	10204	2585	5562

*Active licences are those licences where pot lifts were recorded.

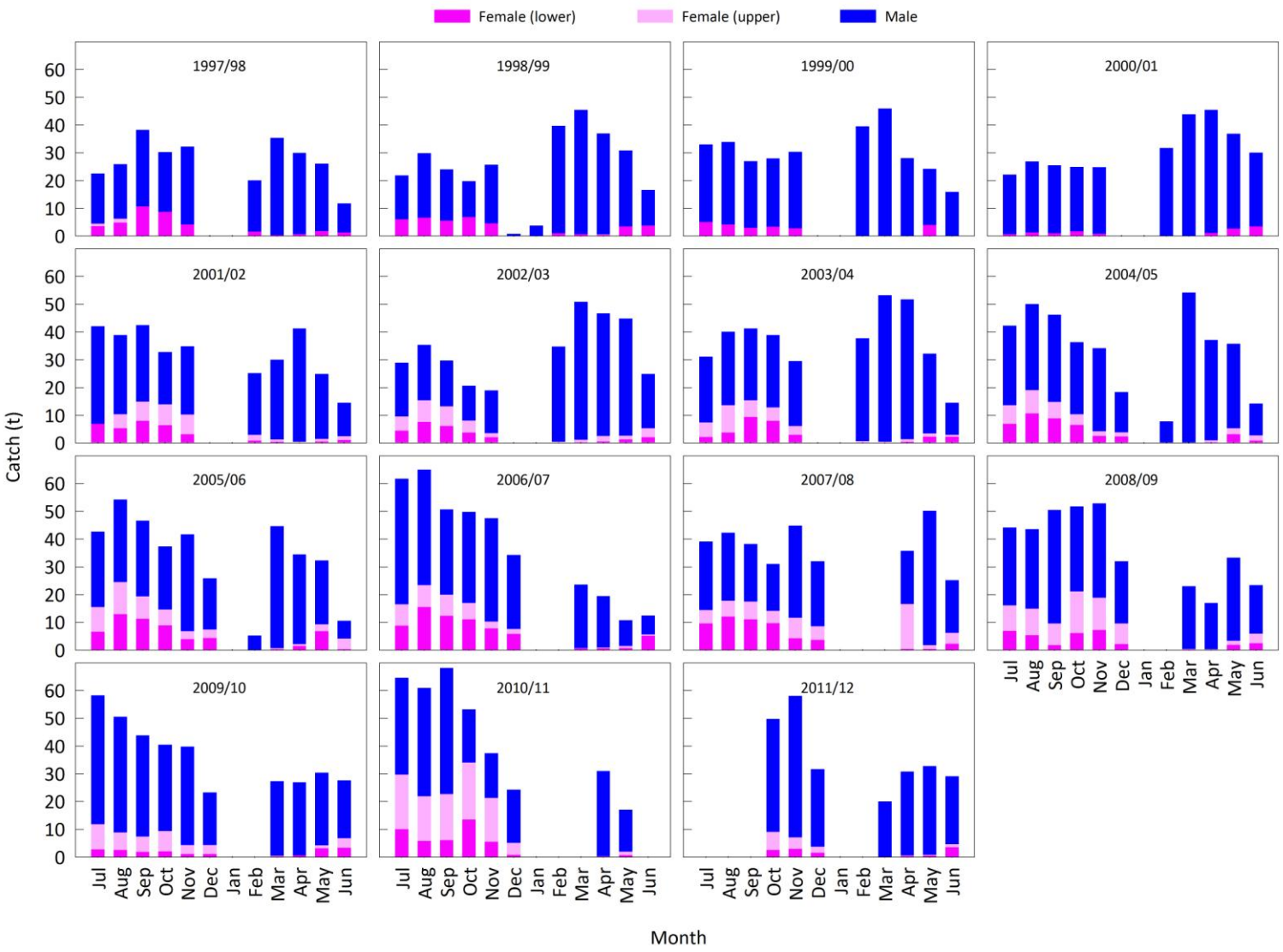


Figure 4.17. Monthly catches of female (pink bars, upper and lower ranges) and male (blue bars) crabs by the Spencer Gulf pot fishing sector from 1997/98 to 2011/12.

4.3.1. Pre-recruit abundance

Reliable pot-sampling data have been collected since 2008. The pot-sampling CPUE for pre-recruits during June and July provide a measure of relative abundance of pre-recruits during the period of peak recruitment (Figure 4.18). Using this approach, the relative abundance of pre-recruits has fluctuated since 2008, with the lowest CPUE in 2011 (5.3 pre-recruits/pot lift) and the highest in 2012 (10.5 pre-recruits/pot lift).

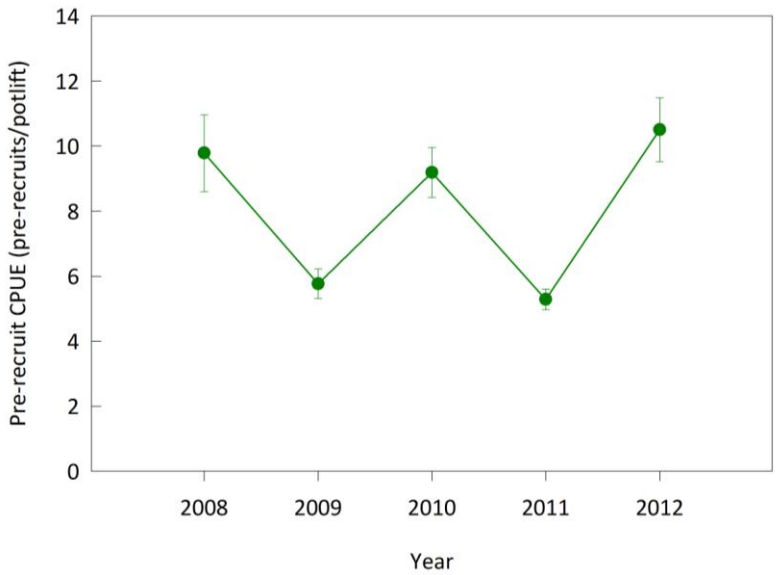


Figure 4.18. Mean (±SE) pot-sampling CPUE for pre-recruits (pre-recruits/pot lift) from pot-sampling undertaken by the Spencer Gulf pot fishing sector during June/July from 2008 to 2012.

Although no trend is apparent between years, pot-sampling data have shown seasonal trends in pre-recruits since 2008, with peaks generally occurring in February, March or July of each year (Figure 4.19). However, during 2012 (up to July) the pot-sampling CPUE of pre-recruits of 14.3 pre-recruits/pot lift during June was the highest recorded for that year.

4.3.2. Sex ratio

Sex-ratio data from the pot-sampling program were available for most months between March 2008 and July 2012 (Figure 4.20). Female crabs were caught in high proportion from July to December, sometimes exceeding 50% of the catch by number. Females were rarely caught during February and March, but began to appear in small proportions from April to June. These trends were consistent among years.

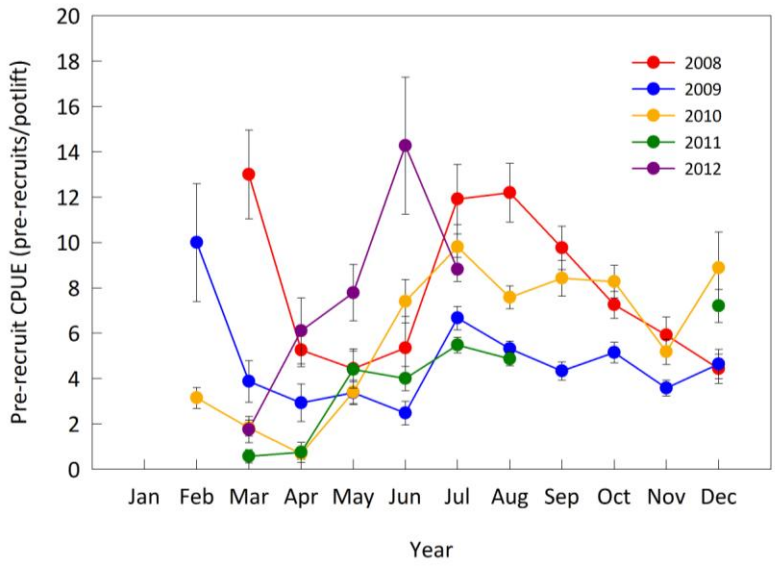


Figure 4.19. Mean (±SE) monthly pot-sampling CPUE for pre-recruits (pre-recruits/pot lift) from pot-sampling undertaken by the Spencer Gulf pot fishing sector from 2008 to 2012.

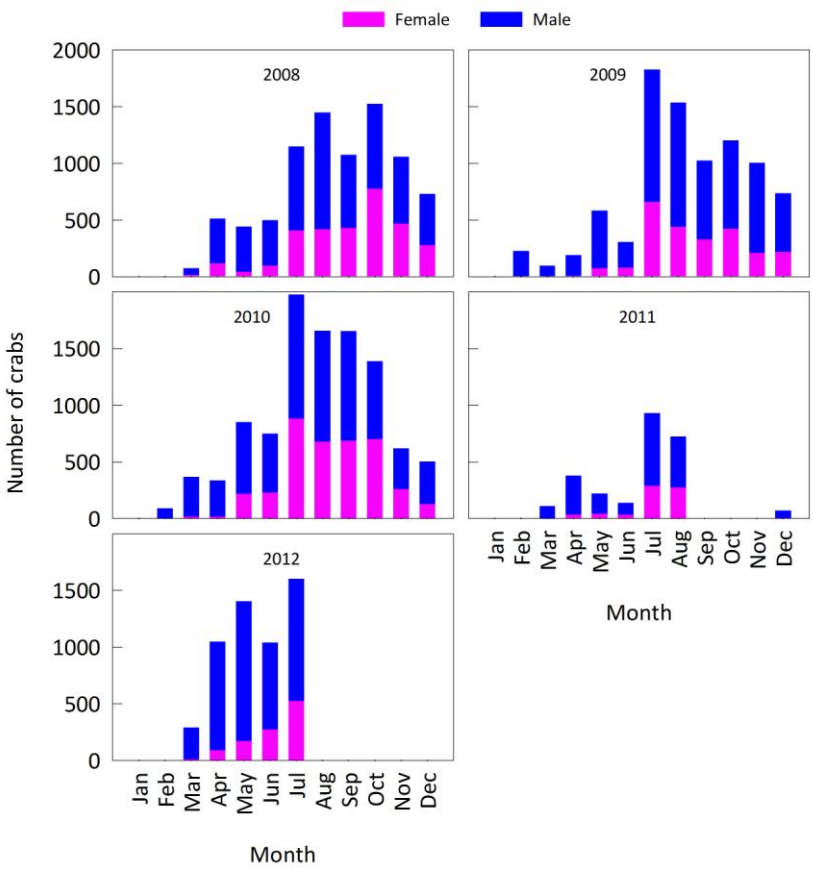


Figure 4.20. Number of female (pink bars) and male (blue bars) crabs caught in small-mesh pots during pot-sampling in Spencer Gulf pot fishing sector from 2008 to 2012.

4.4. Discussion

Assessment of the Spencer Gulf pot fishing sector was based on data from fishery-independent survey data, and fishery-dependent data from commercial logbooks and pot-sampling. Survey data provide a snapshot of relative abundance across the full extent of the fishery during June/July and provide a reliable measure of stock status at the end/start of each season. Pot-sampling data provide useful information to assess resource status throughout the fishing season.

Survey CPUE data indicate that the relative abundance of legal-size and pre-recruit crabs in 2012 were the highest and second highest on record, respectively. There appears to have been a shift in the distribution of crabs in recent years, with survey CPUE in the south-eastern region between Port Broughton and Wallaroo. The high relative abundance of pre-recruits in the 2012 survey is supported by the pot-sampling data, which also indicates a high commercial CPUE for pre-recruits during the recruitment period of June/July and in most other months fished during that year.

Almost all of the TACC (99%) for Spencer Gulf was caught during 2011/12. The spatial distribution of the catch was similar to previous years. The recent increase in commercial CPUE (pot lifts and boat days), and the associated reduction in the number of both first and second pot lifts, are caused, at least in part, by recent gear changes in some of the fleet.

In summary, data from fishery-independent surveys indicate that the relative abundance of both legal-size and pre-recruit crabs remain high and stable in the Spencer Gulf. Pot-sampling data supports these findings. The increase in commercial CPUE in part reflects recent improvements in the efficiency of the fleet. Under the guidelines in the Management Plan, these results suggest that a fishery-independent survey is not required in Spencer Gulf during June 2013.

5. GULF ST VINCENT POT FISHING SECTOR

5.1. Fishery-independent surveys

5.1.1. Relative abundance of legal-size crabs

Relative abundance of legal-size crabs fluctuated from 2002 until it reached its highest level in 2006 (4.7 legal-size crabs/pot lift; Figure 5.1). The survey CPUE of legal-size crabs has generally declined thereafter, falling to 1.6 legal-size crabs/pot lift in 2012, which represents the equal lowest recorded (along with 2004).

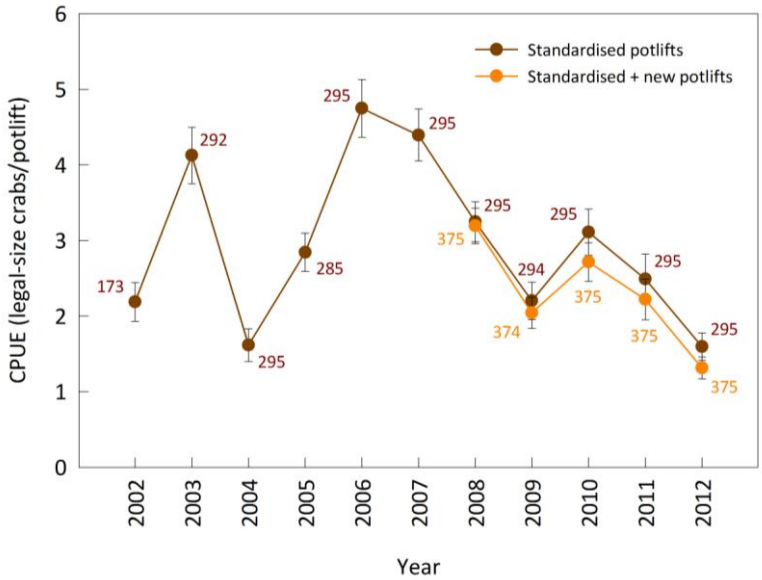


Figure 5.1. Mean (±SE) survey CPUE of legal-size crabs (legal-size crabs/pot lift) for standardised pot lifts (2002-current) and standardised + new pot lifts (2008-current) in Gulf St Vincent during June/July from 2002 to 2012. Labels indicate the number of pot lifts.

5.1.2. Relative abundance of pre-recruits

The relative abundance of pre-recruits also fluctuated in the first few years in which fishery-independent surveys were conducted, with the lowest survey CPUE at 0.4 pre-recruits/pot lift in 2004 and the highest at 10.7 pre-recruits/pot lift in 2006 (Figure 5.2). As with legal size crabs, consecutive declines in the survey CPUE for pre-recruits occurred from 2006 to 2009 (to 1.3 pre-recruits/pot lift) before increasing in 2010 (to 7.3 pre-recruits/pot lift) and then declining in 2011 and 2012 to 2.1 and 0.8 pre-recruits/pot lift, respectively. The survey CPUE for pre-recruits in 2012 is at a similar level to those of 2004 and 2009.

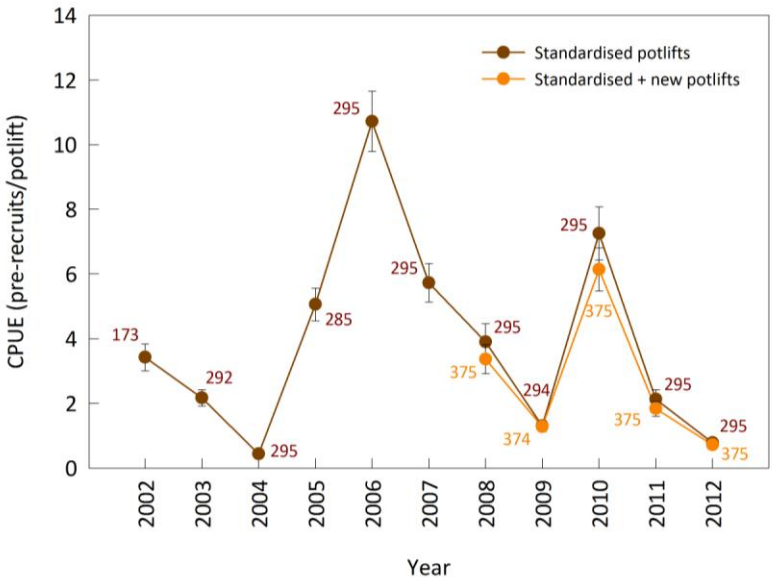


Figure 5.2. Mean (±SE) survey CPUE of pre-recruits (pre-recruits/pot lift) for standardised pot lifts (2002-current) and for standardised + new pot lifts (2008-current) in Gulf St Vincent during June/July from 2002 to 2012. Labels indicate the number of pot lifts.

5.1.3. Spatial distribution of legal-size crabs

The distribution of legal-size crabs was spatially and temporally variable (Figure 5.3). A high survey CPUE (>10 legal-size crabs/pot lift) was observed in block 27 on four occasions (2003 and 2005–2007), in block 35 on three occasions (2008, 2009 and 2011) and in blocks 13, 17, 18, 33 and 34 on one occasion each. Blocks 27 and 35, west of Port Adelaide, were the most productive, consistently yielding high survey CPUE (5-10 legal-size crabs/pot lift) for nine of the 11-year period (2002-2012) in which surveys have been conducted. Survey CPUE for legal-size crabs was low (<2 legal-size crabs/pot lift) on most survey occasions in blocks 3, 9, 10, 12 and 20. During 2012, no blocks achieved high survey CPUE of legal-size crabs, except block 35. The overall spatial distribution of legal-size crabs in 2012 appears similar to distributions in 2002 and 2011 (Figure 5.3).

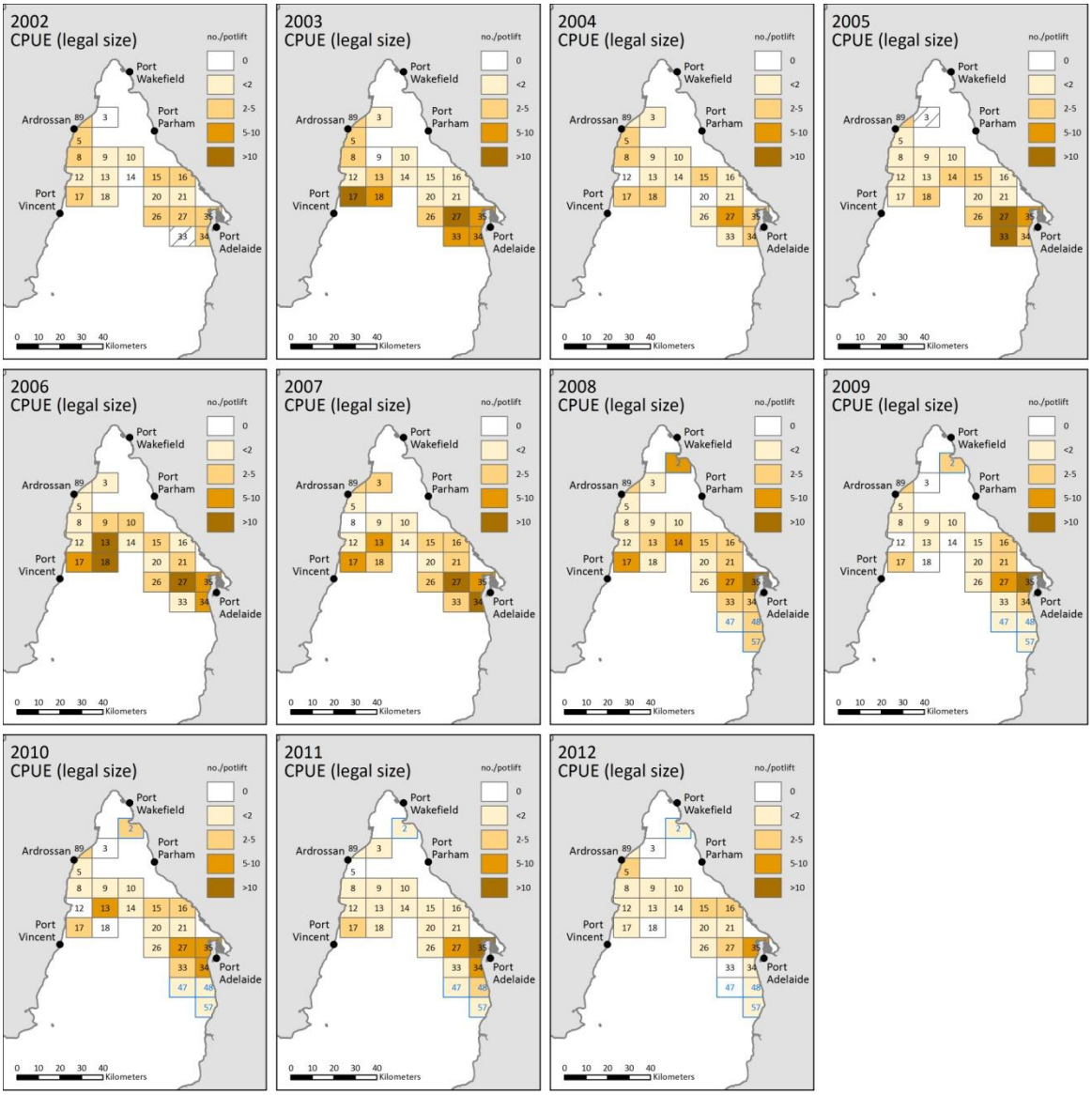


Figure 5.3. Spatial distribution of survey CPUE of legal-size crabs (legal-size crabs/pot lift) from standardised pot lifts in Gulf St Vincent during June/July from 2002 to 2012. Note: 2008 to 2012 maps include new blocks surveyed (2, 47, 48 and 57).

5.1.4. Spatial distribution of pre-recruits

The distribution of pre-recruit crabs was spatially and temporally variable in most years (Figure 5.4). While few consistent trends were evident, the most productive blocks were 13, 27 and 35, each of which had high survey CPUE of pre-recruits on most occasions. During 2012, no blocks yielded high survey CPUE of pre-recruits, and there were no pre-recruit crabs found in 9 of 24 blocks surveyed. The spatial distribution of pre-recruits appears similar to distributions in 2004 and 2011 (Figure 5.4).

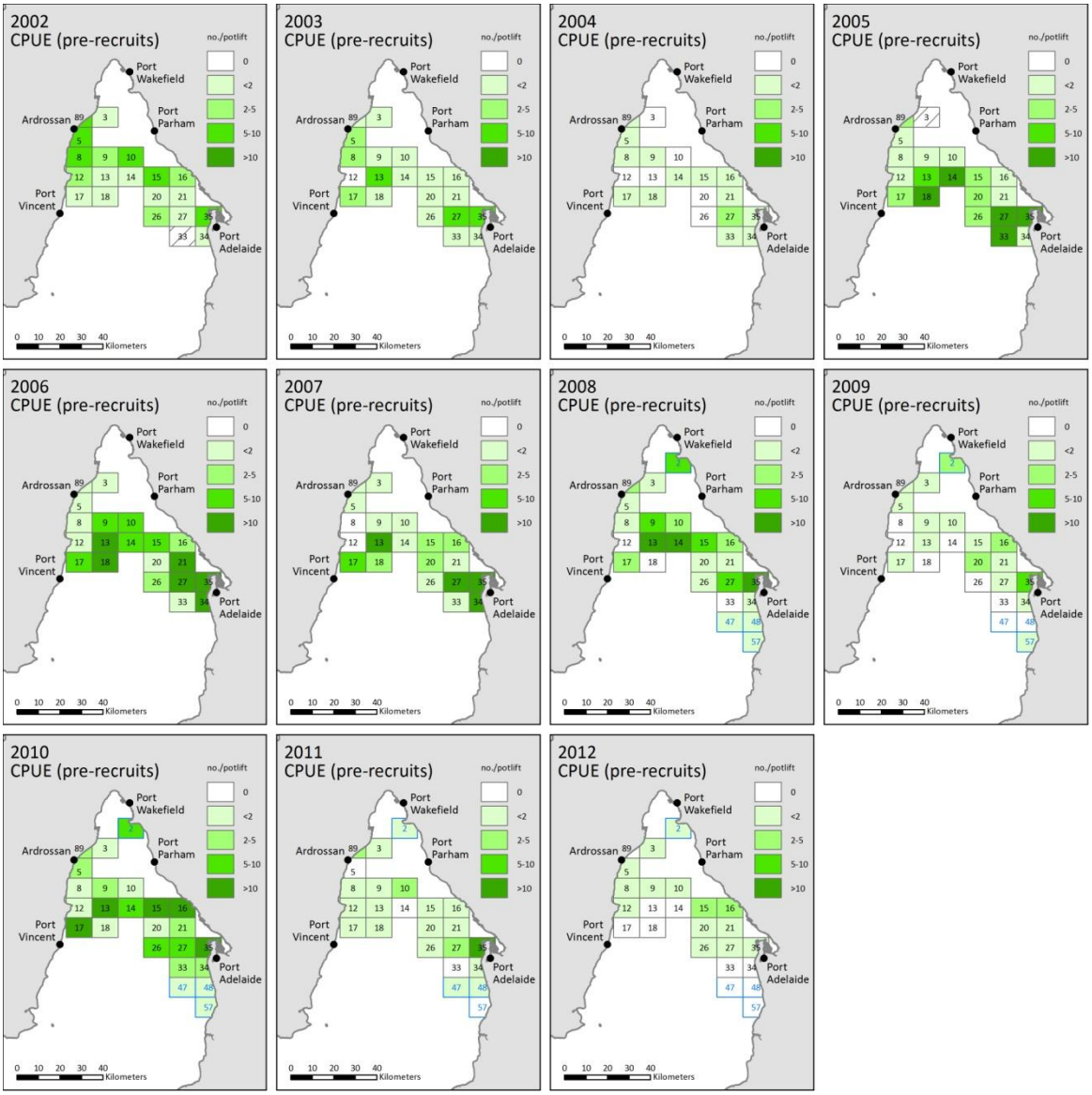


Figure 5.4. Spatial distribution of survey CPUE of pre-recruits (pre-recruits/pot lift) from standardised pot lifts in Gulf St Vincent during June/July from 2002 to 2012. Note: 2008 to 2012 maps include new blocks surveyed (2, 47, 48 and 57).

5.1.5. Crab size

The size distribution of the surveyed population varied substantially among years (Figure 5.5). The modal size of crabs was 100-109 mm (undersize, or pre-recruits) during 2002, 2005-2007, 2010 and 2011, and 110–119 mm (legal-size crabs) during 2003, 2004, 2008, 2009 and 2012. The proportion of pre-recruits ranged from 32% to 70% in all years except 2004, when the total caught was low and pre-recruits comprised only 21% of the population. The size structure in 2012 is similar to that of 2003, however, the proportion of pre-recruits (at 32%) is the second lowest recorded (after 2004, when it was 21%).

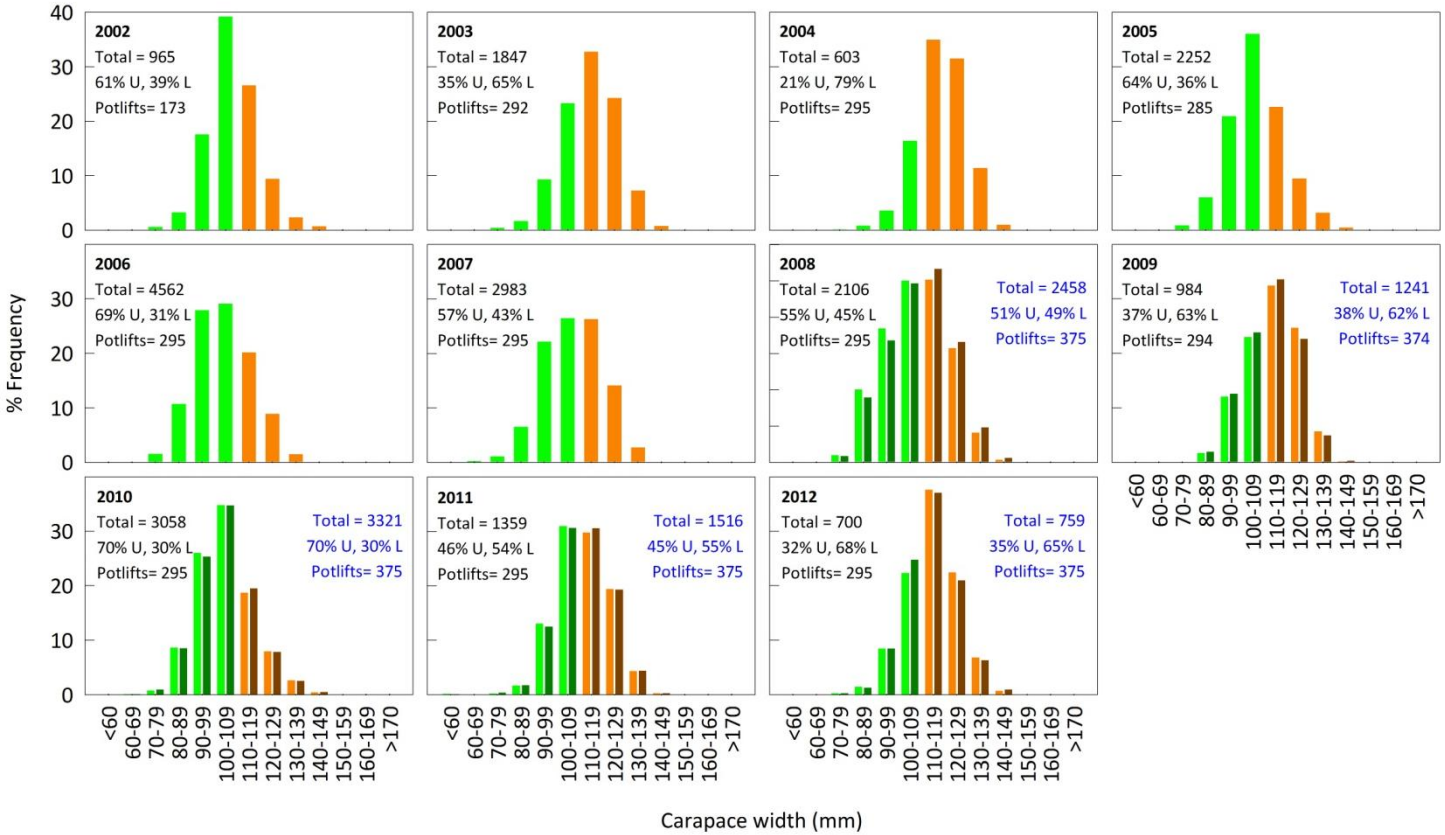


Figure 5.5. Size-frequency distribution of crabs caught during fishery-independent surveys conducted in Gulf St Vincent during June/July from 2002 to 2012. Green and orange bars represent pre-recruits and legal-size crabs, respectively, caught using standardised pot lifts (2002-current), while darker bars (and blue text) represent those caught using standardised + new pot lifts (2008-current).

5.2. Commercial logbook data

5.2.1. Catch and effort

5.2.1.1. Annual trends

The Gulf St Vincent pot fishing sector held 241.9 t (39%) of the 626.8 t TACC for 2012/12 (source: PIRSA Fisheries and Aquaculture), most of which (234.3 t, 97%) was landed (Figure 5.6). Although 2011/12 was the fourth consecutive year that the TACC had not been caught in full, the TACC has only ever been reached once in Gulf St Vincent (i.e. in 2007/08), and further, the total catch in 2011/12 was the next highest since the introduction of quota.

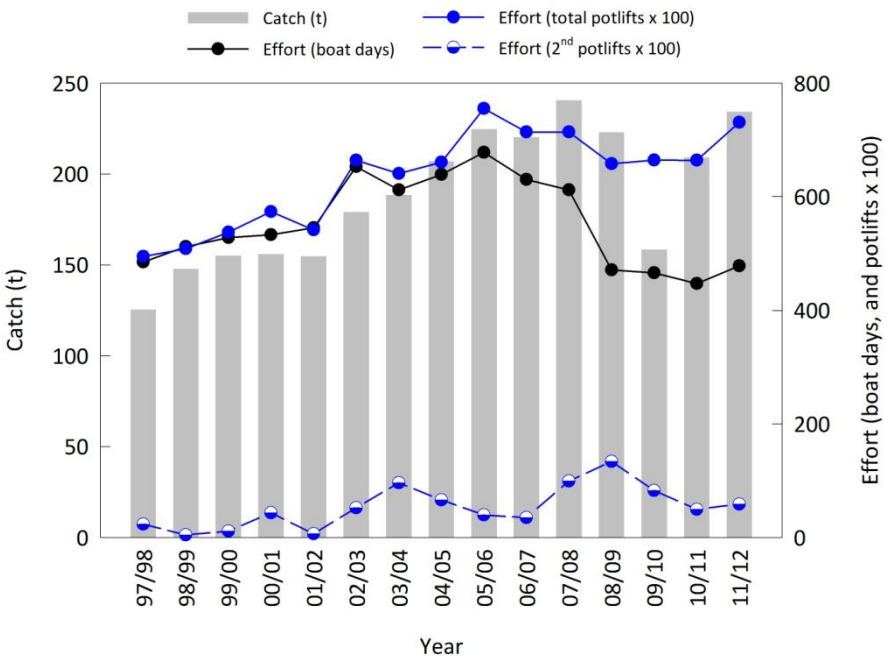


Figure 5.6. Total catch (t) and effort (in boat days, total pot lifts and second pot lifts) for the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12.

Following the introduction of quota in 1996/97, the number of boat days remained relatively constant over the 5-year period 1997/98 to 2001/02 with an average of 521 days fished (Figure 5.6). Boat days increased when a new licence was issued in 2002/03 and was stable thereafter until 2007/08 with an average of 637 boat days, despite the introduction of a new licence in 2007/08. The number of boat days fished has been substantially lower in recent years, with 2010/11 (447 boat days) being the lowest recorded since the introduction of quota. The number of total pot lifts and boat days followed similar trends from 1997/98 to 2004/05. Thereafter the number of pot lifts began to

increase relative to boat days. In 2011/12, there was a 7% increase in the number of boat days (to 478 boat days) and a 10% increase in total pot lifts (to 73,085 pot lifts) compared to 2010/11.

5.2.1.2. Spatial distribution of the annual catch

The spatial distribution of commercial catch has changed since 1997/98 (Figure 5.7, Figure 5.8). There were two licences for the first five years of quota (i.e. 1996/97 to 2000/01), and during this period the number of blocks fished and the amount of catch harvested from these blocks were similar (Figure 5.7). The introduction of a new licence in 2002/03 coincided with an increase in the number of blocks fished, particularly those with low catch (<5 t). Trends in the number of fished blocks remained similar until the introduction of another new licence in 2007/08, when the number of blocks with >20 t harvested was doubled. Since 2008/09 there has been a substantial increase in the number of blocks fished, particularly those of low catch. More blocks were fished during 2011/12 than any previous year.

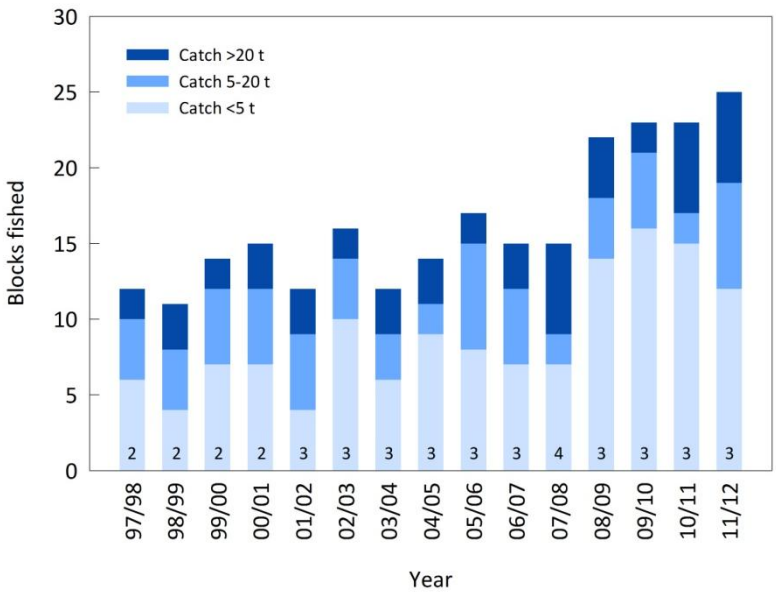


Figure 5.7. The number of blocks fished in the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12 with catches of <5 t, 5-20 t and >20 t. Labels indicate the number of licences fishing.

Most of this area expansion of catch in 2011/12 has been from fishing blocks adjacent to the western shoreline extending from north of Port Vincent to south of Stansbury and from fishing blocks adjacent to the eastern shoreline extending from Port Gawler to southern metropolitan Adelaide (Figure 5.8). In comparison, consistently high catches (>20 t) prior to 2010/11 were located in blocks next to those blocks along the metropolitan coastline (i.e. in deeper water).

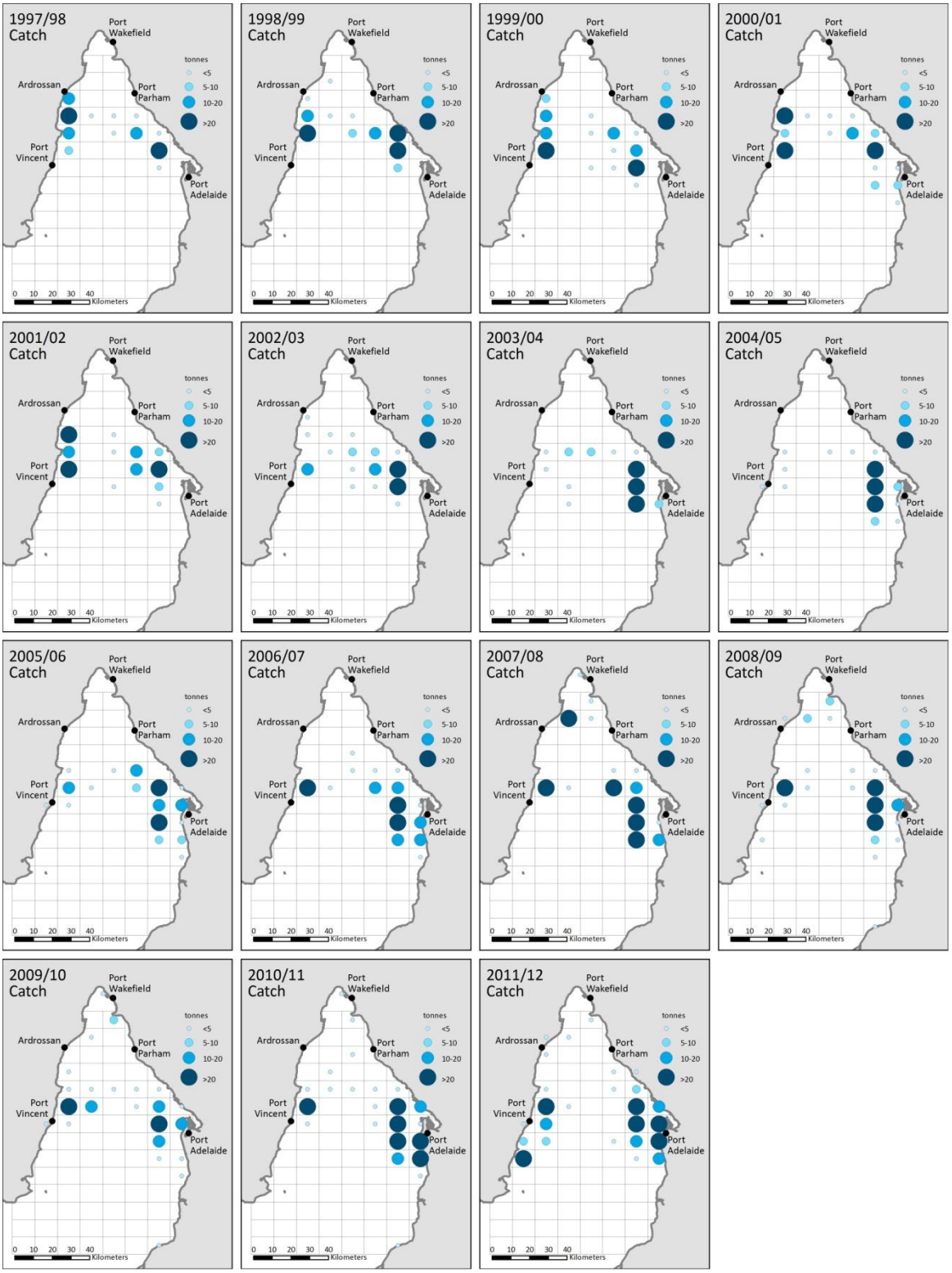


Figure 5.8. Spatial distribution of commercial catch by the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12.

5.2.1.3. Monthly catch and effort

Commercial pot fishing in Gulf St Vincent is closed between November 1 and January 15. Trends in monthly effort generally reflected trends in monthly catch (Figure 5.9). Monthly catch and effort were more variable between January and June. Generally, peak catches were harvested during February, with declining monthly catches thereafter.

In this report, data were assessed for the beginning of the 2012/13 season for Gulf St Vincent. Although no fishing was conducted in October 2012/13, the total catch (41.6 t) and total effort (18,623 pot lifts) for July to September 2012/13 was similar to the average total catch (41.3 t) and effort (18,243 pot lifts) for July to October in 2009/10 and 2010/11.

5.2.2. Catch per unit effort

5.2.2.1. Mean annual CPUE

Mean commercial CPUE generally increased at a steady rate throughout the 15-year period since the introduction of quota, i.e. ranging from 2.54 kg/pot lift in 1997/98 to 3.39 kg/pot lift in 2011/12, except for the low CPUE in 2009/10 at 2.44 kg/pot lift (Figure 5.10).

5.2.2.2. Spatial distribution of mean annual CPUE

The distribution of commercial CPUE in Gulf St Vincent was spatially and temporally variable from 1997/98 to 2011/12 (Figure 5.11). Prior to 2011/12, most blocks with high commercial CPUE (>3 kg/pot lift) were located in the western region of the gulf. While high CPUE were still observed in these blocks in 2011/12, additional blocks identified in the area expansion of catch (see Section 5.2.1.2 above) also yielded high commercial CPUE.

5.2.2.3. Mean annual CPUE for first and second pot lifts

Mean commercial CPUE for first pot lifts was greater than that for the second pot lifts in all years except 2002/03, 2003/04 and 2010/11 (Figure 5.12). While this difference may appear to be due to the difference in soak time (generally 19-20 h for the first pot lift and 4-5 h for the second pot lift), second pot lifts have a much higher catch rate if catch is expressed per hour of soak time. Interpretation of trends in CPUE is further complicated by the relatively low number of second pot lifts compared to first pot lifts (Figure 5.6).

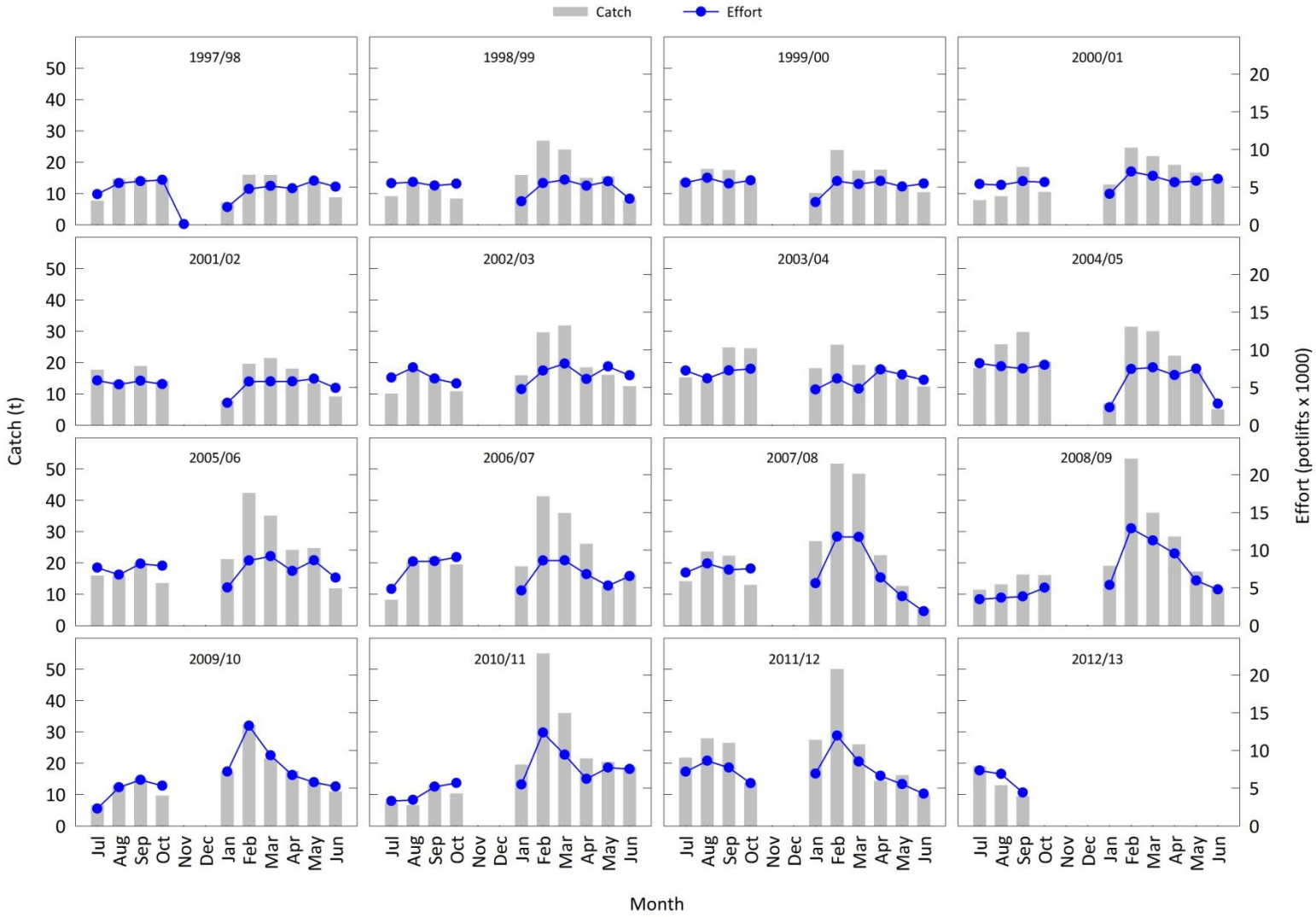


Figure 5.9. Monthly catch (t) and effort (pot lifts) for the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12 and for the first four months of the 2012/13 season (Jul to Oct 2012). Note: there was no fishing in October 2012.

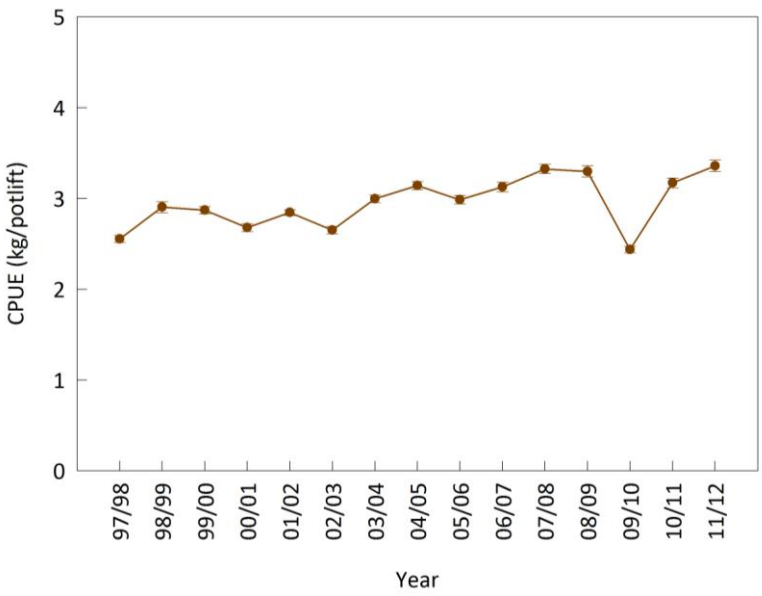


Figure 5.10. Mean (±SE) commercial CPUE (kg/pot lift) in the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12. Note: some error bars are obscured by the data points.

5.2.2.4. Mean monthly CPUE

In most years, commercial CPUE was at a relatively low level in July, at the start of the quota period, after which it increased until September, and then declined rapidly in October (prior to the closure in November and December) (Figure 5.14). Following the closure, commercial CPUE was at a relatively high level, was highest during February and then declined until June, at the end of the quota period.

In this report, additional data were assessed for the beginning of the 2012/13 season for Gulf St Vincent. Comparisons of commercial CPUE from July to September for the last three years indicate that commercial CPUE in early 2012/13 (range 1.9-2.7 kg/pot lift; mean 2.3 kg/pot lift) was similar to the same period in 2010/11 (range 1.9-2.5 kg/pot lift; mean 2.3 kg/pot lift), but below that of 2011/12 (range 3.3-3.7 kg/pot lift; mean 3.5 kg/pot lift).

5.2.2.5. Mean daily CPUE

Mean commercial daily CPUE increased from 259 kg/boat day in 1997/98 to 473 kg/boat day in 2008/09 (Figure 5.13). While commercial daily CPUE decreased in 2009/10, it increased again in 2010/11 before reaching its highest level in 2011/12 (490 kg/boat day).

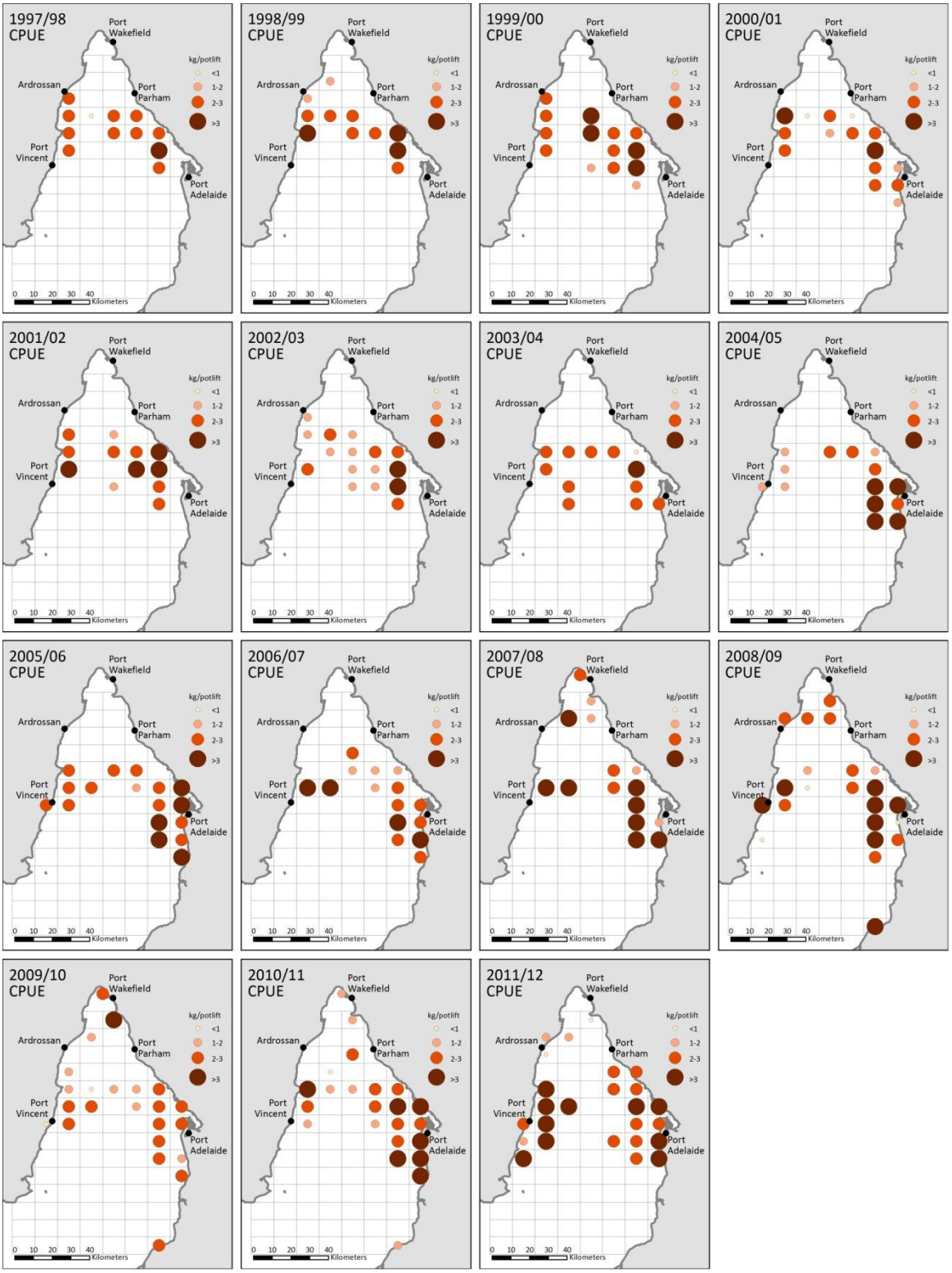


Figure 5.11. Spatial distribution of commercial CPUE for the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12.

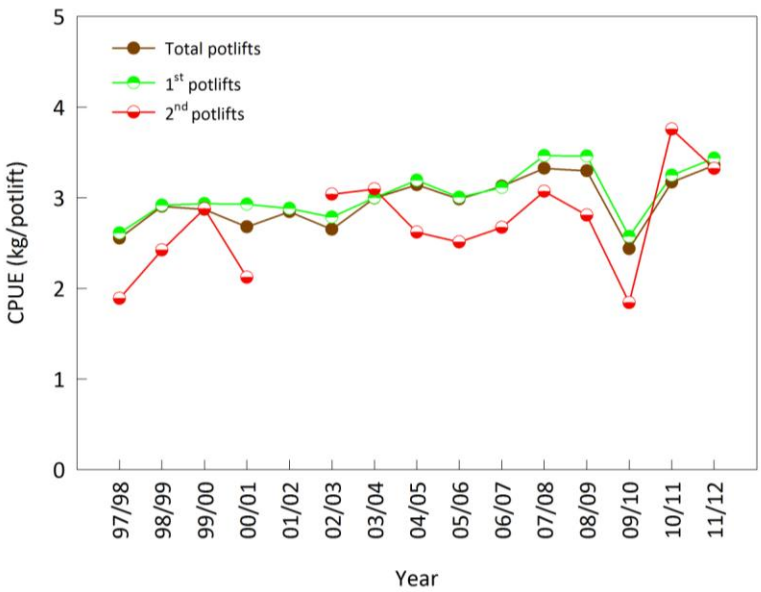


Figure 5.12. Mean commercial CPUE (kg/pot lift) in the Gulf St Vincent pot fishing sector for first pot lifts, second pot lifts and total pot lifts from 1997/98 to 2011/12.

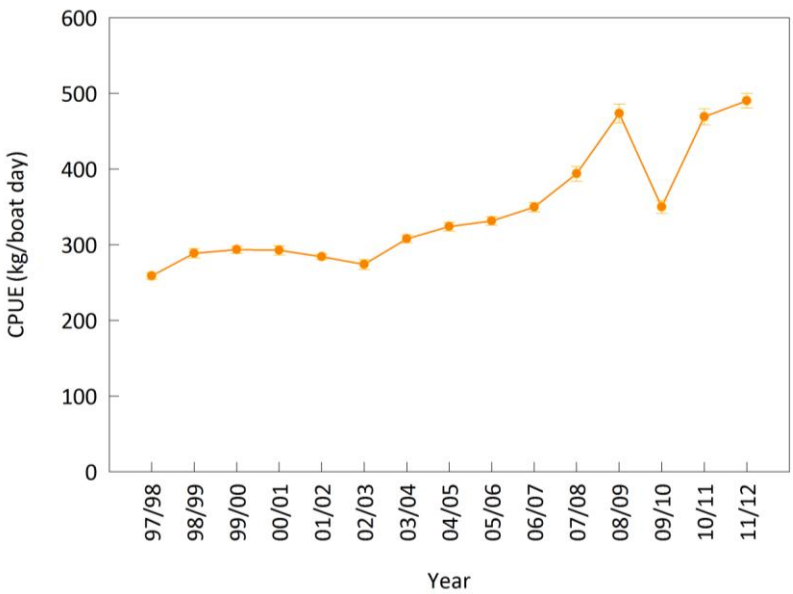


Figure 5.13. Mean (±SE) commercial daily CPUE (kg/boat day) for the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12. Note: some error bars are obscured by the data points.

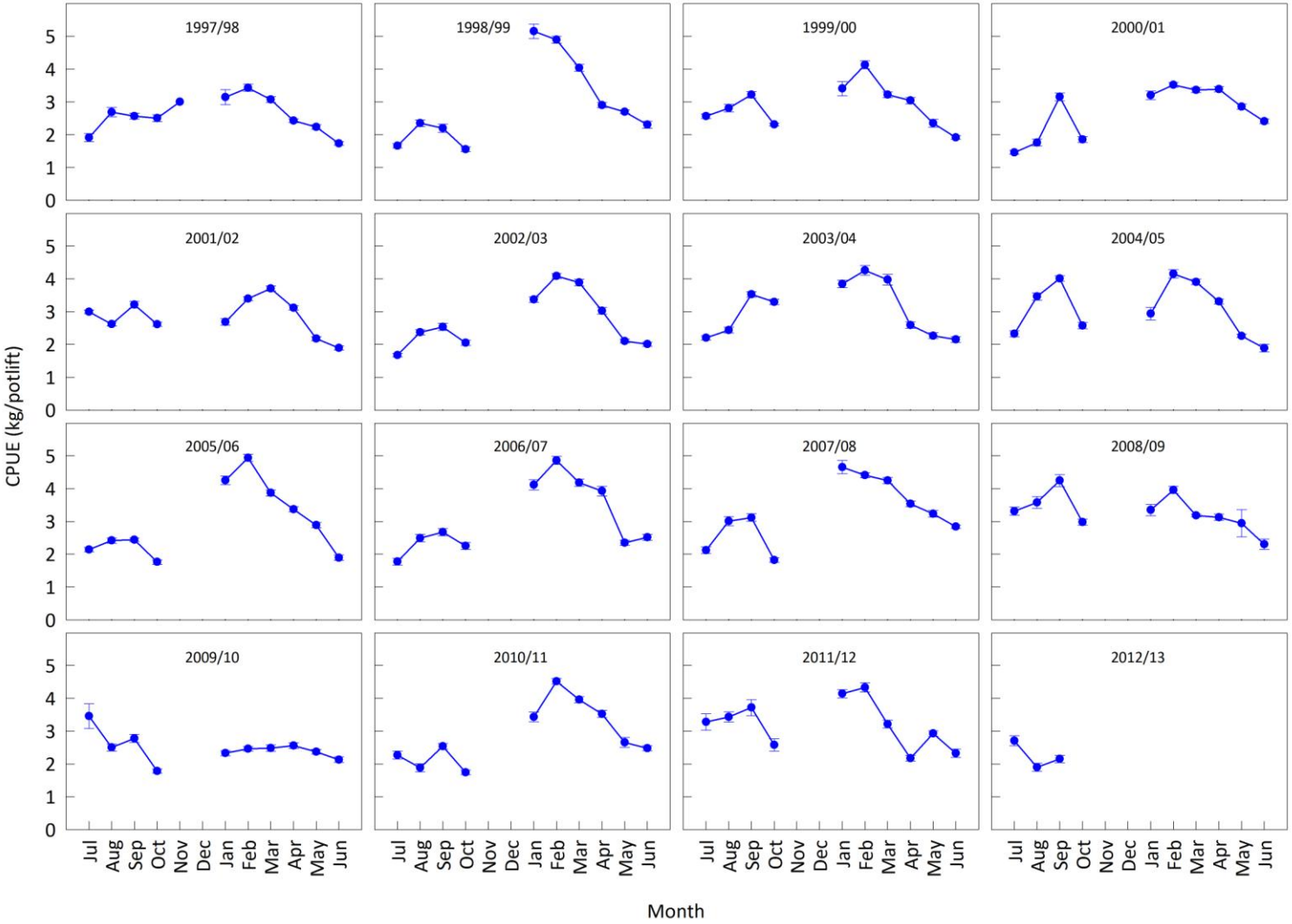


Figure 5.14. Mean (±SE) monthly commercial CPUE (kg/pot lift) for the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12, and for the first four months of the 2012/13 season (Jul to Oct 2012). No fishing took place in October 2012. Note: some error bars are obscured by the data points.

5.2.3. Pre-recruits

For June/July, the commercial CPUE of pre-recruits in Gulf St Vincent was high in 1998 at 5.3 pre-recruits/pot lift, and then ranged between 0.3 and 3.8 pre-recruits/pot lift from 1999 to 2009 (Figure 5.15). While the commercial CPUE of pre-recruits in 2012 represents a decline from 2010 and 2011 levels, the CPUE in those two years were anomalously high (at 12.1 and 8.8 pre-recruits/pot lift, respectively), and the CPUE in 2012 was the next highest at 3.9 pre-recruits/pot lift.

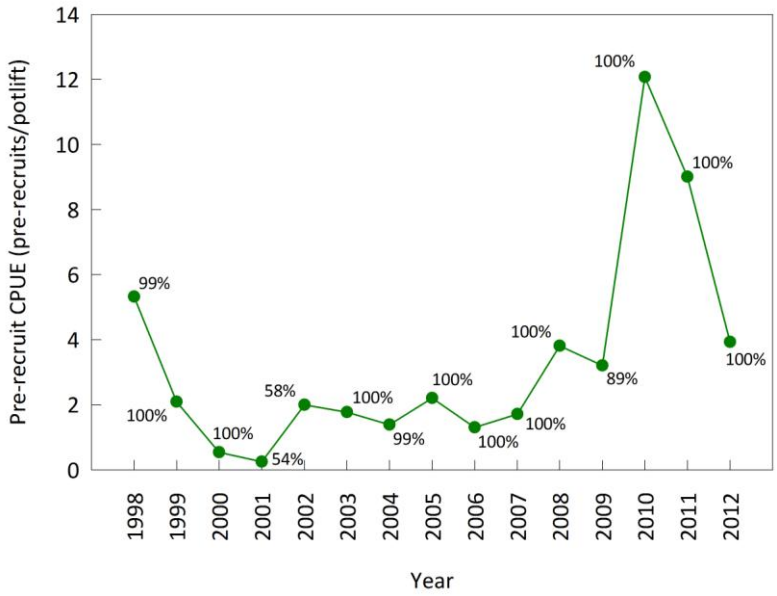


Figure 5.15. Mean commercial CPUE for pre-recruits (pre-recruits/pot lift) in Gulf St Vincent during June/July from 1998 to 2012. Labels indicate the % of days when pre-recruit data were recorded in logbooks.

5.2.4. Sex ratio

Annual catches are predominantly comprised of male crabs by weight (Figure 5.16). Uncertainty in estimates of sex ratio results from incomplete logbook data. Under the assumptions that missing data on sex in daily catch records were: 1) all male (lower female estimate); and 2) an equal proportion to available data for each month (upper female estimate), the percentage of female crabs in the total annual catch between 1997/98 and 2011/12 ranged from: 1) 5-27% (mean 16%); and 2) 8-33% (mean 20%).

Generally, catches of female crabs were highest between May and October in Gulf St Vincent (Figure 5.17). Few female crabs were retained from January to April in any year. Like Spencer Gulf, the timing of capture exerts a strong influence over the proportion of females harvested in any year. In this report, data were assessed for the beginning of the 2012/13 season for Gulf St Vincent. Of the

41.6 t harvested from July to September 2012, 19.0 t (46%) were female crabs. Although only 9.5 t was harvested in September, 7.0 t (73%) were female crabs.

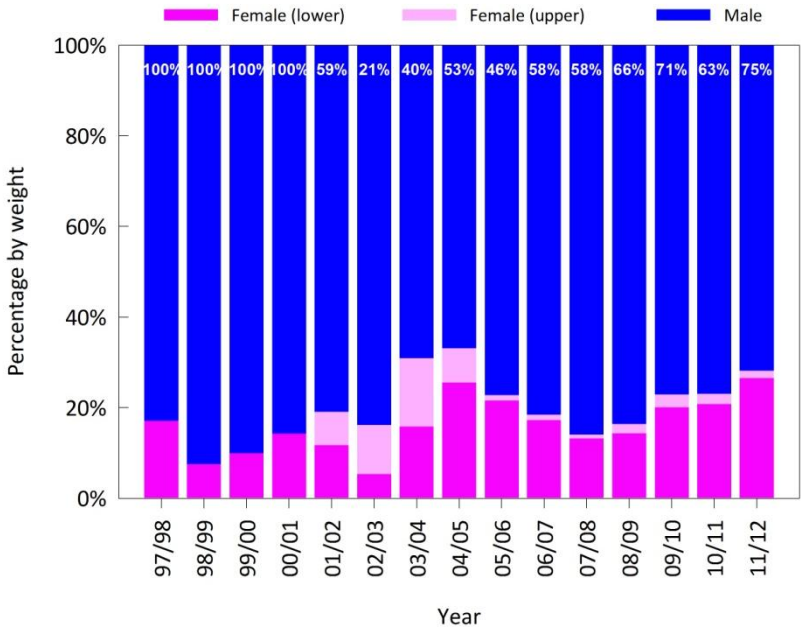


Figure 5.16. The percentage of female (pink bars, upper and lower ranges) and male (blue bars) crabs by weight in Gulf St Vincent from commercial logbook data from 1997/98 to 2011/12. Labels indicate the percentage of the total catch upon which estimates were based.

5.3. Pot-sampling data

Pot-sampling data collected since July 2006, provide supplementary information (to fishery-independent surveys and commercial logbook data) on CPUE of pre-recruits and sex ratio. Fishers are required to provide data from one small-mesh pot per fishing day. The data collected prior to 2008 were excluded from analysis in this report due to the limited number of boat day samples (Table 5.1).

Table 5.1. Statistics on pot-sampling data collected from 2006 to 2012.

Statistic	2006	2007	2008	2009	2010	2011	2012
No. of active licences*	3	4	4	3	3	3	3
No. of licences providing data	1	3	3	3	3	3	3
No. of boat days during the sampling period	674	640	443	492	425	512	407
No. (and % of total) of boat days sampled	13 (2%)	35 (5%)	168 (38%)	327 (66%)	353 (83%)	353 (69%)	300 (74%)
No. (and % of total fished) of blocks sampled	3 (20%)	8 (53%)	10 (71%)	13 (62%)	18 (72%)	15 (63%)	19 (68%)
No. of crabs measured	336	789	3485	5473	7353	6845	6394

*Active licences are those licences where pot lifts were recorded.

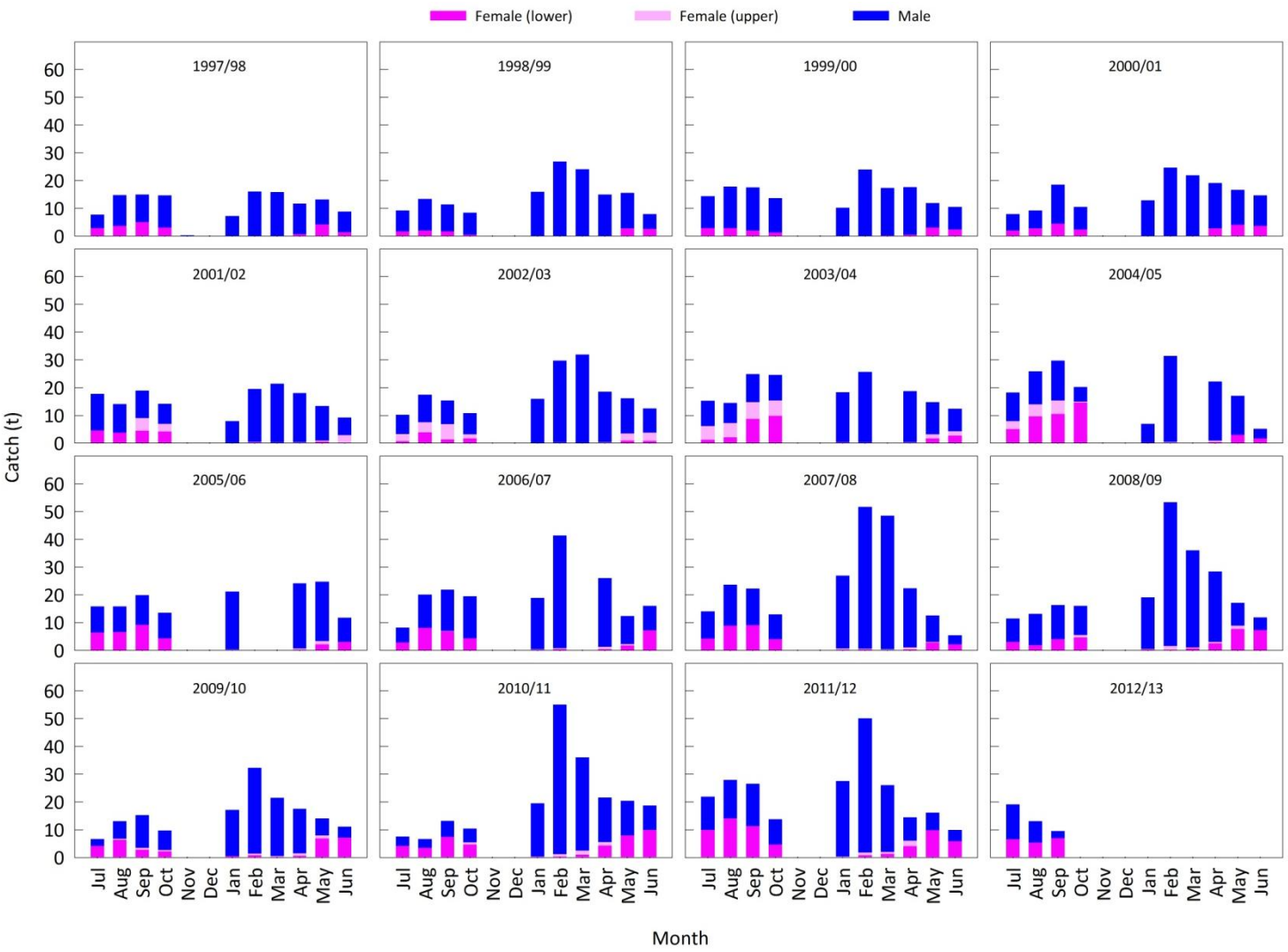


Figure 5.17. Monthly catches of female (pink bars, upper and lower ranges) and male (blue bars) crabs by the Gulf St Vincent pot fishing sector from 1997/98 to 2011/12 and for the first four months of the 2012/13 season (Jul to Oct 2012). Note: there was no fishing in October 2012.

5.3.1. Pre-recruit abundance

Reliable pot-sampling data have been collected since 2008. The commercial CPUE for pre-recruits during June and July provide a measure of relative abundance of pre-recruits during the period of peak recruitment (Figure 5.18). The commercial CPUE for pre-recruits has declined since 2008 from 11.6 to 3.2 pre-recruits/pot lift in 2012.

Monthly pre-recruit estimates were variable among years (Figure 5.19), particularly from July to October in both 2008 and 2010, when commercial CPUE for pre-recruits was relatively high. The commercial CPUE for pre-recruits was marginally higher in June compared to July in all years. For most months during 2012, commercial CPUE for pre-recruits was relatively low.

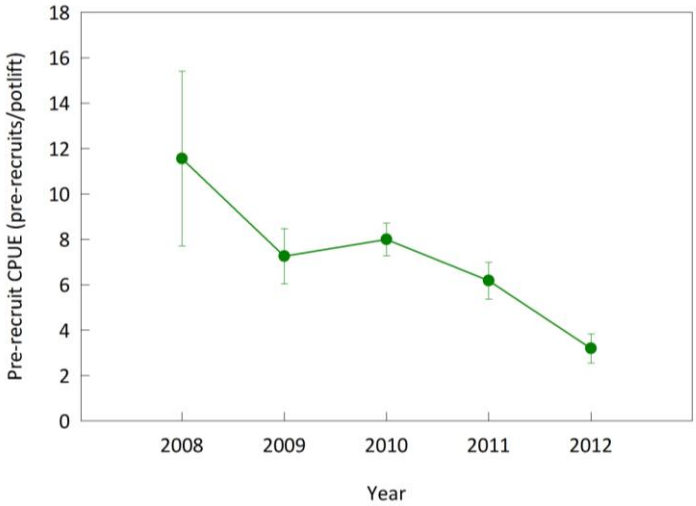


Figure 5.18. Mean (±SE) pot-sampling CPUE for pre-recruits (pre-recruits/pot lift) from pot-sampling undertaken by the Gulf St Vincent pot fishing sector during June/July from 2008 to 2012.

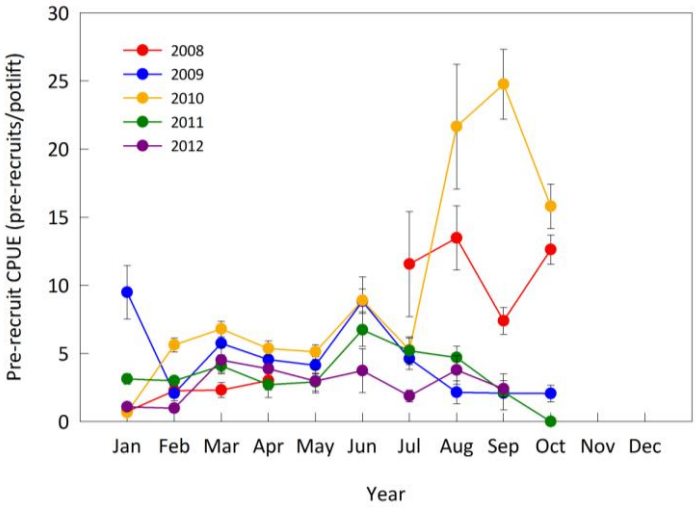


Figure 5.19. Mean (±SE) monthly pot-sampling CPUE for pre-recruits (pre-recruits/pot lift) from pot-sampling undertaken by the Gulf St Vincent pot fishing sector from 2008 to 2012.

5.3.2. Sex ratio

Sex-ratio data from the pot-sampling program were available for most months between July 2008 and July 2011 (Figure 5.20). Female crabs were rarely caught from January to March but their proportion increased during May to October when it approached 50% of the catch by number on some occasions.

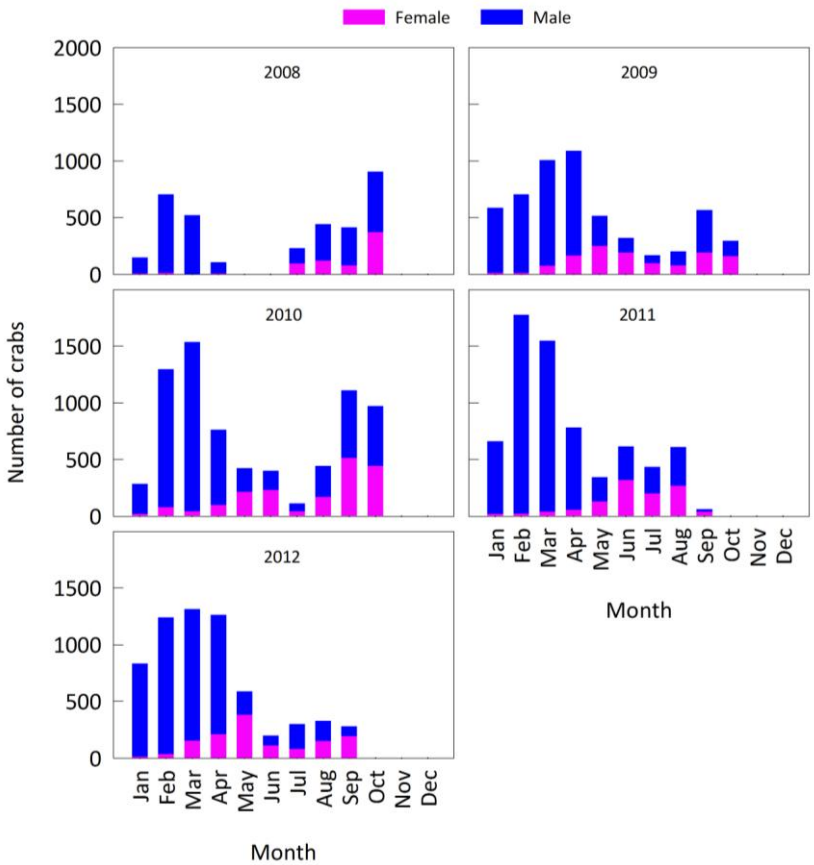


Figure 5.20. Number of female (pink bars) and male (blue bars) crabs caught in small-mesh pots during pot-sampling in Gulf St Vincent pot fishing sector from 2008 to 2012.

5.4. Discussion

Assessment of the Gulf St Vincent pot fishing sector was based on fishery-independent survey data, and fishery-dependent data from commercial logbooks and pot-sampling. Survey data provide reliable measures of stock status across the fishery at the end/start of each fishing season (June/July). Pot-sampling data provide supplementary information to assess the resource status throughout the fishing season.

The 2012 assessment report identified several issues of concern for the fishery. Of primary importance, fishery-independent survey data obtained in July 2011 indicated that the relative

abundance of legal-size and pre-recruit crabs declined between July 2010 and 2011. Furthermore, both legal-size and pre-recruit abundance have generally declined since 2006. Although the 2011 results remained above the low levels observed in 2009, abundances of legal-size and pre-recruit crabs were low in an historical context.

Pot-sampling data collected by fishers were consistent with results of the fishery-independent surveys, suggesting that relative abundance of pre-recruits in June/July has steadily declined since 2008 and in 2012 was approximately half the level observed in 2011. Furthermore, the relative abundance of pre-recruits in 2011/12 remained low throughout the entire season

The fishery-independent survey conducted at the beginning of the 2012/13 season (i.e. July 2012) indicated that the relative abundance of pre-recruits observed was low throughout Gulf St Vincent. The survey CPUE for pre-recruits was the second lowest observed and no pre-recruit crabs were found in 9 of the 24 blocks surveyed. The survey CPUE for legal-size crabs was approximately half that observed in 2010. No legal-size crabs were caught in 3 of the 24 surveyed blocks.

The 2011/12 season was the fourth consecutive year that the quota for Gulf St Vincent was not caught in full. More blocks were fished in 2011/12 than any other year, including new blocks south of Port Vincent. In the last two years high catches have been harvested from blocks close to shore compared to previous years (particularly adjacent to Port Gawler and along the metropolitan coastline). The high levels of catch per pot lift and catch per boat day in 2011/12 are likely to reflect the recent introduction of a new vessel with larger pots and are not considered to be indicative of the relative abundance of legal-size crabs.

The relative abundance of pre-recruits in pot-samples remained low during the first few months of the 2012/13 season. Commercial logbook data indicated that levels of catch and effort between July and September 2012 (October 2012 was not fished) were similar to the July to October periods in 2009 and 2010. Although only 10 t was harvested during September 2012, 73% of this catch comprised female crabs. This proportion of females is high in an historic context; however, the importance of the sex ratio on sustainability is poorly understood.

In summary, 2011/12 was the fourth consecutive year that the full TACC was not taken from Gulf St Vincent. Catches were spread across more fishing blocks than previous years. Relative abundance of pre-recruits was low during every month fished. Fishery-independent surveys indicated that relative abundance of legal-size and pre-recruit crabs were very low at the start of the 2012/13 season. This finding was reflected in pot-sampling data collected in the first three months of the 2012/13 season.

6. PERFORMANCE INDICATORS

This section summarises the performance of the Spencer Gulf and Gulf St Vincent pot fishing sectors of the BCF for 2011/12 against the key biological performance indicators (and their associated limit reference points) as defined in the harvest strategy of the Management Plan (Table 6.1).

Table 6.1. Summary of the performance of the South Australian Blue Crab Fishery for 2011/12 against the performance indicators of the Management Plan. The value highlighted in red indicates that the lower limit reference point was not achieved for that performance indicator.

Gulf	Data source	Performance indicator	Reference range		2011/12
			lower	upper	
SG	Fishery-independent survey	CPUE of legal-size crabs (legal-size crabs/pot lift)	5	8	9.3
	Fishery-independent survey	CPUE of pre-recruits (pre-recruits/pot lift)	2	9	8.7
	Commercial catch and effort	CPUE of legal-size crabs (kg/pot lift)	2	4	4.4
GSV	Fishery-independent survey	CPUE of legal-size crabs (legal-size crabs/pot lift)	1.5	4	1.6
	Fishery-independent survey	CPUE of pre-recruits (pre-recruits/pot lift)	1.5	8.5	**0.8**
	Commercial catch and effort	CPUE of legal-size crabs (kg/pot lift)	2	4	3.4

For Spencer Gulf, survey CPUE of pre-recruits was just below the upper limit reference point (i.e. within the reference range), while CPUE of legal-size crabs from both fishery-independent surveys and commercial catches were above their respective upper limits.

For Gulf St Vincent, the survey CPUE of 0.8 pre-recruits/pot lift was below the lower limit reference point (1.5 pre-recruits/pot lift), while CPUE of legal-size crabs from both fishery-independent surveys and commercial catches were within the reference range.

7. GENERAL DISCUSSION

7.1. Available data and uncertainty in the assessment

Assessment of the Spencer Gulf and Gulf St Vincent pot fishing sectors is based primarily on measures of relative abundance of legal-size and pre-recruit crabs obtained from fishery-independent surveys of each gulf. Interpretation of these indices and the status of the resource are supplemented by fishery-dependent information provided from pot-sampling.

Fishery-independent surveys provide the most meaningful indices of relative abundance of legal-size and/or pre-recruit crabs for the fishery. Surveys provide a snapshot of the full spatial extent of the relative abundance at the end (June for Spencer Gulf) or beginning (July for Gulf St Vincent) of the quota season, which is around the period of peak recruitment. Surveys have been conducted annually in each gulf since 2002, with the exception of Spencer Gulf during 2011 when the high catch rates of legal-size and pre-recruit crabs in 2010 enabled a survey to be skipped as identified in the Management Plan (PIRSA 2012). Based on the continued good performance of the Spencer Gulf sector presented in this report, a fishery-independent survey will not be required in Spencer Gulf in 2013.

The location of survey sites was rationalised in consultation with PIRSA and industry prior to the 2008 survey to ensure that surveys adequately represent the current harvestable biomass. A subset of 'standardised' sites, which have been consistently surveyed since 2002, were analysed to provide meaningful comparisons over time. Data from research pots deployed during commercial fishing were assessed to provide an unbiased index of relative abundance, particularly for pre-recruits. Whilst surveys provide a reliable index of relative abundance, these measures could potentially be improved by standardisation of CPUE (see review by Maunder and Punt 2004).

Commercial logbook data have been collected for the fishery since the introduction of quota in 1996/97. Interpretation of temporal trends in relative abundance legal-size from commercial CPUE data is impeded by changes in gear and vessel technology (particularly in 2010/11), changes in fisher demographics and experience, temporal and regional shifts in catch and effort, and changes in fishing behaviour such as conducting second pot lifts (not always recorded). During 2010/11, an increase in the size of the pot used by part of the fleet increased the uncertainty associated with interpretation of commercial logbook data from both gulfs. Commercial logbooks also provide some data on the relative abundance of pre-recruits, however, these are biased underestimates as commercial crab pots are highly selective and relatively few small crabs are captured.

The pot-sampling program was established in 2006, with the objective of obtaining more robust information on relative abundance (size and sex) from one small-mesh pot (research), or up to two small-mesh pots since 2010/11, for each day's fishing. The use of small pots in the pot-sampling program overcomes many of the issues associated with interpreting the logbook data from commercial pots. Increasing the number of research pots sampled during each day's fishing could further improve the reliability and value of these data and the potential to use these data as a supplementary measure of relative abundance of legal-size and pre-recruit crabs to augment future assessments of stock status.

7.2. Status of the Blue Crab Fishery

7.2.1. Spencer Gulf pot fishing sector

The biomass upon which the Spencer Gulf pot fishing sector is based remains in a strong position. Fishery-independent survey data indicate that the relative abundance of legal-size and pre-recruit crabs in June 2012 were the highest and second highest levels recorded, respectively. Relative abundance of legal-size crabs has remained at high levels since 2008. Pot-sampling data suggest that recent high levels of relative abundance of pre-recruits continued throughout the 2011/12 season. Commercial catches have also been also stable with almost the entire TACC harvested. Recent increases in mean catch per pot lift and catch per day over the last two years in part reflect an increase in efficiency in part of the fleet. Under an option provided in the Management Plan, these results indicate that a survey will not be required in Spencer Gulf during June 2013. On the weight of evidence, the Spencer Gulf TACC appears to be fished within sustainable limits. Using the national framework for stock status reporting (Flood *et al.* 2012), the Spencer Gulf pot fishing sector would be classified as a sustainable stock[1].

7.2.2. Gulf St Vincent pot fishing sector

Available data for the Gulf St Vincent pot fishing sector indicate that the biomass upon which the fishery is based is currently at its lowest level since the introduction of quota. Trends in relative abundance of legal-size and pre-recruit crabs from fishery-independent surveys have declined since 2006. During this period the entire quota was caught on only one occasion (i.e. 2007/08). While most of the TACC was caught in 2011/12, the distribution of catches was different to most previous years, with more blocks fished and larger catches being harvested from new areas and areas close to

[1] The stock status classification 'sustainable' is described in Flood *et al.* (2012) as a 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.

shore. Pot-sampling data collected throughout 2011/12 indicate that relative abundance of pre-recruits was low throughout the entire season. Data collected during the July 2012 fishery-independent survey (i.e. at the start of the 2012/13 season), indicated that the relative abundance of legal-size and pre-recruit crabs were the lowest and second lowest recorded, respectively.

In this report we examined commercial catch and effort and pot-sampling data for the beginning of the 2012/13 season (July to October) to provide an up-to-date assessment of current status. In response to the poor survey result obtained in July 2012, blue crab fishers decided not to fish in October 2012. Available pot-sampling data indicated that relative abundance of pre-recruits remained low from July to September 2012. Despite the decision to not fish in October 2012, catch and effort levels in the first three months of fishing (July to September 2012) were similar to catch and effort levels in the first four months of the 2009/10 and 2010/11 seasons. In addition, monthly commercial CPUE was the equal to lowest for the fishery for these first three months despite the recent increases in the efficiency of the fleet. These data indicate that stock status may have declined further since the end of the 2011/12 season.

There is strong evidence that the Gulf St Vincent blue crab resource is at its weakest since the introduction of quota. Substantial proportions of the TACC were not harvested in 2008/09, 2009/10 and 2010/11, and the TACC has not prevented declines in relative biomass. On the weight of evidence, the current Gulf St Vincent TACC does not appear to be sustainable. Using the national framework for stock status reporting (Flood *et al.* 2012), the Gulf St Vincent pot fishing sector would be classified as a transitional-depleting stock[2].

7.3. Performance indicators

The current Management Plan for the BCF was released in 2012 (PIRSA 2012). The previous stock assessment report (Dixon *et al.* 2012) suggested that the primary performance indicators of biological 'stock status' of the resource should be the relative abundance measures of legal-size and pre-recruits obtained from surveys. The Management Plan also includes commercial CPUE as an index of abundance of legal-size crabs; however, this is not as reliable an indicator of stock status due to the influence of changes in gear and vessels, fisher demographics and experience, shifts in the distribution of effort and changes in the frequency of second pot lifts, While standardisation of commercial CPUE data or

[2] The stock status classification 'transitional-depleting' is described in Flood *et al.* (2012) as a deteriorating stock, where biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished.

examination of CPUE trends by individual fishers may reduce this uncertainty, estimates of relative abundance from fishery-independent surveys provide a more reliable measure of stock status.

Pot-sampling data provide a useful measure for the relative abundance of pre-recruits throughout the season. Increasing the number of pot-samples taken per trip has the potential to provide a useful secondary index of abundance for legal-size and pre-recruit crabs. However, relative abundances of legal-size and pre-recruit crabs derived from fishery-independent surveys should remain the key performance indicators for this fishery.

7.4. Future research needs

Industry members have expressed concern that the primary limitation of conducting pot-sampling is the time taken to measure the carapace widths of all crabs in a pot. While size should continue to be measured for crabs in one pot, the data collected from additional pots may include counts of legal-size and pre-recruit crabs by sex. This would minimise the imposition on crews while improving the reliability of results obtained from the pot-sampling program.

Currently, the Spencer Gulf and Gulf St Vincent prawn fisheries conduct regular, fishery-independent trawl surveys throughout each gulf. Blue crabs are caught during these surveys as by-catch. There is potential for prawn surveys to provide a useful and cost-effective data source to inform assessments of blue crabs. Prawn surveys have also been conducted in the upper parts of each gulf, where juvenile prawns were sampled using a 'jet net' method (Roberts *et al.* 2005). Although the abundance of juvenile blue crabs among these samples was relatively low (SARDI unpublished data), alternative sites and sampling times could be sampled to assess the jet net as a tool for sampling pre-recruit crabs.

Anecdotal evidence suggests that high abundances of juvenile blue crabs occur in the intertidal zone of each gulf at certain times of the year. If an appropriate sampling method and design could be developed it may be possible to develop another indicator of pre-recruit abundance.

A better understanding of the importance of sex ratio in the catch is needed. The possibility of utilising processor information to augment commercial logbook data should be investigated. Future research should aim to examine the historical sex ratio of the catch and assess whether reference levels for the proportion of females harvested should be developed.

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