Stock Assessment Report to PIRSA Fisheries

Blue Crab (*Portunus pelagicus*) Fishery 2006/07

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

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EXECUTIVE SUMMARY

1. This fishery assessment report updates the 2007 report and assesses the current status of the Blue Crab Fishery (BCF) in South Australia.

2. All available evidence suggests that blue crab stocks in both Spencer Gulf (SG) and Gulf St Vincent (GSV) are being harvested within sustainable limits. In 2006/07, >98% of the TACC was harvested.

3. Annual catch per potlift ($CPUE_L$) from the fishery was stable for each Gulf between 1997/98 and 2006/07. The lack of sensitivity in annual $CPUE_L$ and the uncertainty associated with changes in fishing efficiency and distribution of fishing effort, limit the use of annual $CPUE_L$ as a performance measure for the BCF.

4. Data from commercial logbooks provides an inadequate measure of pre-recruit abundance. Limited pot sampling data were collected between May 2006 and December 2007. These data could provide an appropriate measure of fishery-dependent pre-recruit abundance.

5. Fishery-independent survey data suggest that the abundance of pre-recruit crabs in Spencer Gulf was the highest recorded during 2007, whilst the abundance of legal sized crabs remained stable. In Gulf St Vincent, the abundance of pre-recruit and legal size crabs was the highest and second highest recorded during 2006 and 2007, respectively.

6. Uncertainty associated with survey data would be reduced by ensuring that surveyed regions are representative of the fishery and ensuring that surveys methods are consistent between years (e.g. timing and gear).

7. Data were available to assess the fishery's performance against nine of the 11 Performance Indicators (PIs). Eight of these nine PIs were above the target reference point.

8. A combination of fishery-independent and commercial data would provide a suitable framework for ongoing assessment of the fishery. Uncertainties in each of these measures should be minimised to ensure that assessments are as robust as possible.

1 INTRODUCTION

This report is the fourth version of a "living" document that has been updated annually as part of SARDI Aquatic Sciences ongoing assessment program for the South Australian Blue Crab Fishery (BCF). 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 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.

Section 1 of this report provides information on management of the BCF, the biology of blue crabs in South Australia, and the data available for stock assessment.

Section 2 presents an overview of the catch and effort history of the fishery from inception up to 31 July 2007. Section 2 also provides analyses of the catch history of the Marine Scalefish sector. Sections 3 and 4 provide comprehensive analyses of Pot Fishery data available since the introduction of quota (1997/98) for each of the Spencer Gulf and Gulf St Vincent regions, respectively.

Assessment against the performance indicators in the Management Plan is provided in Section 5. The final section provides a summary discussion of the current status of the resource in each region and the uncertainty associated with assessment, discusses limitations in the current Performance Indicators, and identifies future research needs.

1.1 HISTORY OF THE FISHERY

1.1.1 Commercial Fishery

Blue swimmer crabs (*Portunus pelagicus*) were first harvested as by-product in South Australian prawn and marine scalefish fisheries in the 1970's. In 1981, an experimental trawl fishery with four licensed fishers was established in northern Spencer Gulf. This approach was soon abandoned and, in 1983, six experimental pot fishing permits were offered to marine scale fishers. In 1985/86 the number of experimental licenses was increased to 12: four in the West Coast, six in Spencer Gulf, and two in Gulf St. Vincent. Shortly after, the West Coast fishery declined and the four licence holders surrendered their entitlements in 1986. Also during 1986, the sale of blue swimmer crabs as by-product from the prawn fishery was prohibited.

In June 1996, management arrangements for a fully commercial Blue Crab Fishery (BCF) were established. An initial management strategy was implemented along with a core research program to support the development and maintenance of a sustainable and viable fishery. In 1997, PIRSA Fisheries proposed a 3-year development strategy for the BCF. During this period, the capacity for expansion of the fishery was to be determined through research and continued fishing. A limited entry fishery was created with access based on historical catches.

The fishery is based on the capture of a single species, *Portunus pelagicus,* although other crab species may also be landed. The fishery is comprised of two fishing zones; Spencer Gulf and Gulf St Vincent (Figure 1.1). There is a single TACC for the fishery with separate quota units for each zone. Blue crabs may also be taken from specified waters on the West Coast, however this region is not subject to the quota system.

Commercial pot fishers generally haul their gear every 24 hours using specifically designed crab pots covered with netting. Commercial marine scale-fish 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 in port. Most of the commercial catch is marketed in Australia, primarily in the Sydney and Melbourne fish markets. In 2005/06 the commercial landed value of blue crabs in South Australia was $3.626 million (Knight *et al*, 2007). This value includes commercial quantities of blue crabs taken from the West Coast, which are part of the MSF catch.

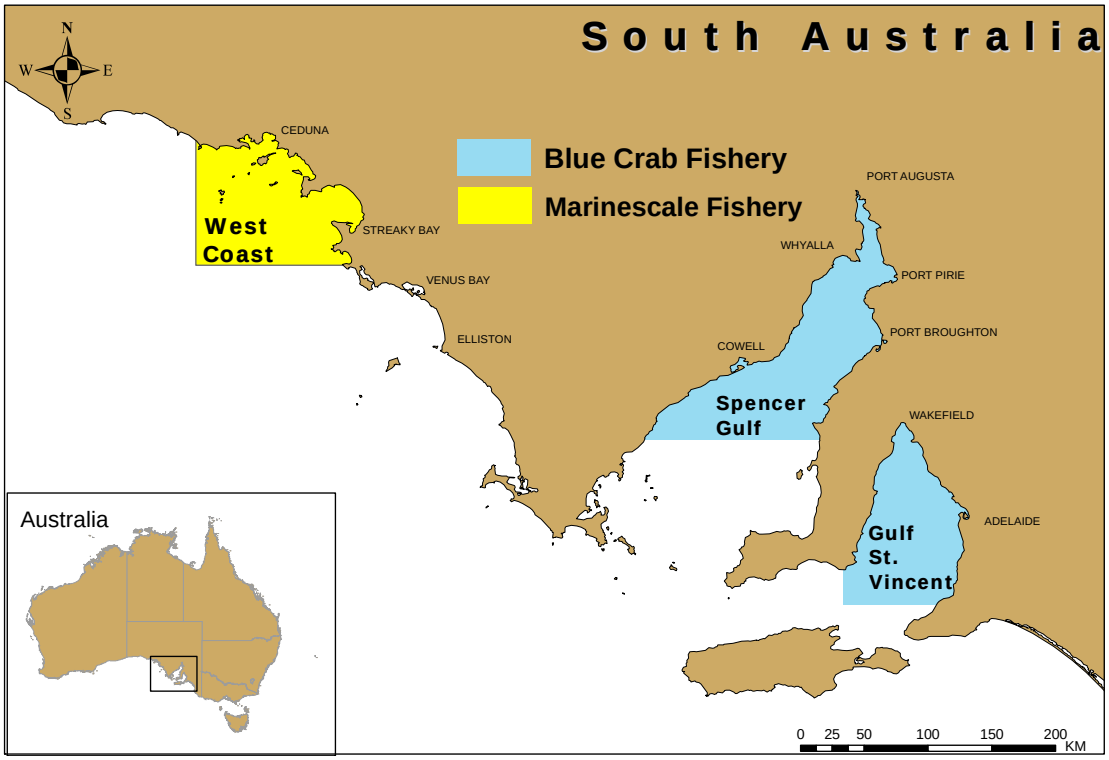


Figure 1.1 The location of blue crab fishing regions in South Australia.

1.1.2 Recreational Fishery

There is no regular assessment of the recreational harvest of blue swimmer crabs in South Australia. McGlennon and Kinloch (1997) estimated a total 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. Thus, the recreational catch was estimated to be 32.9% in Gulf St Vincent, 10.8% in Spencer Gulf and 20% of the overall TACC. This estimate does not include the recreational shore-based fishery, which is considered to be significant.

More recently, a National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) was conducted between May 2000 and April 2001. The estimated annual catch taken by recreational fishers during this period for South Australia was 389.8 t. This indicates that the recreational harvest was 37.5% of the total catch during 2000/2001. A further 31.7% of the total catch was released after capture (Anon, 2003).

1.2 MANAGEMENT

The Blue Crab Fishery is managed by Primary Industries and Resources South Australia (PIRSA) under the framework provided by the *Fisheries Management Act 2007*. General Regulations pertaining to commercial and recreational harvest of blue crabs in South Australia are described in the *Fisheries Management (General) Regulations 2007*, with specific legislation located in the *Fisheries Management (Blue Crab Fishery) Regulations 1998*, and the *Fisheries Management (Marine Scale Fisheries) Regulations 2006*. These documents provide the statutory framework for management of South Australia's blue crab resources.

1.2.1 Management History

Several fishing sectors have had historic access to blue crab resources in South Australia. During the 1970's and early 1980's, prawn trawlers were allowed to retain blue crabs as a by-product of commercial prawn fishing. This practice was banned in 1986. Whilst blue crabs were seldom a target species for marine scale fishers in the early history of this fishery, they were seasonally caught as by-catch in haul and gill nets in waters less than 5 metres deep. In 1981, an experimental trawl fishery was established for four marine scale fishers, but this was abandoned soon after and replaced with an experimental pot fishery in 1983.

The commercial blue crab fishery was fully realised in 1996, with formalised management arrangements established that included pot restrictions, splitting of the fishery into two zones (Spencer Gulf and Gulf St Vincent) and a single Total Allowable Commercial Catch (TACC) that is allocated into quotas units for each zone. Quota is transferable between the pot fishing and marine scalefish sectors.

Since the implementation of the TACC in the South Australian BCF in 1996/97, there has been a transfer of fishing effort from the MSF to the pot fishing sector (Figure 1.2). The number of MSF licences entitled to blue crab quota has reduced from 29 to nine during this period. When quota was first introduced, there were four licensed pot fishers in Spencer Gulf (SG) and two in Gulf St Vincent (GSV). An additional licence was added to each of the SG and GSV fisheries in 2001/02 and 2002/03, respectively. Note that an additional pot fishing licence was added to the GSV fishery in 2006/07, but is not shown here as it was transferred at the end of the fishing season.

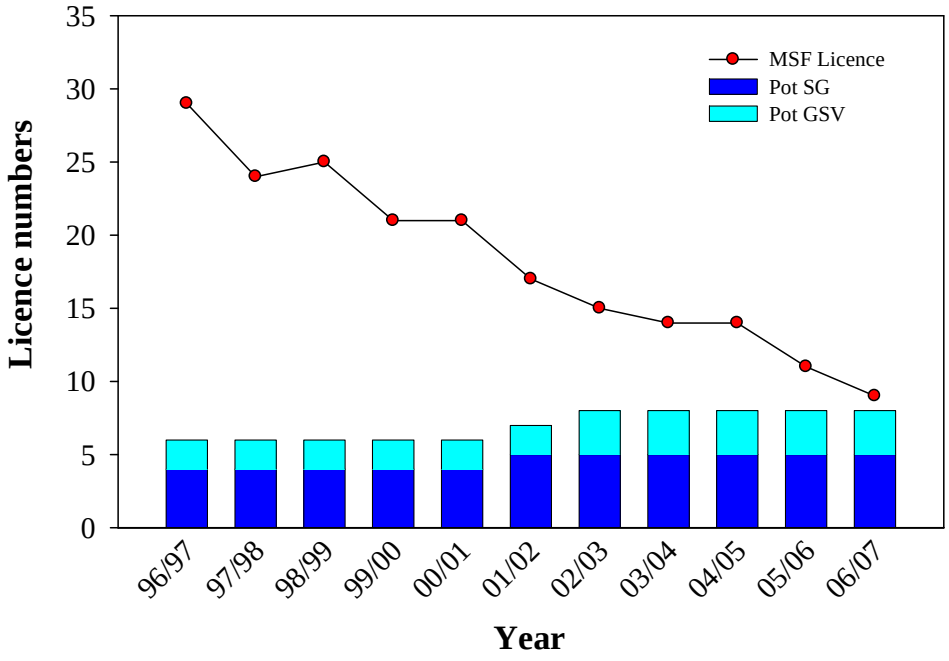


Figure 1.2 Number of licence holders in the commercial Blue Crab Fishery.

1.2.2 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 until it reached 626.8 t in 2000/01, where it has remained ever since.

The fishery operates with a minimum legal size of 110 mm carapace width, which is measured at the anterior base of the first spine. The commercial fishery also has closed seasons (21 December to 19 February in Spencer Gulf, and 1 November to 15 January in Gulf St Vincent) and fishers are not permitted to retain egg-bearing females.

Recreational fishers are subject to a daily bag limit of 40 crabs (blue crabs and/or sand crabs) per person per day. When fishing from a boat, the personal bag limit applies up to a total of three people, after which a boat limit of 120 crabs per day applies.

1.2.3 Blue Crab Fishery Management Plan

A draft Management Plan (referred to hereafter as the Plan) was developed by the Blue Crab Fishery Management Committee in conjunction with PIRSA Fisheries in 2000. The Plan is currently being updated by PIRSA Fisheries in light of the introduction of the *Fisheries Management Act 2007*.

The primary objectives for the BCF as provided in the Plan are:

- Ensure sustainable harvests from the blue crab resource.
- Ensure equitable allocation of the blue crab resource to the commercial and recreational sectors.
- Provide efficient and cost effective management of the fishery.
- Provide for secure access to the resource for each sector.
- Minimise the impact of blue crab fishing on the environment.
- Provide society with a return from the blue swimmer crab resource.

To ensure a robust assessment of the fishery, performance is measured annually against the key fishery indicators defined in the Plan (Table 1.1).

Table 1.1 Key performance indicators for the Blue Crab Fishery

Indicator	Interim Target Ref.	Interim Limit Ref.
Catch	TACC	80% of TACC
Relative exploitation rate		
Gulf St Vincent (% of 1994 level)	50	100
Spencer Gulf (% of 1990 level)	40	80
Pre-recruit (as % under-size in June and July)		
Gulf St Vincent	10	5
Spencer Gulf	30	15
Sex Ratio (% female in June and July)	30	15

1.3 BIOLOGY OF THE BLUE SWIMMER CRAB

1.3.1 Description

The blue swimmer crab (*Portunus pelagicus,* Linnaeus 1766) is a true crab (Brachyura) belonging to the family Portunidae.

The blue swimmer crab has five pairs of legs. 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 Male (top) and female (bottom) blue swimmer crabs *Portunus pelagicus* (L.).

1.3.2 Distribution and stock structure

Portunus pelagicus is distributed throughout the coastal waters of the tropical regions of the western Indian Ocean and the Eastern Pacific (Kailola *et al.*, 1993); they are adapted to a life in warmer waters. 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 are elevated to those similar to the tropical regions. Activity reduces during the colder winter months.

P. pelagicus occurs in a wide range of algal and seagrass habitats and on both sandy and muddy substrata, from the intertidal zone to at least fifty metres of depth (Williams, 1982; Edgar, 1990). In coastal waters, smaller crabs are found in shallow waters, while adults are found in comparatively 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. pelagicus* 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. pelagicus* in different embayments in South Australia often constitute genetically different meta-populations. The level of migration between these populations is probably limited is likely to be determined by local factors.

1.3.3 Reproductive biology

Male and female *P. pelagicus* generally reach sexual maturity at a size of 70 to 90 mm in carapace width, 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 3 to 4 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 in females appears to be triggered by rising water temperatures 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 spematheca of female *Callinectes sapidus* could remain viable for at least 12 months. This is likely to also be the case for *P. pelagicus*. 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 1 (S1): Gonad immature, white or translucent

Stage 2 (S2): Gonad maturing, light yellow/orange, not extending into hepatic region

Stage 3 (S3): Gonad maturing, yellow/orange not extending into hepatic region

Stage 4 (S4): Gonad mature, dark yellow/orange extending into hepatic region

Stage 5 (S5): Ovigerus, female bearing fully matured eggs (pale to dark yellow eggs) externally.

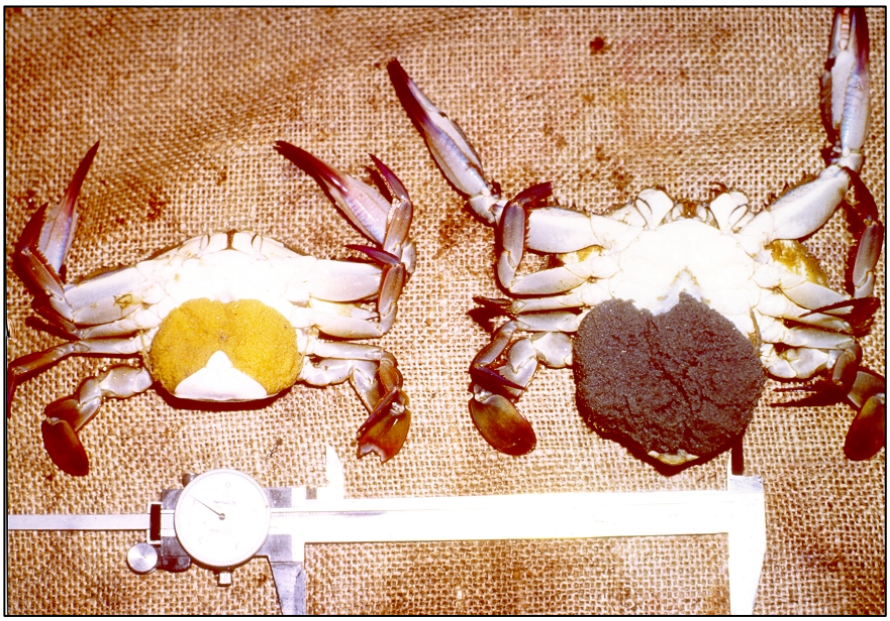
The fourth stage of ovarian development was observed in late October to November in conjunction with rising seawater temperatures. Kumar *et al.* (2000) demonstrated that during November, more than 40% of crabs were in advanced Stage 4, and 80% caught were between Stages 3 and 4.

Stage 1

Stage 2

Stage 3

Stage 4



Stage 5

Figure 1.4 Ovarian stages of the blue swimmer crab (from Kumar *et al.,* 2000).

In tropical waters, female blue swimmer crabs are found to carry eggs throughout the year. However, seasonal variation in the number of egg-bearing females can be observed (see Kumar *et al.,* 2000). During embryonic development (Stage 5), the colour of the eggs changes from yellow to a dark grey (Figure 1.4).

In South Australian waters, while egg-bearing females have been observed throughout the year there is a substantial increase in the proportion of berried females in late spring. Data from the commercial fishery logbooks shows the percentage of berried females caught in GSV from July 1997 to June 2005 (Figure 1.5). In Spencer Gulf, a larger proportion of berried females appeared in the catch slightly later than in Gulf St Vincent. This pattern was consistent between years.

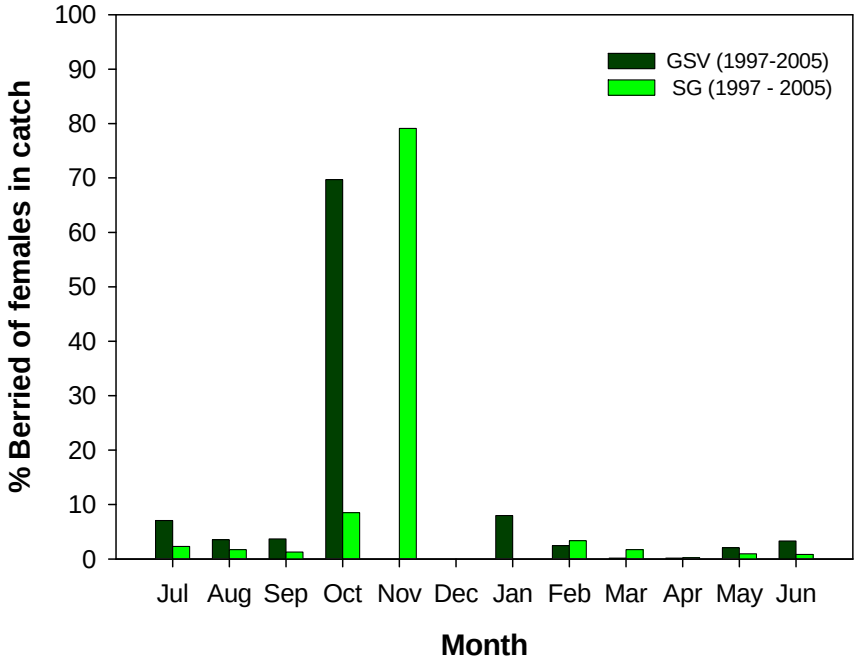


Figure 1.5 Mean monthly percentage of berried females in commercial catches from 1997 to 2005. GSV=Gulf St Vincent; SG=Spencer Gulf.

Fecundity is calculated as the number of eggs carried externally by the female. Kumar *et al.* (2003) found that the fecundity of female crabs is size-dependent and increases up to a carapace width of 134 mm and decreases thereafter. Fecundity increased by 83.9% with an increase of carapace width 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.

P. pelagicus 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 2 and 3 in the ovary whilst also carrying an external egg mass (Kumar *et al.*, 2003). While blue crabs are capable of producing more than one batch of eggs in a season, successive ovulations do not always occur (Meagher, 1971).

1.3.4 Parasites

The parasites of some decapod crustaceans are known to cause sterilisation of their host, and can therefore have an important impact of the population of infested species (Gaddes and Sumpton, 2004). The barnacle *Sacculina granifera* is a known parasitic castrator of *P. pelagicus*, 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.

1.4 DATA SOURCES FOR STOCK ASSESSMENT

1.4.1 Previous Related Research

The first report on the South Australian Blue Crab Fishery was published in 1987 by the South Australian Department of Fisheries (Grove-Jones, 1987). In 1994, the blue crab fishery was reviewed (Baker and Kumar, 1994). SARDI completed the first stock assessment report for the fishery in 1998, and has since provided annual reports (Kumar, *et al.,* 1998; Kumar, *et al.,* 1999a; Kumar *et al.,* 1999b; Boxshall, *et al.,* 2000; Boxshall, *et al.,* 2001; Hooper and Svane, 2003; Svane and Hooper, 2004; Currie and Hooper, 2006; Currie *et al.*, 2007). The Proceedings of the First National Workshop on Blue Swimmer Crab were published in 1997 (Kumar *et al.,* 1997).

Initiated by the Fisheries Research and Development Corporation (FRDC), the Centre of Research on Ecological Impacts of Coastal Cities at the University of Sydney completed an independent review into the research needs of the fishery in February 2001. This report, which was done in consultation with stakeholders, includes comments on the sampling issues for Ecological Sustainable Development (ESD) outcomes, and provides a research review, short-term monitoring advice, and recommendations for a 5-year research program (Scandol and Kennelly, 2001).

A more recent FRDC report (Svane and Cheshire, 2005), reviewed the biology of blue crabs and the key biological determinants for the fishery. This report also provides information on the geographical patterns of post-settlement in juvenile crabs.

1.4.2 Fishery statistics

SARDI maintains a comprehensive catch and effort database for the BCF using data collected from the compulsory fishing logbook system. To simplify reporting, each gulf is divided into a series of administrative fishery blocks. Data provided includes: fishing block, depth, effort, catch weight and catch abundance. The logbook system is also used to collect biological data, including the number of undersized crabs, berried females and the sex ratio of the catch. These data were first obtained in 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.

1.4.3 Pot sampling

Pot sampling data was first collected in May 2006. Sampling was voluntarily undertaken for one research pot and one commercial pot each fishing day. Data collected includes: date, licence number, fishing block, GPS co-ordinates, depth, water temperature, and the sex and size of individual crabs (see Appendix 8.1).

1.4.4 Fishery-independent survey

Fishery-independent surveys for the Blue Crab Fishery were conducted on an annual basis during June/July from 2002 (Table 1.2). The primary aim of the survey was to collect data on the spatial abundance and size composition of blue crabs in Spencer Gulf and Gulf St Vincent during winter, when juvenile crabs generally recruit to the fishery. Section 4 of the report provides an assessment of spatial and temporal trends in crab size and abundance among the six surveys.

The timing of surveys in Spencer Gulf was variable, particularly between 2002 and 2005 (Table 1.2). Whilst most surveys were conducted in June and early July, surveys were held in late July to early August in 2003 and were extended throughout the month of July in 2005. In Gulf St Vincent, surveys were conducted in July from 2002 to 2004, and June thereafter.

The surveyed area covers waters with depths ranging from 3 m to 22 m northwards of line from Glenelg to Port Vincent in the Gulf St Vincent and northwards of a line from Wallaroo to

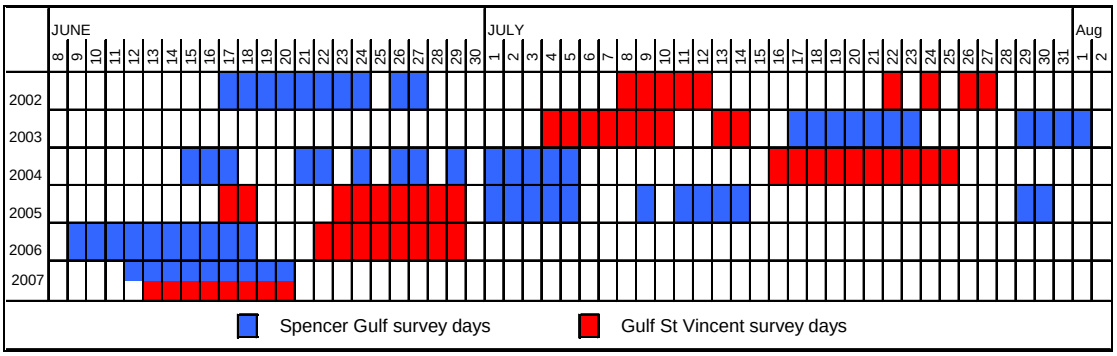
Cowell in Spencer Gulf (Figure 1.6). Sampling sites were determined based on fisher experience and historical catch and effort data. From these recommendations, four sites were selected in each fishing block to be surveyed (Figure 1.6).

For interpretation of spatial trends, the data from each block were grouped into three areas for each gulf. In SG, blocks 1-12 constitute the "North" area, blocks 13-26 the "Centre" area, and the remaining blocks the "South" area. In GSV, blocks 1-11 plus 37, 38, 39 and 89 constitute the "North" area, blocks 12-21 plus 36, 40 and 41 comprise the "Centre" area, and the remaining blocks the "South" area.

At each site, both commercial crab pots (Figure 1.7) and research pots (Figure 1.8) were set and hauled on a daily basis. Commercial pots have a diameter of 1.2-1.4 m, a height of 50 cm, and are covered with a 90 mm mesh. Research pots, used specifically for surveys, have a diameter of 1.4 m, a height of 50 cm, and a smaller mesh covering of 55 mm. At each survey site, five sets of gear were deployed along a line, each comprising one commercial and one research pot. Each pot was separated by 40 m of rope and each set of gear spaced 150 m apart. Pots were baited with fresh Australian salmon or striped trumpeter, and were hauled at dawn.

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

Table 1.2. Dates of fishery independent surveys conducted in Spencer Gulf and Gulf St Vincent from 2002 to 2007.



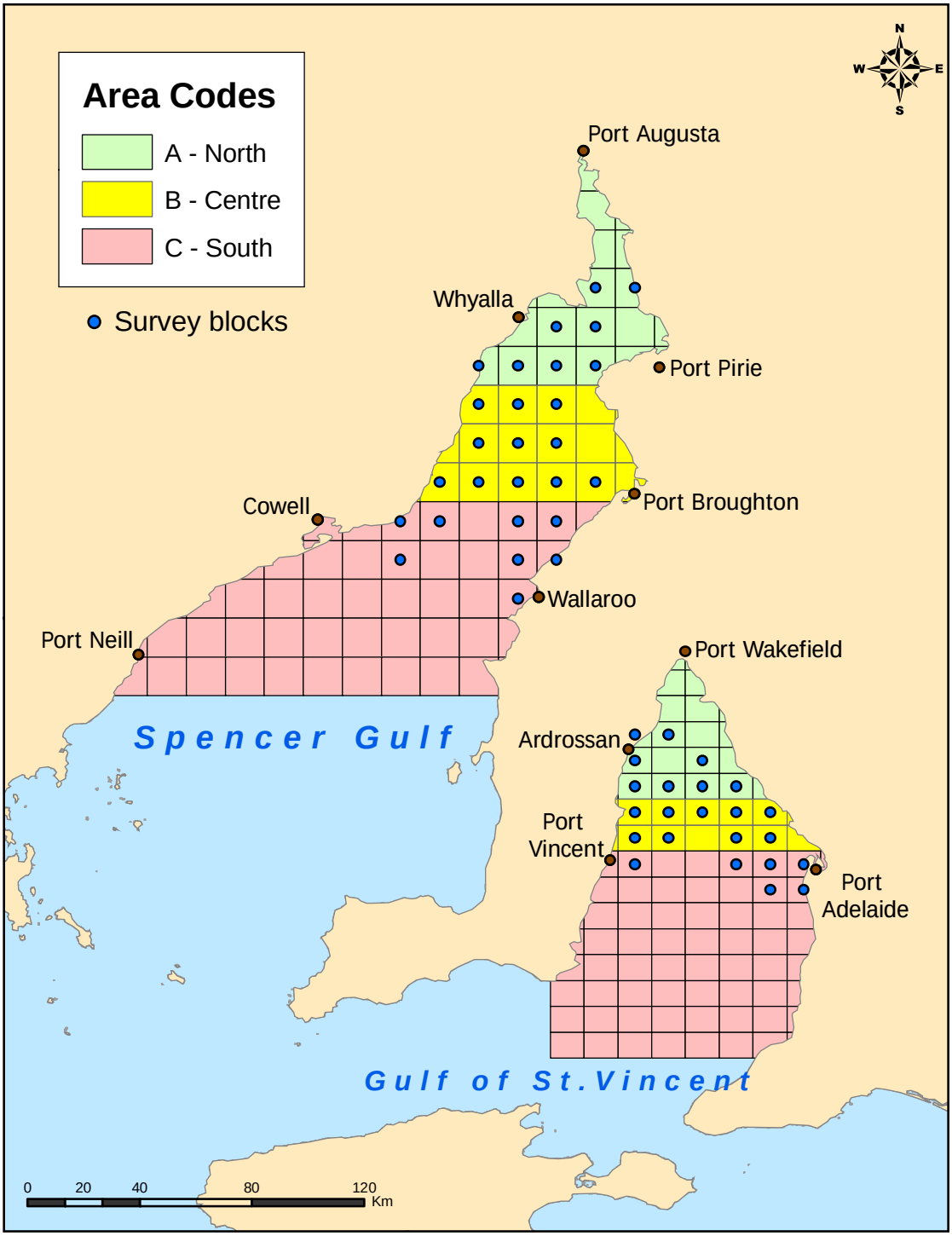


Figure 1.6. Commercial fishing blocks (squares), regions (green=north; yellow=central; pink= south), and surveyed fishing blocks (blue dots) for the blue crab fishery in Spencer Gulf and Gulf St. Vincent.

Figure 1.7. Commercial crab pot used by the fishery with a mesh size of 90 mm.

Figure 1.8. Research crab pot with a mesh size of 55 mm.

1.5 DISCUSSION

Despite diverse methods of capture from a number of harvesting sectors, the history of the blue crab fishery is well documented and the fishery sustainably managed. Fully commercialising the fishery in 1996/97, including the establishment of a TACC, has encouraged the focus of harvest toward the highly efficient pot fishing sector. In turn, this has enabled the development of refined management approaches based on an improved biological understanding of the fishery.

The reproductive biology of *P. pelagicus* in South Australia is well understood. This understanding will be augmented by a current FRDC project that aims to combine a model of the hydrodynamic processes in Spencer Gulf, with biological information on the extent and distribution of spawning female blue crabs, and the behaviour of blue crab larvae, to predict the environmental conditions and favourable locations for blue crab post-larval settlement.

Of particular importance, both growth and movement patterns of *P. pelagicus* in South Australia are poorly understood. Previous tagging studies have generally failed to obtain sufficient tag recaptures for useful analyses. This is a common problem associated with tagging studies of crab species. Alternative techniques need to be sought to obtain information on these critical population parameters.

Important sources of fishery-dependent data (commercial logbook and pot sampling) and fishery-independent data (survey) are available for assessment of the pot fishing sector of the Blue Crab Fishery in each of Spencer Gulf and Gulf St Vincent. The following sections of this report provide detailed analyses and interpretation of these datasets for each gulf, including discussion of the limitations of and future research needs for stock assessment. Also, analyses of commercial logbook data for the marine scalefish sector of the Blue Crab Fishery are provided.

2 FISHERY OVERVIEW

2.1 TOTAL CATCH AND EFFORT

Data on total catch and effort includes both the Marine Scalefish and Pot Fishery sectors. Detailed analyses of the Marine Scalefish Fishery are provided in section 2.2. Detailed analyses on the Pot Fishery sector in Spencer Gulf and Gulf St Vincent since the introduction of quota (1996/97) are provided in sections 3 and 4, respectively.

Catches of blue crabs were first recorded in 1983/84, when 26.9 t of crabs were harvested from 530 boat days (Figure 2.1). Over the following twelve years catches progressively increased and reached a historical high of 651.3 t in 1995/96. The introduction of quotas in the following season resulted in a 29% reduction in catch, with 462.4 t being harvested during 1996/97. Since then, catches have generally increased each season.

Over the past seven years the TACC has been set at 626.8 t. The total catch during 2006/07 was 616.1 t, with 96.6% harvested by the pot fishery and 3.4% harvested by the MSF. This total catch represented a 0.5% decrease in catch from 2005/06. Whilst the TACC has not been fully harvested since implementation (1996/97), the proportion of TACC harvested has increased substantially in recent years and during 2006/07 represented 98.3% of that available.

Prior to the introduction of quota, trends in commercial catch generally followed trends in effort (boat days). During 1996/97, effort was 2,213 boat days, rising to a maximum (post TACC) of 2,458 boat days in 1999/00. Since then, effort has generally decreased, with the number of boat days fished during 2006/07 (1,618 days) being 34% less effort than that expended during 1999/00 and 12% less than during 2005/06.

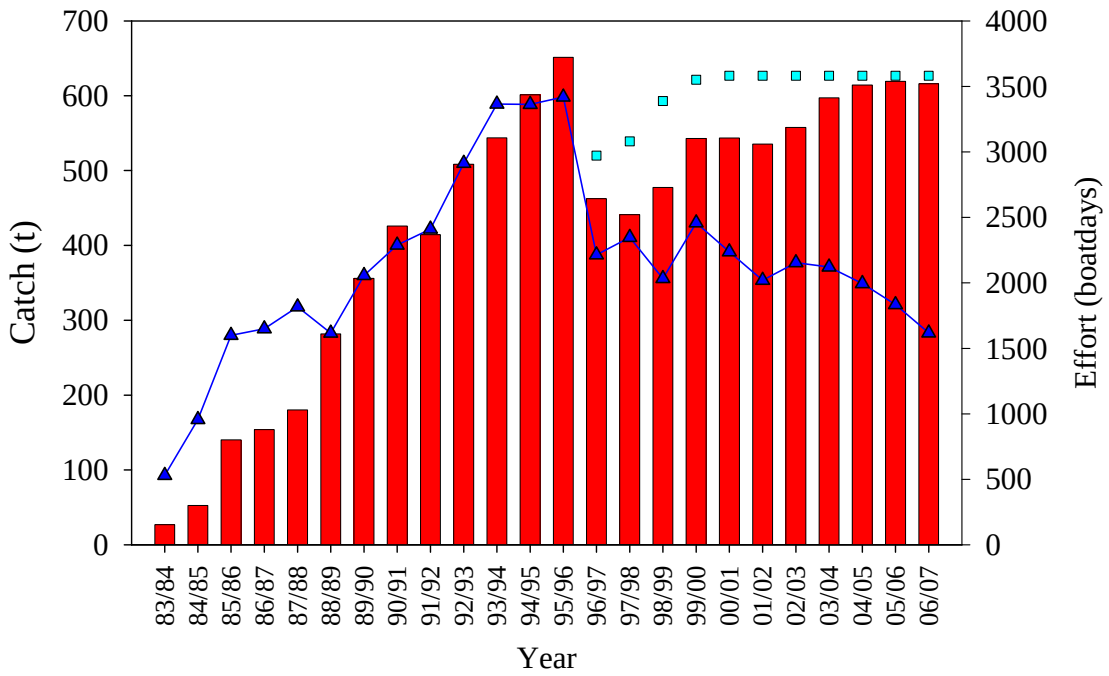


Figure 2.1 Total commercial catch (vertical bars, t), TACC (squares, t) and fishing effort (line, boatdays) for the Blue Crab Fishery from 1983/84 to 2006/07.

2.2 MARINE SCALEFISH FISHERY

2.2.1 Catch and effort

In 2006/07, the MSF sector held 28.47 t of the TACC (source: PIRSA Fisheries). This sector harvested 21.01 t of crabs in 2006/07, representing 73.8% of the TACC available to this sector. Crab catches by the MSF have fluctuated considerably since the implementation of the TACC in 1996/97 (18–79 t, Figure 2.2). Since 1999/00, catches (and the amount of quota held by this sector) have progressively declined.

Annual trends in fishing effort for the MSF (boat days) have generally mirrored trends in catch (Figure 2.2). Since the peak catch and effort observed in 1995/96 (147.7 t and 1,859 boat days, respectively), catch and effort have reduced dramatically such that during 2006/07 the annual catch and effort (21.0 t and 140 boat days) represented an 86% and 92% reduction from their respective peaks. These declines were largely attributed to reductions in the number of licensed MSF fishers operating in the BCF (Figure 1.2).

The majority of the catch in 2006/07 was harvested with either hoop nets or drop nets (99.89%). A small proportion was captured using a floating, gar-mesh haul-net (0.09%) while the residual catch (0.02%) was harvested using a sinking, mixed-mesh haul-net. These trends were similar to those recorded during previous seasons.

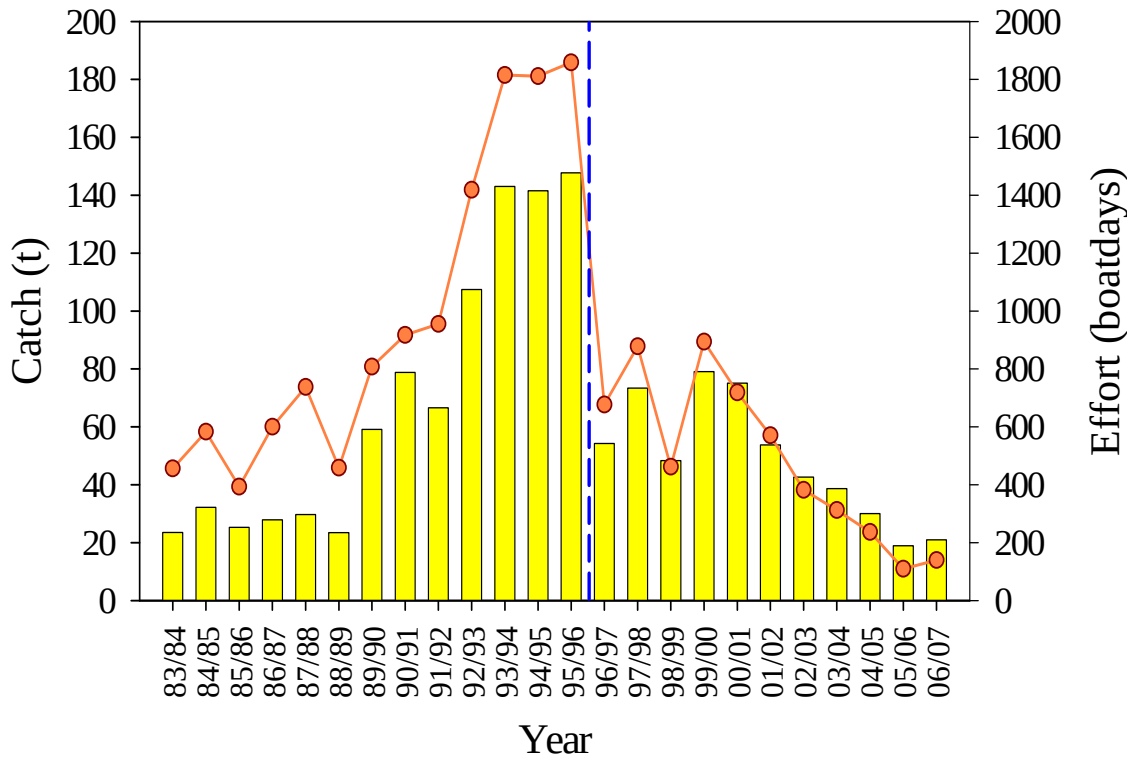


Figure 2.2 Annual crab catch (columns, t) and fishing effort (line, boatdays) for marine scale fishery from 1983/84 to 2006/07. Vertical blue line indicates the year when the TACC was implemented.

Seasonal trends in catches indicate that the largest proportion of the catch in the MSF fishery was landed during February and March (Figure 2.3). In 2006/07, 12.5 t (59.4% of the annual catch) was harvested during these two months. Seasonal patterns in fishing effort closely resembled patterns in catch (Figure 2.3). During 2006/07, effort peaked during March (43 boat days) and was lowest during July (1 boat day).

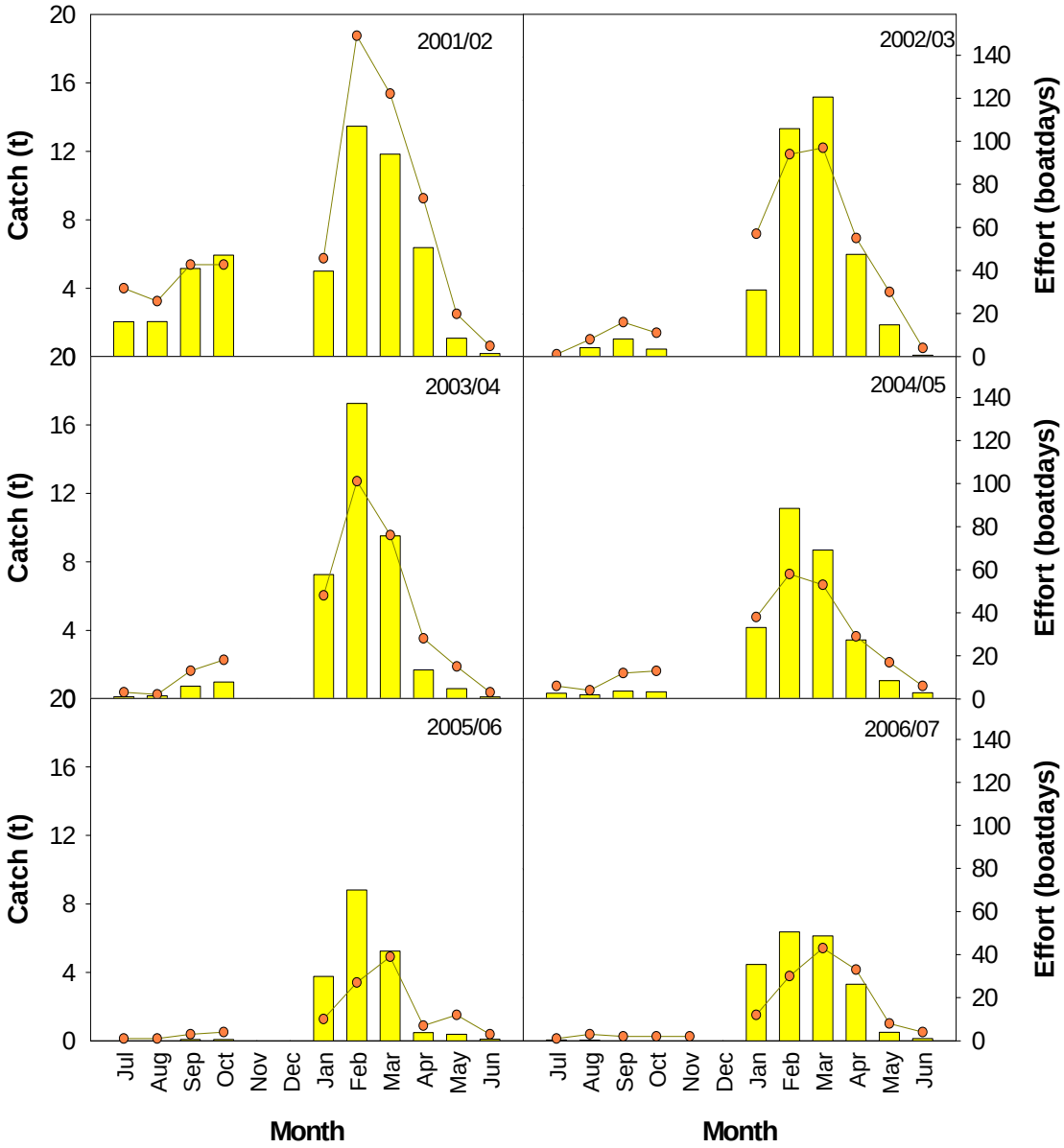


Figure 2.3 Monthly crab catch (columns, t) and fishing effort (line, boatdays) for the marine scale fishery from 2001/02 to 2006/07.

2.2.2 Catch Per Unit Effort

Catch rate for the MSF sector was determined as catch per boat day: $CPUE_D = \frac{Catch(kg)}{No.\ Boatdays}$

Daily catches ($CPUE_D$) gradually increased from 1983/84 to 2005/06 (Figure 2.4). Whilst catch rates during 2006/07 were approximately 13% lower than they were in the previous season (2005/06; 172.52 kg/boat day), they were still the second highest recorded.

It is likely that the increase in commercial CPUE observed from this sector is the result of a reduction in effort from less efficient MSF fishers, leaving the most efficient and dedicated MSF fishers remaining in the fishery. The uncertainty associated with the changes in efficiency in this sector mean that these CPUE data should not be used to infer changes in blue crab abundance.

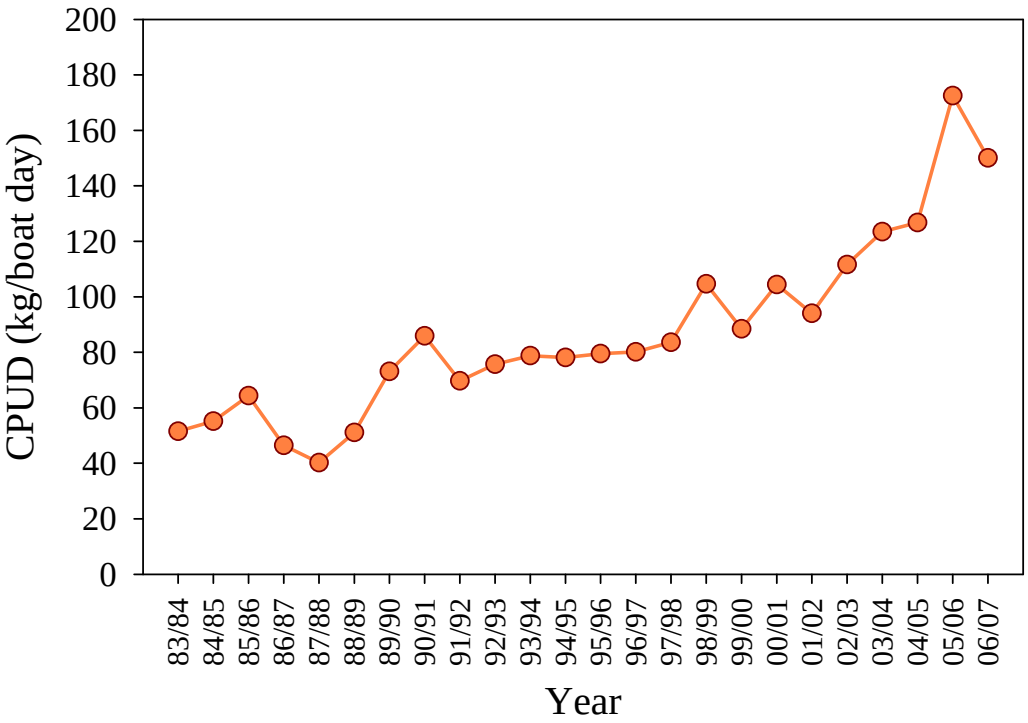


Figure 2.4 $CPUE_D$ in the Marine Scale Fishery since 1983/84.

2.3 DISCUSSION

Commercial logbook data have been collected from the Blue Crab Fishery since its inception in 1983/84. Both catch and effort rose steadily during the first 13 years, reaching an historic maximum catch of 651 t during 1995/96, prior to the introduction of quota. The TACC was initially set at 520 t, however only 462 t was harvested in this first year. The TACC was gradually increased over the next four years, and has been set at 626.8 t since 2000/01. During the quota period there has been a substantial increase in total catch, with more than 98% of the TACC caught in 2006/07.

The introduction of quota has resulted in a marked reduction in catch and effort from the Marine Scalefish Fishery (MSF). Since 1995/96, effort from the MSF has reduced from 1,859 boat days to 140 boat days, catch has reduced from 148 t to 21 t, and the number of licensed fishers has reduced from 29 to nine. The reduction in effort appears to have increased fishing efficiency in the MSF sector, with CPUE (catch per boat day) doubling between 1996/97 and 2005/06.

3 SPENCER GULF POT FISHERY

3.1 FISHERY STATISTICS

3.1.1 Catch and Effort

Blue Crab pot fishers in Spencer Gulf held 377 t of the TACC during 2006/07 (source: PIRSA Fisheries), of which 374.73 t was landed; a 0.23% decrease compared to 2005/06 fishing season. Catch from this sector has steadily increased since 1997/98 (272.4 t, Figure 3.1).

During the first six years following the implementation of quota, the number of boat days remained relatively constant with an average of 993 days fished (Figure 3.1). Boat days increased sharply in 2002/03 when a new licence was issued in February 2002, and have generally decreased since. In 2006/07, the number of boat days (848) was the lowest since TACC implementation, decreasing by 18.9% compared to 2005/06 (1,046 days).

Between 1996/97 and 2004/05 the number of pot lifts followed a similar trend to the number of days fished, however in the last two seasons there was a substantial reduction in the number of days fished (Figure 3.1). This was likely to have resulted from a decrease in the "conversion value" (the ratio of the number of quota units held on a licence per number of pots that may be used) which effectively enabled more potlifts per day (Alice Fistr, PIRSA Fisheries, pers. comm.).

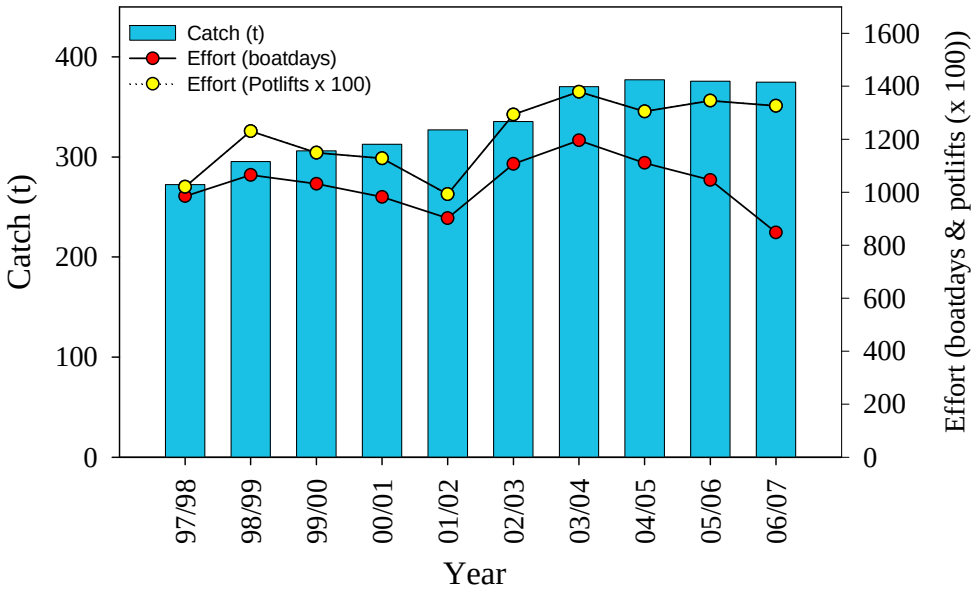


Figure 3.1 Total catch (t) and effort (boatdays and potlifts) for the commercial pot fishery in Spencer Gulf from 1997/98 to 2006/07.

Historically, commercial pot fishing in Spencer Gulf has been conducted throughout the year except during the closed season of December and January. In 2004/05, the closed season was modified to take advantage of expected higher market prices in the lead up to Christmas. The Spencer Gulf season is now closed from the 21st of December to the 19th of February.

From 1997/98 to 2005/06, seasonal catch and effort showed similar trends among years (Figure 3.2). Generally, catches were lowest during June each year (the last month of the quota season), and highest during March.

During 2006/07, there was a substantial shift in seasonal catch and effort. Monthly catches during July and August 2006 were the highest recorded since the introduction of quota, exceeding 60 t. Catches remained high from September to December, and as a result the catch and effort expended between March and June was considerably lower than any previous year.

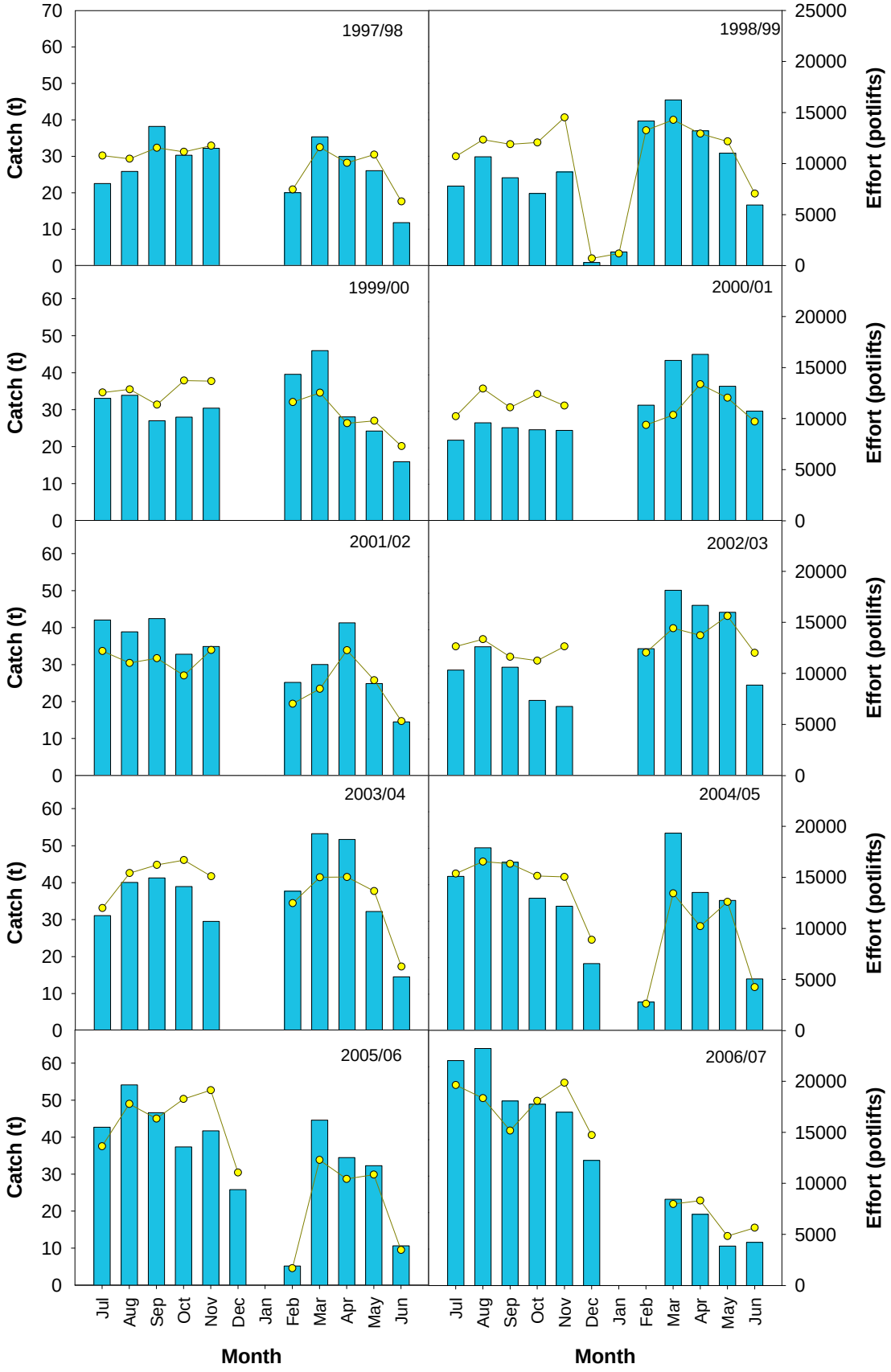


Figure 3.2. Monthly catch (t) and effort (potlifts) for the Spencer Gulf pot fishery 1997/98–2006/07.

3.1.2 Catch Per Unit Effort

The catch rate of blue crabs for the commercial pot fishery is determined as the catch per pot lift:

$$CPUE_L = \frac{Catch(kg)}{No.\ Potlifts}$$

Since the introduction of quota in 1996/97, $CPUE_L$ for the Spencer Gulf pot fishery has been stable (Figure 3.3), ranging from 2.40 kg/potlift (1998/99) to 3.29 kg/potlift (2001/02). During 2006/07, $CPUE_L$ was 2.83 kg/potlift, an increase of 1.2% on the 2005/06 season (2.79 kg/potlift). There have been no apparent long terms trends in commercial $CPUE_L$ since the introduction of quota.

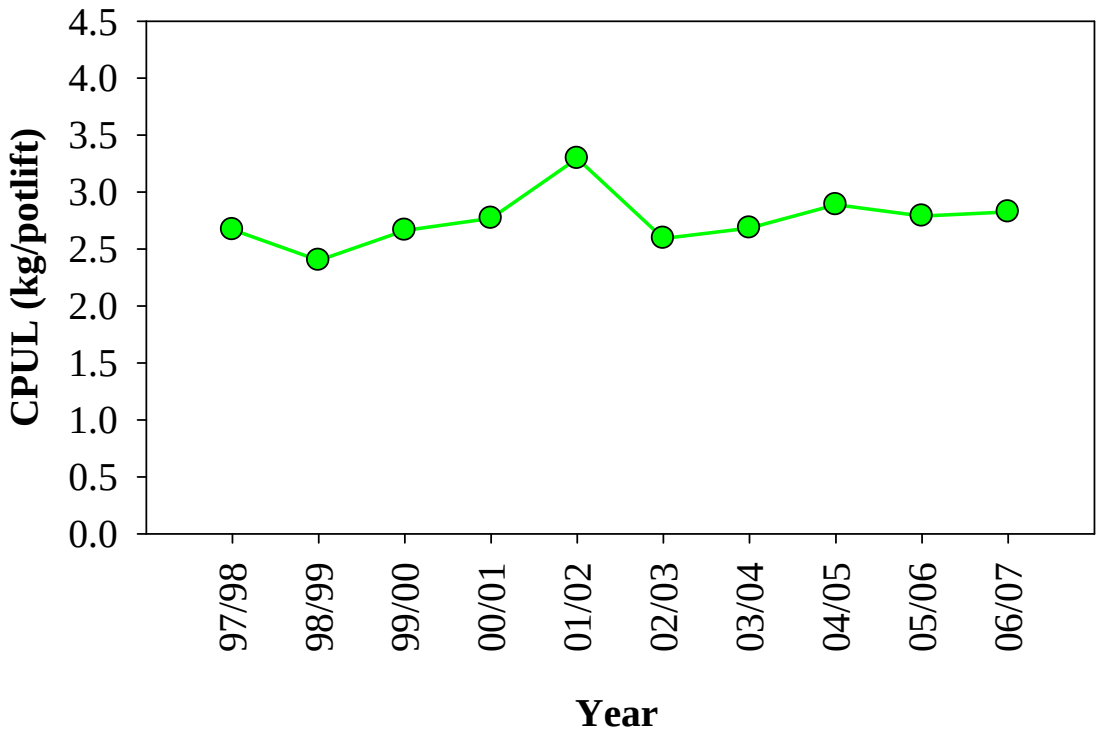


Figure 3.3 Estimated $CPUE_L$ (kg/potlift) in the commercial Spencer Gulf pot fishery since 1997/98.

Whilst annual $CPUE_L$ trends were stable between years, seasonal patterns were more variable in Spencer Gulf (Figure 3.4). Generally, $CPUE_L$ was high during at the start of the quota period (July) and declined until the closure (December). $CPUE_L$ increased immediately after the closure (January), was highest during February or March and then gradually declined until the end of the quota year (June). Since 1997/98, monthly $CPUE_L$ has generally ranged between 1.5 and 4.3 kg/potlift. In 2006/07, $CPUE_L$ was lowest in June (2.1 kg/potlift) and highest in August (3.5 kg/potlift).

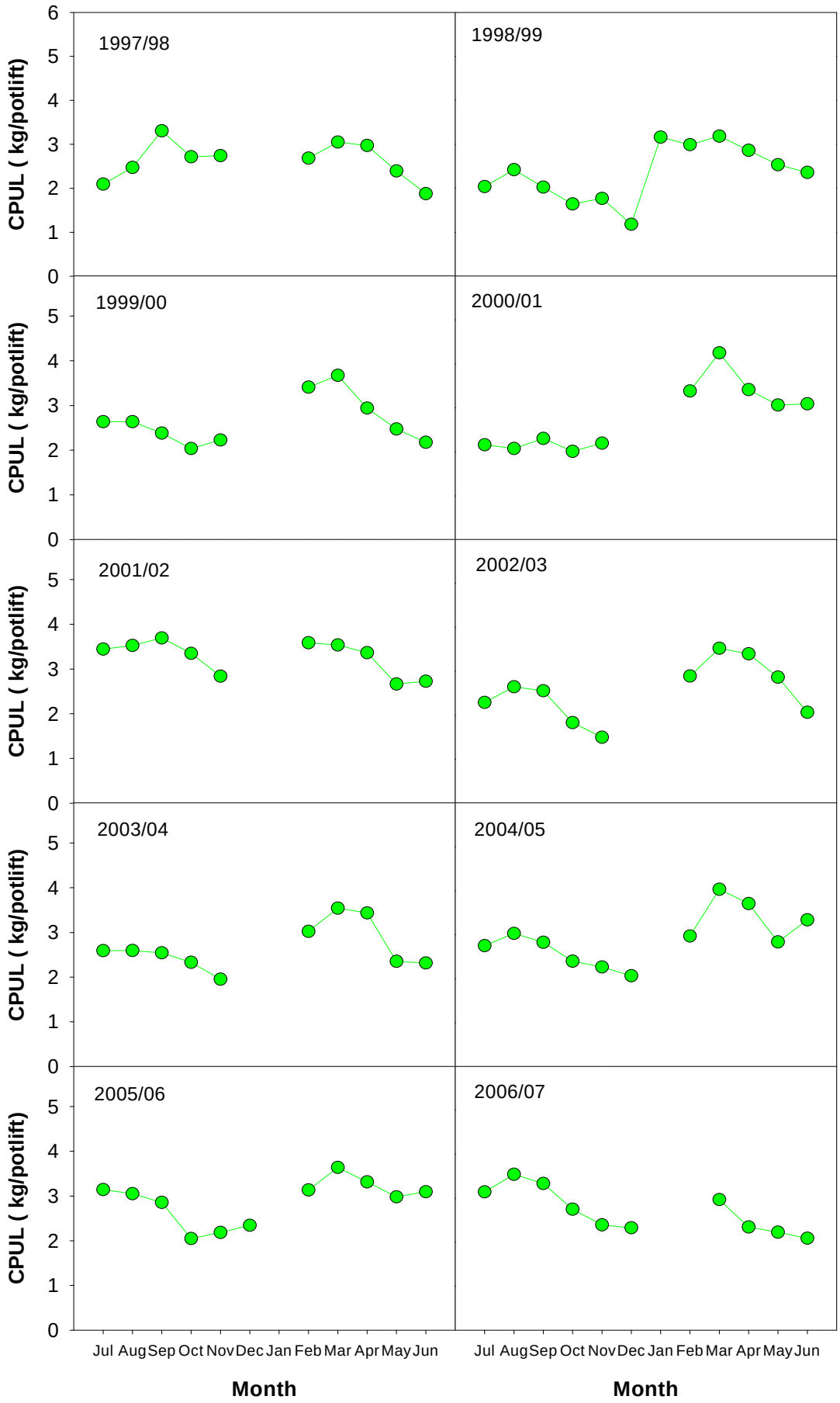


Figure 3.4. Monthly $CPUE_L$ (kg/potlift) for the commercial SG pot fishery 1997/98 to 2006/07.

3.1.3 Pre-recruits

Information on recruitment to the fishery can be obtained from commercial logbook data on the number of pre-recruit (< 110 mm, males and females) crabs in the catch during June and July.

The catch rate of pre-recruit crabs in Spencer Gulf was highly variable between 1998 and 2007, ranging from 0.9 crabs per potlift in 2000 to 10.2 crabs per potlift in 2007 (Figure 3.5). During 2007, pre-recruit abundance was almost twice that of any previous year.

There is considerable uncertainty associated with pre-recruit estimates in Spencer Gulf due to variable reporting rates among years (data provided on 14–71% of days fished annually, Figure 3.5). Relative reporting rates varied substantially among fishers and consequently, these data may not be fully representative of the annual commercial harvest.

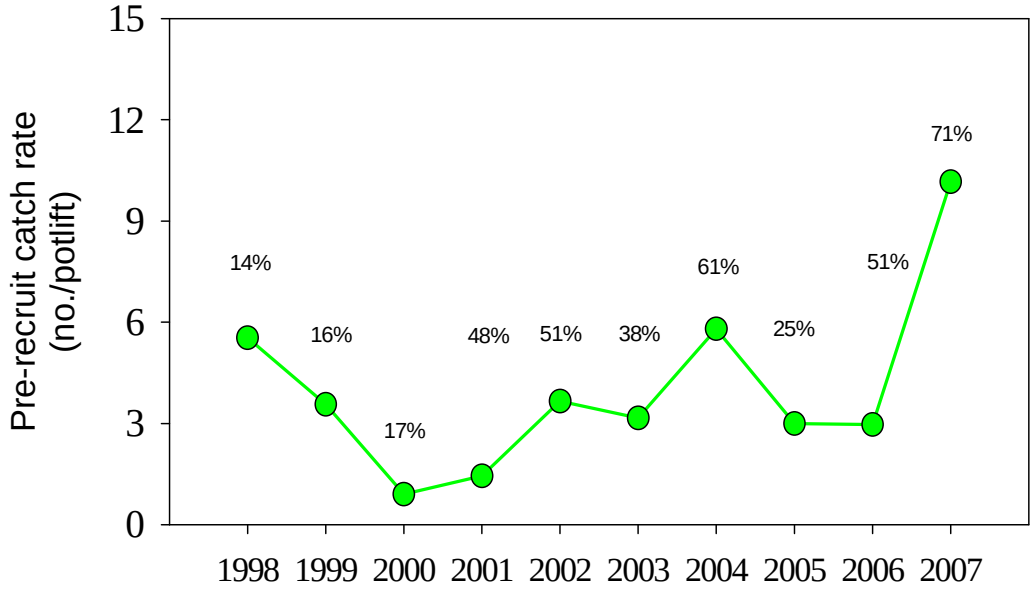


Figure 3.5 Annual trends in pre-recruit CPUE (no./potlift) in Spencer Gulf from 1998 to 2007. Labels indicate the % of days where pre-recruit data were recorded in logbooks.

3.1.4 Sex ratio

Commercial logbooks require the provision of data on the daily catch weight by sex. However, these data were often unreported or reported incorrectly. Data on catch weight by sex were only included in sex ratio analyses when the reported total catch weight was equal to the reported catch weight of male plus female crabs.

Differences in the catch weight of crabs between sexes can arise from a number of factors that may include: differences in abundance between sexes on the fishing grounds; differences in catchability between sexes; fishers returning legal-sized crabs to the water for management requirements (e.g. berried females), or; fishers targeting a specific sex due to marketing demands. This latter factor may be particularly important for fishery management if targeting results in a disproportionate catch of mature female crabs.

In Spencer Gulf, appropriate data on catch weight by sex were available for 5,082 of 9,105 days fished (56%) from 1997/98 to 2006/07. Relative reporting rates varied substantially among fishers and consequently, these data may not be fully representative of the annual commercial harvest.

The weight of male crabs dominated the catch on an annual and daily basis (Figure 3.6). The percentage of female crabs in the total annual catch varied from 11–27% (annual mean=19%) between 1997/98 and 2006/07. Daily catches were dominated by male crabs in all years. During 2006/07, whilst the % of females crabs retained was relatively high (27%), the number of days that female crabs dominated the catch was low (16 of 531 days).

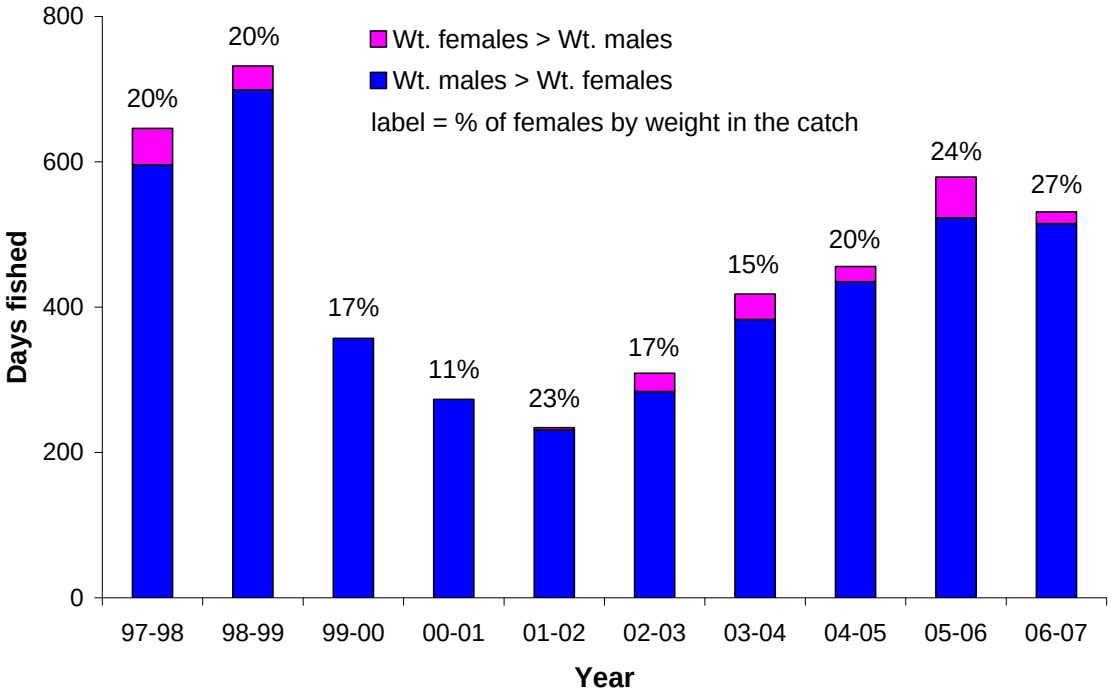


Figure 3.6 The number of days fished when the retained weight of male crabs exceeded the weight of females (blue bars) and when the retained weight of females exceeded males (pink bars) in Spencer Gulf. Labels indicate the percentage of females in the annual catch by weight.

Generally, catches of female crabs were highest between July and November in Spencer Gulf (Figure 3.7). Few female crabs were retained during February, March and April in any year. The higher percentage of females observed in the annual catch during 2006/07 (27%, Figure 3.6) appears to have resulted from an increased proportion of the catch being harvested from July to December rather than February to April as in previous years.

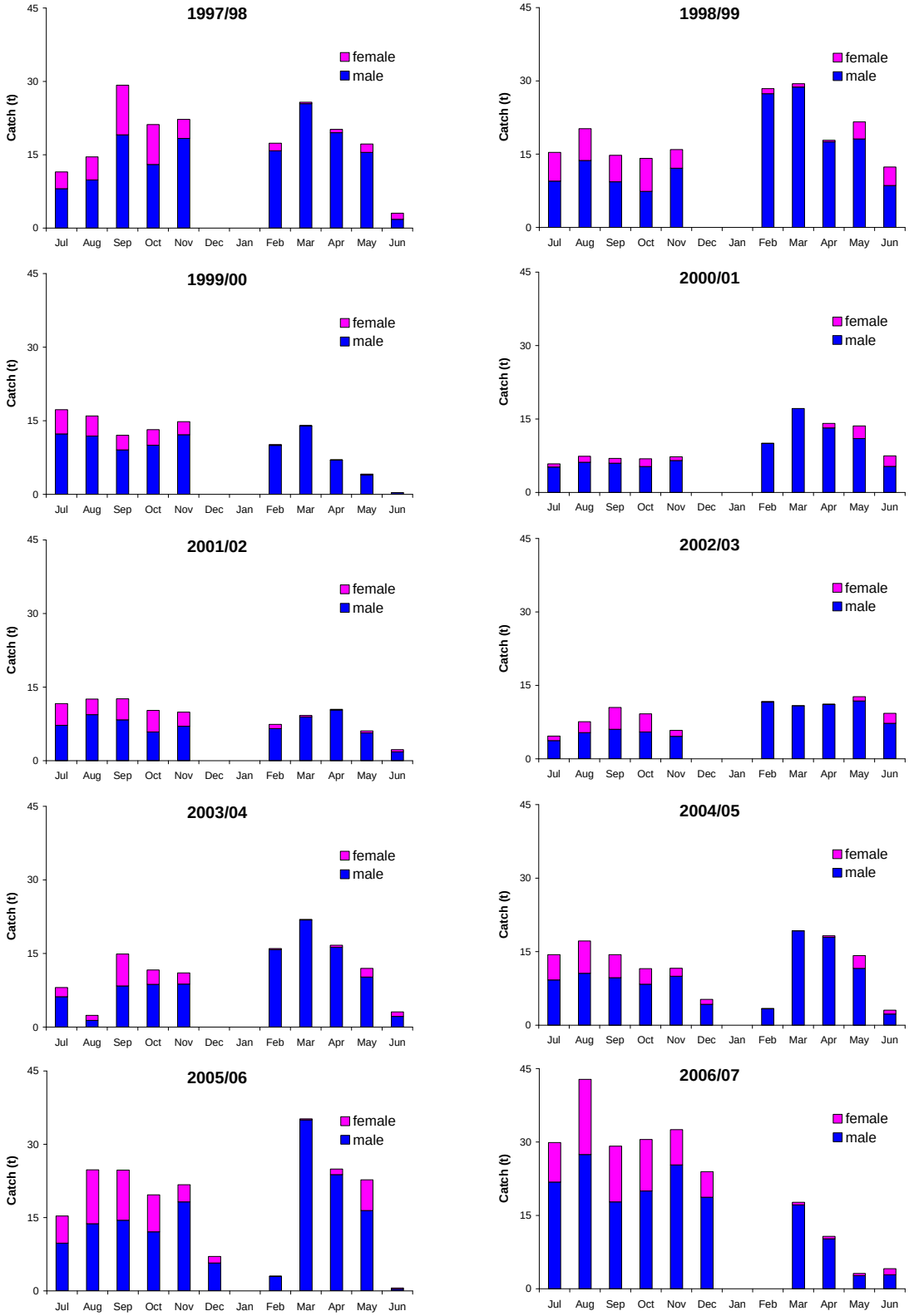


Figure 3.7 Reported monthly catch weights of male and female crabs in Spencer Gulf from 1997/98 to 2006/07.

3.2 COMMERCIAL POT SAMPLING

Four fishers provided pot sampling data from July 2006 to December 2007 for the Blue Crab Fishery in Spencer Gulf (Table 3.1). These data were provided from one research and one commercial pot on 5% of days fished. Whilst the proportion of days sampled was low, there was a considerable spread of blocks sampled, with data provided for 76% of blocks fished during this period. During the sampling period, 3,544 crabs were measured in total, with 1,091 of these being pre-recruit crabs measured from research pots.

Table 3.1 Statistics on pot sampling data collected in Spencer Gulf from July 2006 to December 2007.

Number of fishers providing data	4
Number of boat days during the sampling period	1,459
Number (and % of total) of boat days sampled	76 (5%)
Number (and % of total fished) of blocks sampled	22 (76%)
Number of crabs measured from all pots	3,544
Number of pre-recruit crabs measured from research pots	1,091

Catches of up to 50 pre-recruit crabs per research pot were observed in Spencer Gulf between July 2006 and December 2007 (Figure 3.8). Generally, catches were relatively low (<20 per potlift) during 2006 and higher during 2007. Seasonal trends were not clearly evident in the available data.

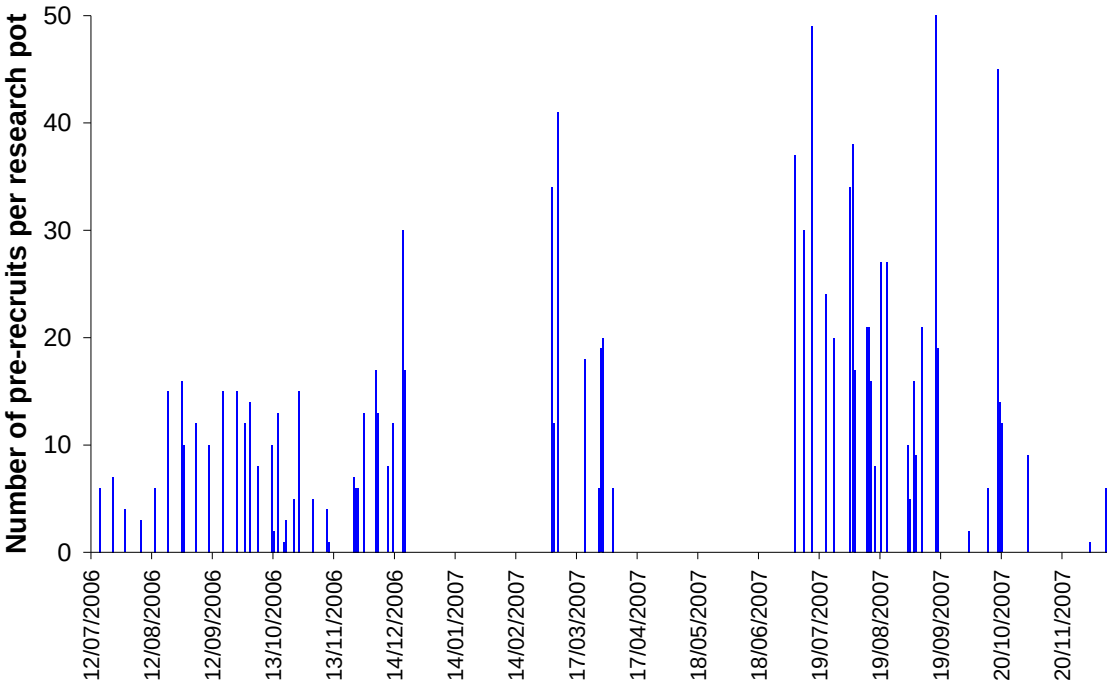


Figure 3.8 The number of pre-recruit crabs caught in research pots sampled from Spencer Gulf between July 2006 and December 2007.

3.3 FISHERY-INDEPENDENT SURVEYS

3.3.1 Differences between research and commercial pots

Differences in mesh size between research (55 mm) and commercial (90 mm) pot types are likely to result in substantial variation in the size distributions of crabs captured during surveys. Determining these differences is paramount for interpretation of trends in crab size and abundance. The balanced design of fishery independent surveys enabled a robust statistical comparison of pot types (Figure 3.9).

Between 2002 and 2007 in Spencer Gulf, 52,284 crabs were captured and measured from commercial and research pots during fishery-independent surveys (Figure 3.9). At sizes above the legal minimum size (110 mm carapace width), the abundance of crabs in research and commercial pots was almost identical at every size class, suggesting that selectivity differences were negligible. In total, 16,388 legal size crabs were measured from commercial pots and 16,263 legal size crabs were measured from research pots.

Abundance in commercial pots was lower than that of research pots at all size increments below legal minimum size. As size reduced, the divergence between capture frequencies increased. In commercial pots, <1% of crabs were caught below 89 mm, whereas in research pots <1% of crabs were caught below 64 mm.

These differences between pot types indicate that commercial pots will provide biased estimates of abundance for pre-recruit crabs in Spencer Gulf and thus, future indices of pre-recruit abundance from surveys should only consider data from research pots. Whilst there is no difference in selectivity for legal size crabs, suggesting that data from both commercial and research pots could be used, analyses of legal size abundance in this report will only consider data from research pots for simplicity.

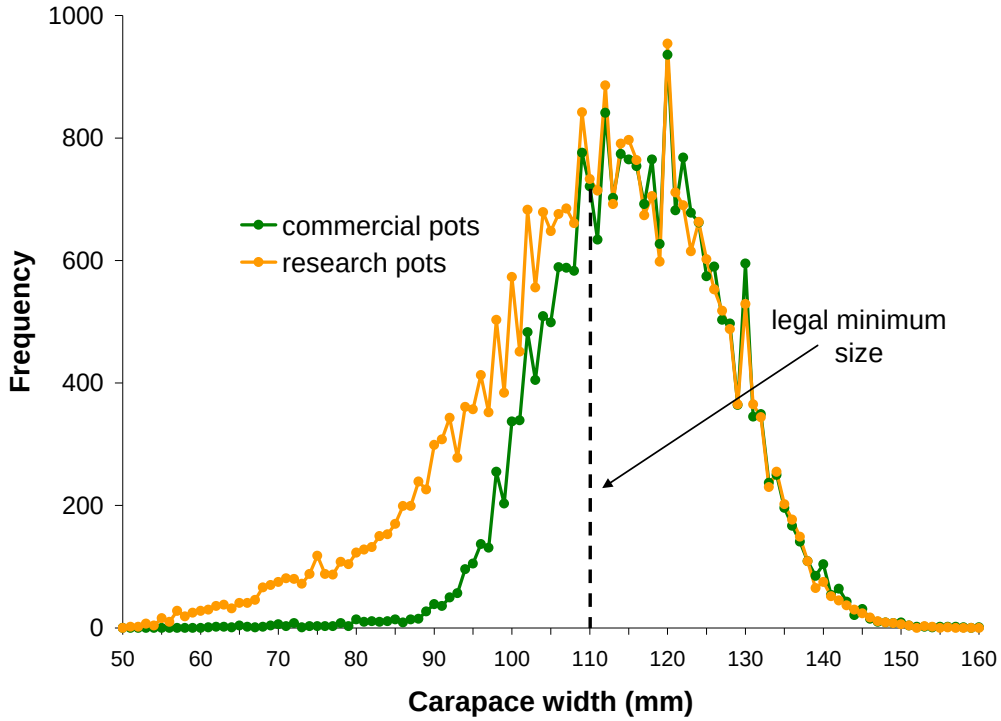


Figure 3.9 Size distribution (carapace width, mm) of crabs measured during surveys conducted in Spencer Gulf between 2002 and 2007 from research and commercial pots.

3.3.2 Relative abundance

Annual trends

Relative abundance was represented by survey CPUE, and was calculated here as the mean number of pre-recruit and legal sized crabs caught per pot (research pots only) for each fishery-independent survey.

Pre-recruit abundance was high in 2002 (6.7 crabs per potlift), declined to 1.9 crabs per potlift in 2005 and then increased to its highest level (8.9 crabs per potlift) in 2007 (Figure 3.10). The abundance of legal size crabs remained relatively stable throughout the survey period (range 4.3 to 6.3 crabs per potlift), with no obvious temporal trends.

The number of potlifts done during 2002 surveys was 30% less than subsequent years. Most of the sites that were added were in the southern region of Spencer Gulf, where abundance was generally lower (see Figures 3.11 and 3.12). Consequently, it is likely that abundance in 2002 is overestimated relative to subsequent years.

There are considerable sources of uncertainty in estimates of survey CPUE. These include, but are not exclusive to: the employment of different fishers and gear types between and within years; differences in the timing and duration of surveys; extrinsic factors such as weather and water temperature, and; differences in the spatial distribution of survey pots.

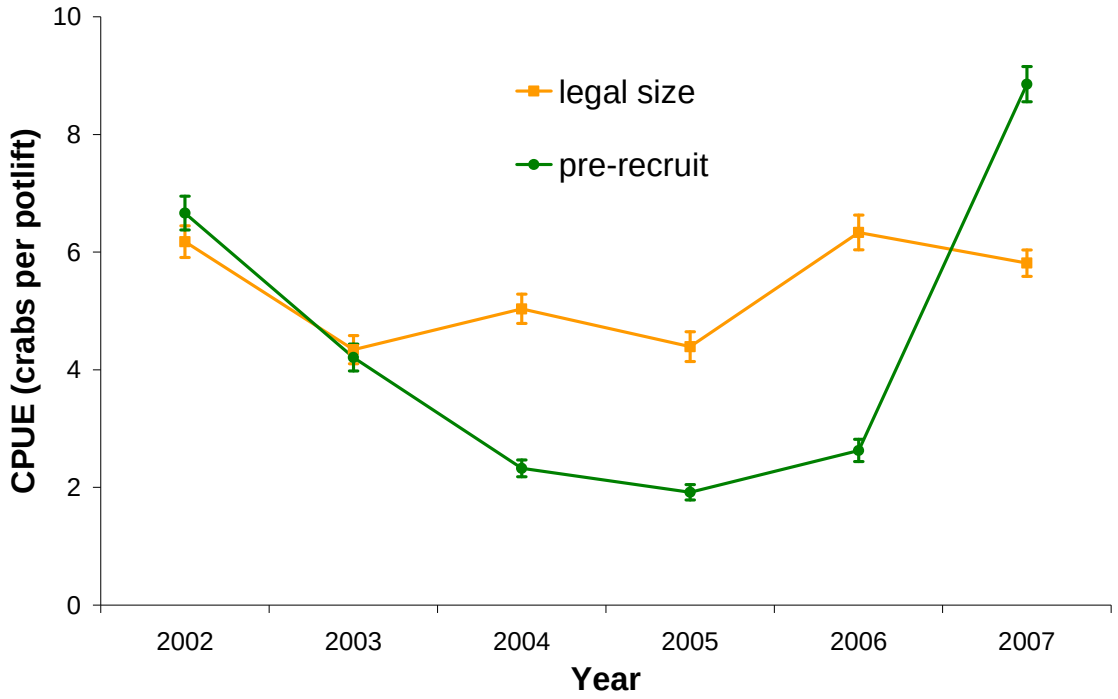


Figure 3.10 Mean catch per unit effort (CPUE, crabs per potlift, and SE) of pre-recruit and legal sized crabs from fishery independent surveys conducted in Spencer Gulf between 2002 and 2007.

Spatial distribution of legal size

Legal size crabs measured from research pots during fishery-independent surveys were broadly distributed throughout the surveyed region in most years (Figure 3.11).

Very high abundance (>10 crabs per potlift) was observed most consistently in block 3 in upper Spencer Gulf (in 4 of 6 years), and sporadically in several other blocks throughout the survey period (blocks 4, 7, 11, 12, 15, 23, 24 and 26). High or very high abundance (>5 crabs per potlift) was observed during all years in blocks 3, 11, 12, 14, 24 and 25.

Abundance tended to be lowest (<2 crabs per potlift) on the western shoreline of Spencer Gulf in blocks 9, 13, 22, 27, 28 and 33. Abundance was also low in block 37 (near Tickera on the eastern Spencer Gulf) in every year except 2002, when abundance was very high (>10 crabs per potlift).

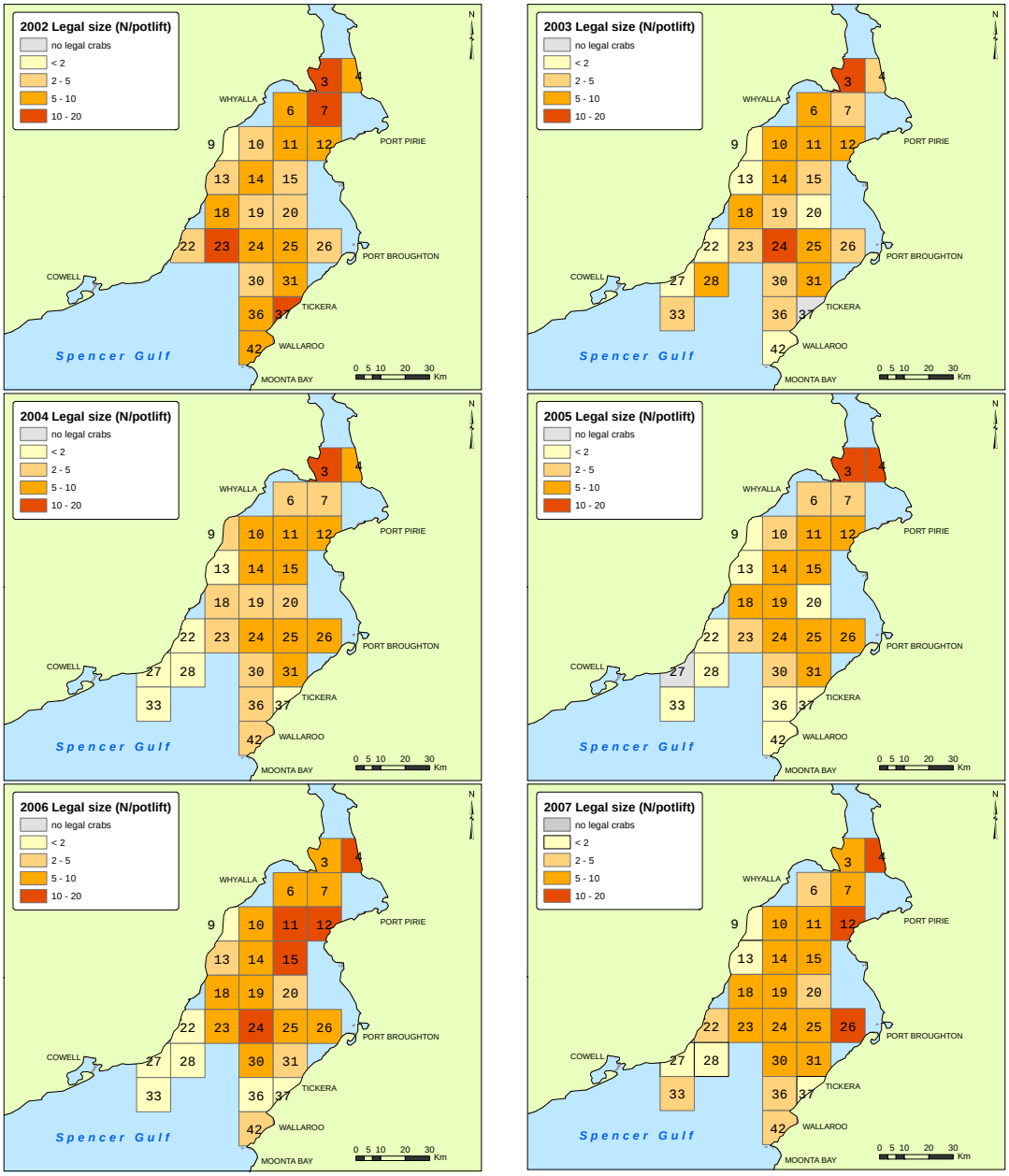


Figure 3.11 Spatial distribution of blue crab abundance (CPUE) during fishery independent surveys conducted in Spencer Gulf during June or July from 2002 to 2007.

Spatial distribution of pre-recruits

The abundance of pre-recruit crabs sampled during fishery-independent surveys was variable, both spatially and temporally, in Spencer Gulf (Figure 3.12). Whilst pre-recruit crabs were broadly distributed throughout the surveyed region, there was a general trend of decreasing abundance from north to south during most years.

Abundance was highest during 2007, when 23 of 27 surveyed blocks had >5 pre-recruits per potlift. In contrast, during 2005 there was only one of 27 blocks with >5 pre-recruits per potlift.

The distribution of crabs varied substantially over time. During 2002 and 2006, the highest abundance was observed in upper Spencer Gulf, during 2004 abundance was highest near Port Broughton, and in all other years crabs were distributed relatively evenly throughout the gulf. Also, abundance within blocks was highly variable over time. For example, no crabs were caught in block 33 from 2004 to 2006, then during 2007 abundance was very high (>10 crabs per potlift).

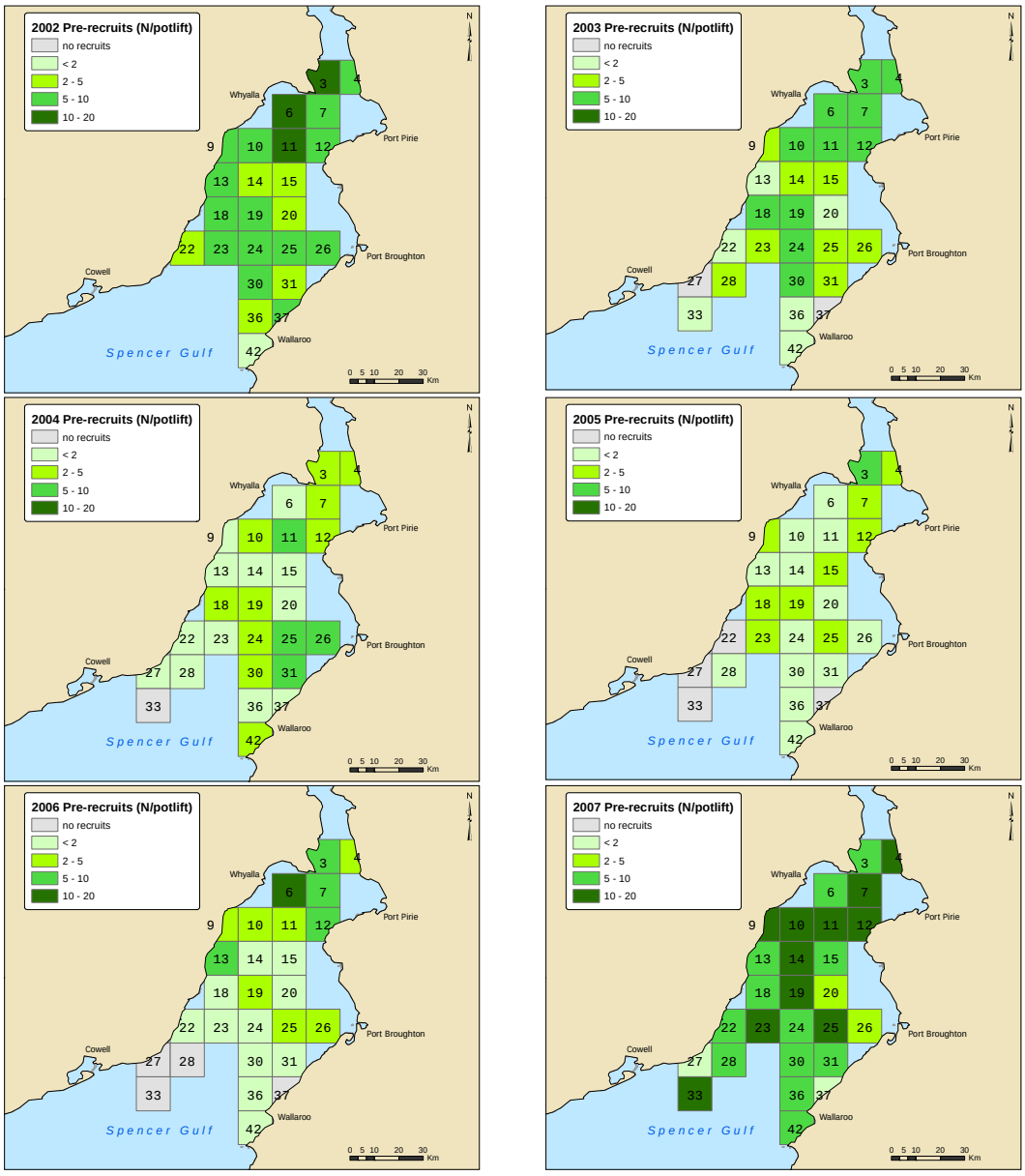


Figure 3.12 Spatial distribution of pre-recruit CPUE during fishery independent surveys conducted in Spencer Gulf during June or July from 2002 to 2007.

3.3.3 Crab size

Annual size distributions of surveyed crab populations were determined for Spencer Gulf from research pots only, for legal size and pre-recruit crabs (Figure 3.13).

The size distribution of surveyed crabs varied substantially among years in Spencer Gulf (Figure 3.13). The modal size of crabs was 100–109 mm in 2002 and 2007, 110–119 mm in 2003 and 2004, and 120–129 mm in 2005 and 2006. The abundance of very large crabs (>130 mm) was clearly highest during 2006. During the same year there was also a relatively high abundance of very small crabs (<79 mm), with an apparent bi-modal distribution likely indicating a large recruitment of juvenile crabs. Further evidence of a strong recruitment event was apparent in the following year (2007), with high abundances of crabs just below the size limit (90–109 mm).

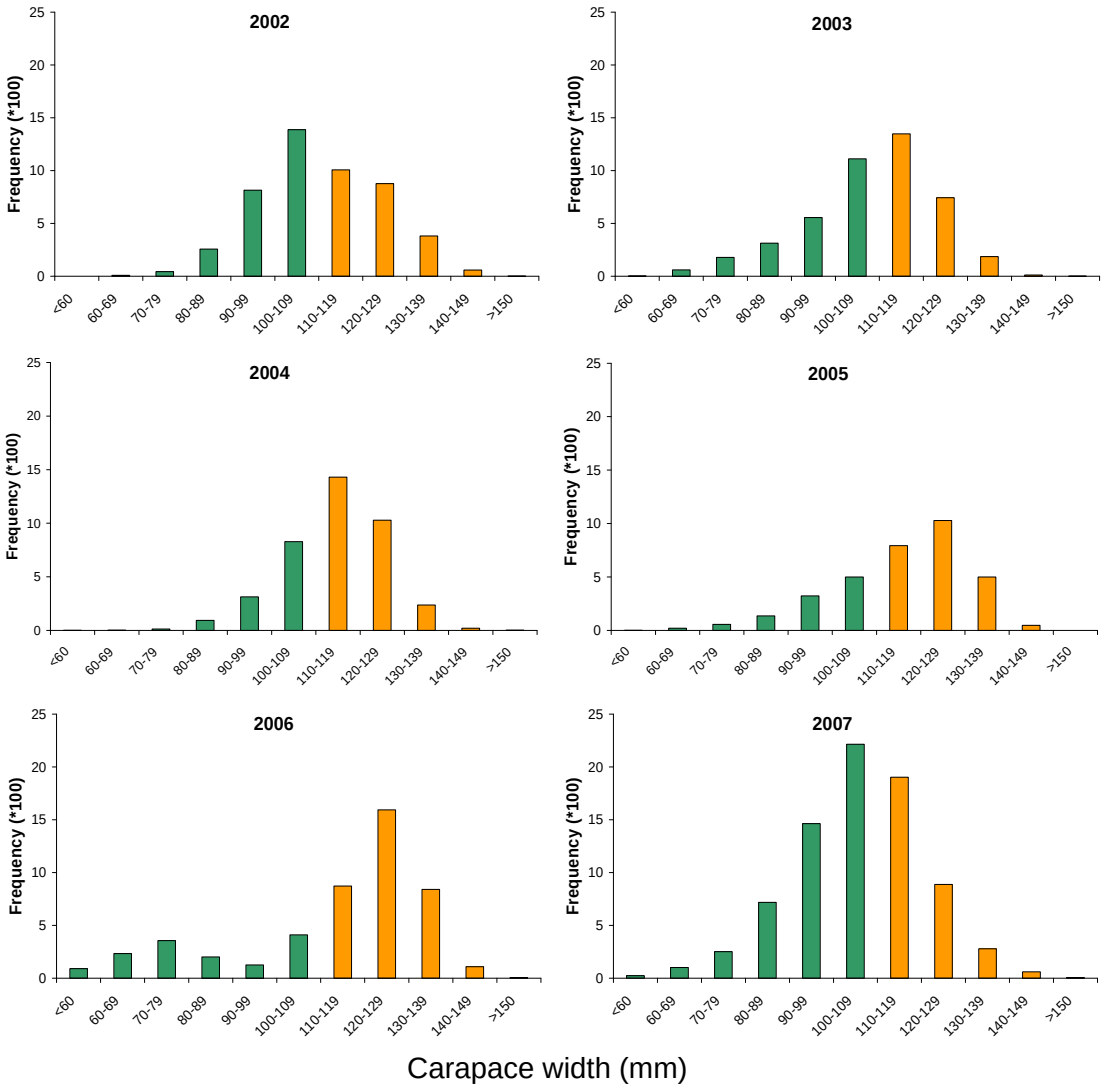


Figure 3.13 Size distributions of crabs caught during surveys conducted in Spencer Gulf from 2002 to 2007. Green bars denote pre-recruits, orange bars denote legal size. Note, 30% less pots were surveyed during 2002 than all other years.

3.4 DISCUSSION

Effort patterns in the Spencer Gulf pot fishery were generally consistent from 1996/97 to 2004/05, with the number of boat days fished and the number of potlifts reflecting the number of licensed fishers. During the past two seasons there has been a marked increase in the number of potlifts per boat day, probably the result of a change in the conversion value (the ratio of the number of quota units held on a licence per number of pots that may be used).

From 1997/98 to 2005/06, seasonal catch and effort was generally lowest during June and highest during February or March of each year. During 2006/07, there was a marked shift in seasonal catch and effort trends, with monthly catches during July and August being the highest recorded, resulting in historically low catches in the following March to June period.

Annual commercial catch per potlift ($CPUE_L$) was stable between 1997/98 and 2006/07. With the exception of 2001/02, annual $CPUE_L$ has varied by <20% during this period. Further, there were no clear temporal trends evident in annual $CPUE_L$. In contrast, seasonal patterns in $CPUE_L$ were quite variable. Peaks in seasonal $CPUE_L$ have tended to occur during February and March each year, however there were large differences in the magnitude of inter-annual variation. There is considerable uncertainty in the factors that affect $CPUE_L$. These include but are not exclusive to: changes in fisher experience, gear and vessel technology, and; temporal and regional shifts in catch and effort.

Interpretation of data gathered by Spencer Gulf fishers on pre-recruit abundance, sex-ratio and commercial pot sampling is substantially impeded by inconsistent reporting. Since 1997/98, data on pre-recruit abundance were recorded on 36% of days fished (during June and July) and data on sex-ratio were recorded on 56% of days fished. Also, commercial pot sampling data were only collected on 5% of days fished between May 2006 and December 2007. Relative reporting rates varied substantially among fishers and consequently, these data may not be fully representative of the annual commercial harvest.

The available data on pre-recruits indicated that their abundance was low during 2001 and 2002, and high during 2007. Sex-ratio data suggest that male crabs dominate the commercial catch, although high proportions of females are caught on some occasions. Informative assessments were unable to be determined from the available commercial pot sampling data.

Fishery-independent surveys were conducted annually in Spencer Gulf from 2002 to 2007. The timing of surveys was sporadic, varying from early June to early August and occasionally taking up to 30 days to complete. The effect of these seasonal differences on catch rates is unknown. Surveys were conducted north of a line between Cowell and Wallaroo. An inability to present data on the spatial distribution of commercial catches prevents assessment of how well the surveyed blocks represent the commercial fishery.

Survey data provide useful comparisons of the different pot types (mesh sizes) available for use by commercial fishers. The different fishing selectivity of each pot type has implications for the interpretation of both fishery-independent and commercial fishery data. Comparisons of length frequency data between pot types in Spencer Gulf demonstrated that differences in selectivity began at or just below the legal minimum size (110 mm carapace width). The difference in abundance of pre-recruit crabs between pot types indicated that commercial pots provide biased estimates of pre-recruit abundance. As a consequence, only data from research pots was considered for analyses of survey data.

The relative abundance of pre-recruit and legal size crabs on surveys was determined as the catch rate from research pots. The abundance of pre-recruits declined from 2002 to 2004, stabilised until 2006 and then increased sharply in 2007 to reach its highest observed level. The abundance of legal size crabs remained relatively stable throughout the survey period, with no obvious temporal trends.

Legal size crabs were broadly distributed throughout Spencer Gulf during most surveys. Several blocks in the upper and central parts of the surveyed region consistently produced high abundances of legal size crabs throughout time. Several blocks on the western shoreline of Spencer Gulf consistently produced low abundances of legal size crabs, particularly the blocks closest to Cowell.

There was a general trend of decreasing abundance of pre-recruits from north to south during most years. However, localised distributions were highly variable over time. For example, no crabs were caught during surveys in block 33 from 2004 to 2006, then during 2007 abundance was very high (>10 crabs per potlift).

Assessment of size composition data indicated that the size of crabs observed on surveys was highly variable among years in Spencer Gulf, particularly for pre-recruit size-classes. Exemplifying this, modal size varied from 100–109 mm to 120–129 mm among years. Of note, the size structure of crabs from surveys conducted during 2006 was bi-modal, indicating a strong pulse of small pre-recruits (60–89 mm) to the fishery. This observation was supported by a large increase in the abundance of crabs 90–109 mm during 2007.

Whilst there is considerable uncertainty in many of the sources of data available for assessment of the Spencer Gulf pot fishery, all available evidence indicates that the fishery is currently being harvested within sustainable limits. This includes: data from fishery-independent surveys (collected from 2002–2007) that indicate the abundance of recruit sized crabs in Spencer Gulf was the highest recorded during 2007, whilst the abundance of legal sized crabs remained stable; commercial $CPUE_L$ was similar to previous years, and; $CPUE_L$ of recruit sized crabs from commercial logbook data were the highest observed since 1998.

4 GULF ST VINCENT POT FISHERY

4.1 FISHERY STATISTICS

4.1.1 Catch and Effort

The Gulf St Vincent pot fishery in 2006/07 held 221.30 t of the TACC (source: PIRSA Fisheries) of which 220.34 t was landed, a 1.9% decrease compared to 2005/06. The catch in this sector has increased substantially since 1997/98 (125.4 t, Figure 4.1).

During the first six years following the implementation of quota, the number of boat days remained relatively constant (Figure 4.1). Boat days increased sharply when a new licence was issued in 2002/03 and has remained relatively constant since. The number of boat days fished in 2006/07 (630) decreased by 7.1% from the 2005/06 season (678 days).

The number of pot lifts followed a similar trend to boat days from 1997/98 to 2004/05, however during the last two seasons there was an increase in the number of potlifts per boat day (Figure 4.1). This was likely to have resulted from a decrease in the "conversion value" (the ratio of the number of quota units held on a licence per number of pots that may be used) which effectively enabled more potlifts per day (Alice Fistr pers. comm.). In 2006/07 there were 71,392 pot lifts, a decrease of 5.4% on 2005/06 (75,508 potlifts).

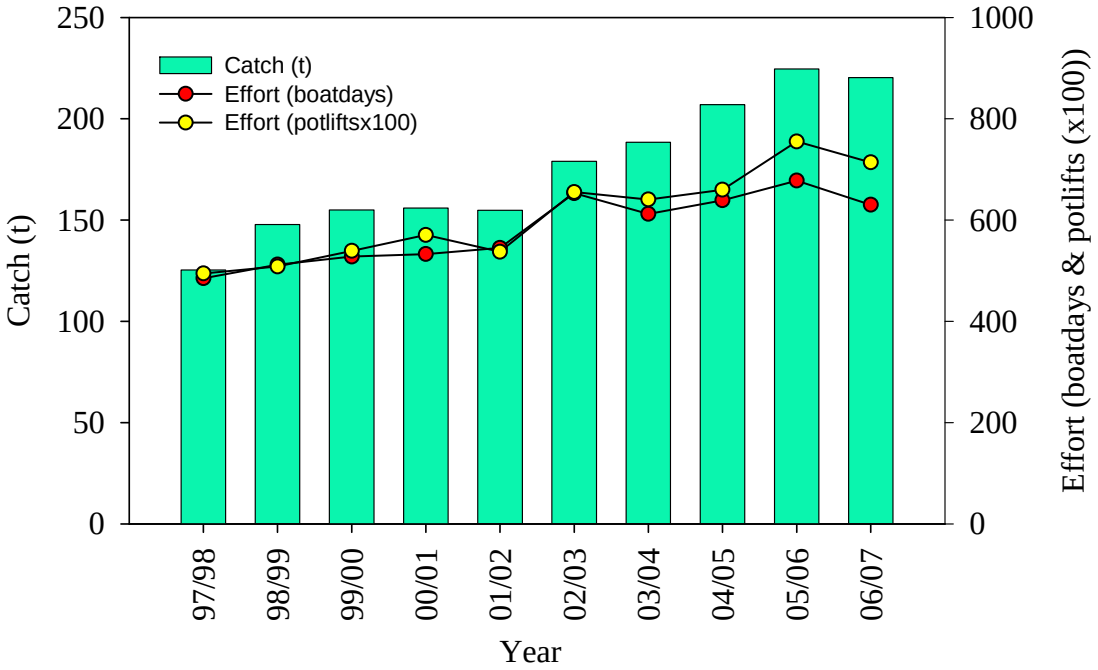


Figure 4.1 Total catch (t) and effort (boatdays and potlifts) for the commercial pot fishery in Gulf St Vincent from 1997/98 to 2006/07.

The commercial pot fishery in GSV is closed between November 1 and January 15. Since 1997/98, catch and effort between July and October has been generally consistent, ranging from 10–30 t and 6,000 to 8,000 potlifts, respectively, each month (Figure 4.2).

Catch and effort was more variable among years for the period between January and June. Whilst the magnitude of catch and effort during this period variedly markedly among years, there was a general trend of peak catches harvested during February, with declining monthly catches thereafter. In contrast, effort during this period was relatively consistent. Note that half of January is not fished due to the seasonal closure.

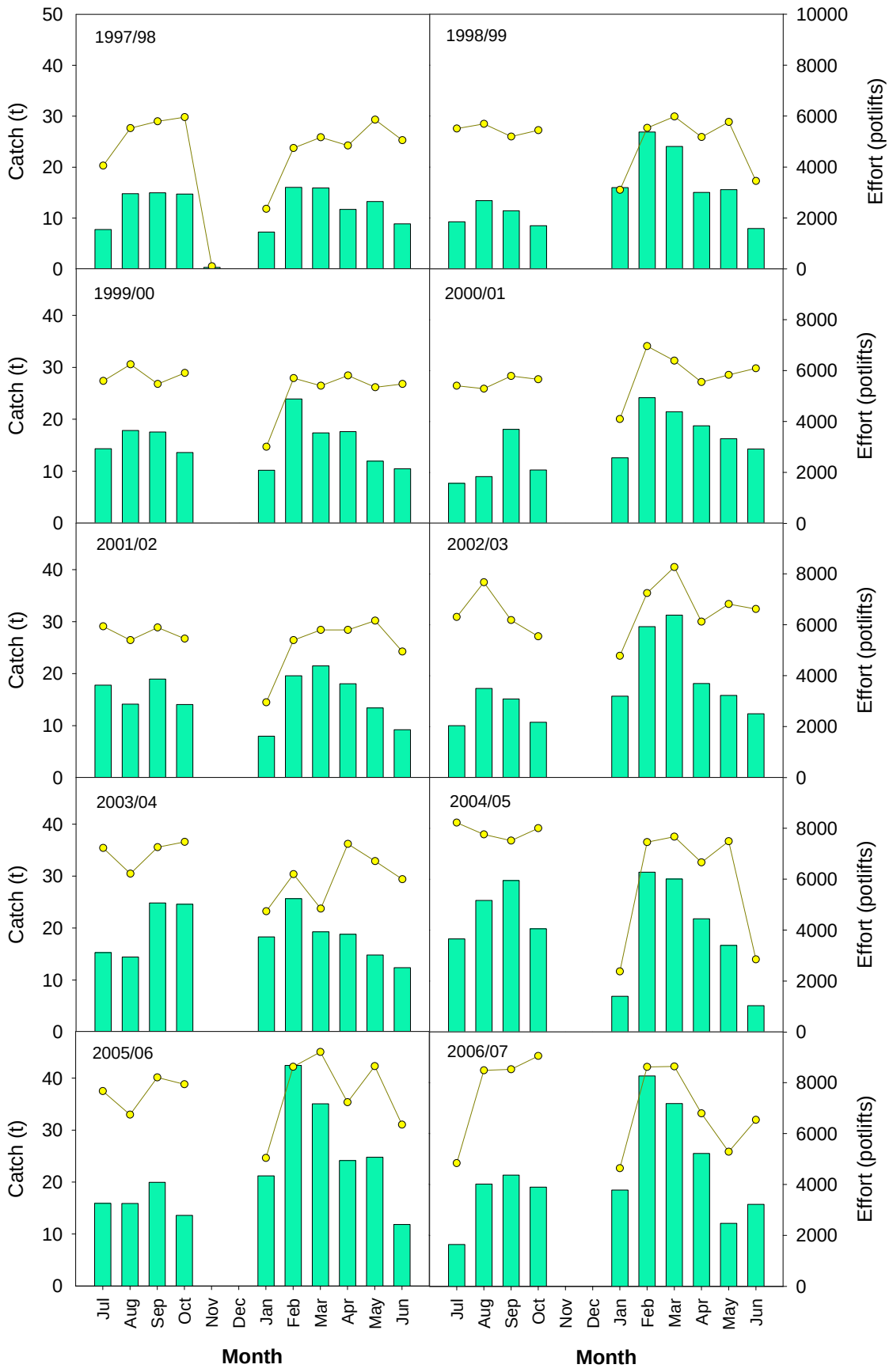


Figure 4.2 Monthly catch (t) and effort (potlifts) for the GSV pot fishery 1997/98 - 2006/07.

4.1.2 Catch Per Unit Effort

The catch rate of blue crabs for the commercial pot fishery is determined as the catch per pot lift:

$$CPUE_L = \frac{Catch(kg)}{No.\ Potlifts}$$

Since the introduction of quota in 1996/97, $CPUE_L$ for the Gulf St Vincent pot fishery has been stable (Figure 4.3), ranging from 2.54 kg/potlift (1997/98) to 3.14 kg/potlift (2004/05). During 2006/07, $CPUE_L$ was 3.09 kg/potlift, an increase of 3.7% on the 2005/06 season (2.98 kg/potlift). There have been no apparent long terms trends in commercial $CPUE_L$ since the introduction of quota.

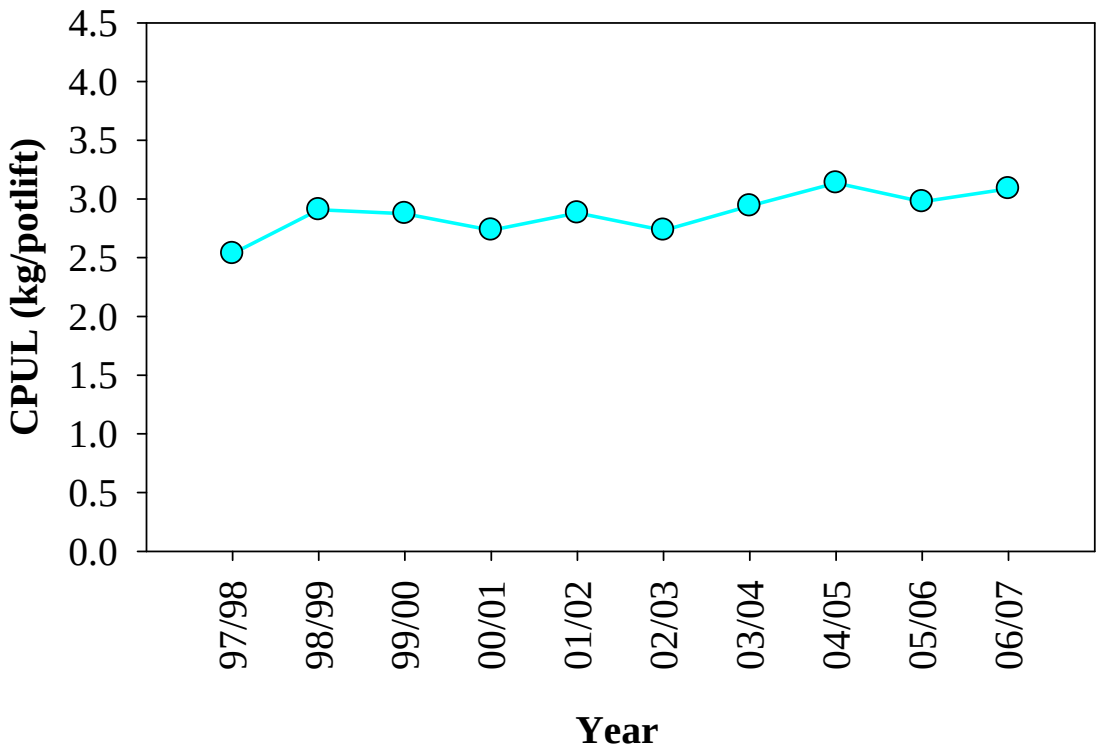


Figure 4.3 Estimated $CPUE_L$ (kg/potlift) in the commercial GSV pot fishery since 1997/98.

Seasonal patterns in $CPUE_L$ in Gulf St Vincent were more variable than annual trends (Figure 4.4). Generally, in Gulf St Vincent $CPUE_L$ was low at the start of the quota period (July), increased until September and declined rapidly prior to the closure in November. $CPUE_L$ increased substantially after the closure (January), was highest during February and then declined continuously until the end of the quota year (June). Since 1997/98, $CPUE_L$ has generally ranged between 1.5 and 4.8 kg/potlift. In 2006/07, $CPUE_L$ was lowest in June (1.7 kg/potlift) and highest in August (4.8 kg/potlift).

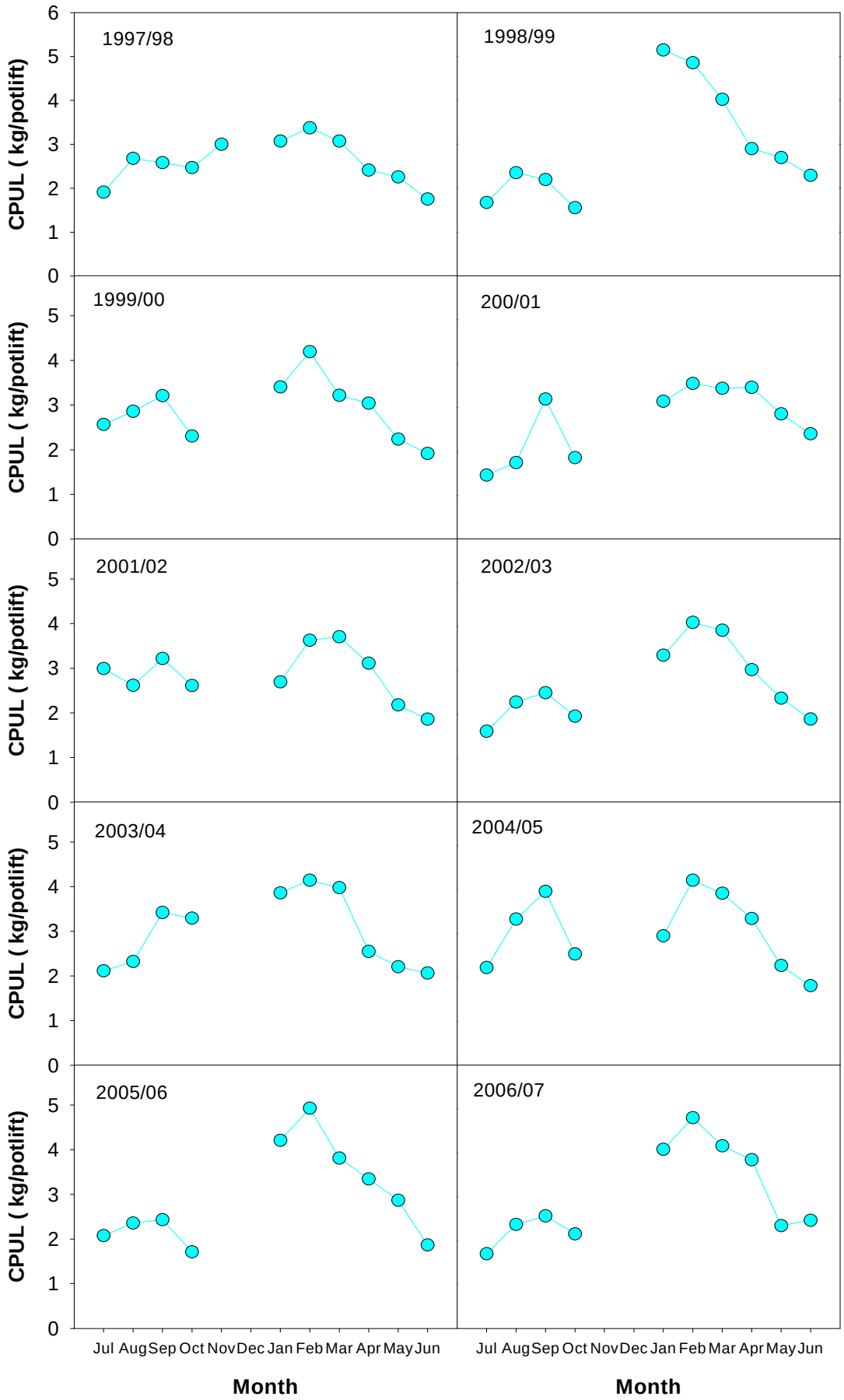


Figure 4.4. Monthly CPUE$_L$ (kg/potlift) for the commercial GSV pot fishery 1997/98 to 2006/07.

4.1.3 Pre-recruits

Information on recruitment to the fishery can be obtained from commercial logbook data on the number of pre-recruits (< 110 mm, males and females) crabs in the catch during June and July.

The catch rate of pre-recruit crabs in Gulf St Vincent was highest during 1998 (5.3 crabs per potlift) and then declined rapidly to 0.3 crabs per potlift in 2001 (Figure 4.5). Between 2002 and 2007, the catch rate of pre-recruit crabs was relatively consistent, ranging from 1.3 crabs per potlift in (2006) to 2.2 crabs per potlift (2005).

In general, commercial fishers in GSV diligently recorded data on the abundance of pre-recruit crabs from 1998, with the exception of 2001 and 2002 where appropriate data were collected on only half of the days fished. The high proportion (> 97%) of appropriate data collected during all other years suggests that these indices are robust reflections of the proportion of pre-recruits in the catch.

Despite the high level of compliance in data reporting, it is difficult to assess how well these indices reflect recruitment to the fishery. This uncertainty arises from factors such as changes in commercial operators, differences in the timing and spatial distribution of the catch, and biases in pre-recruit abundance associated with commercial pots.

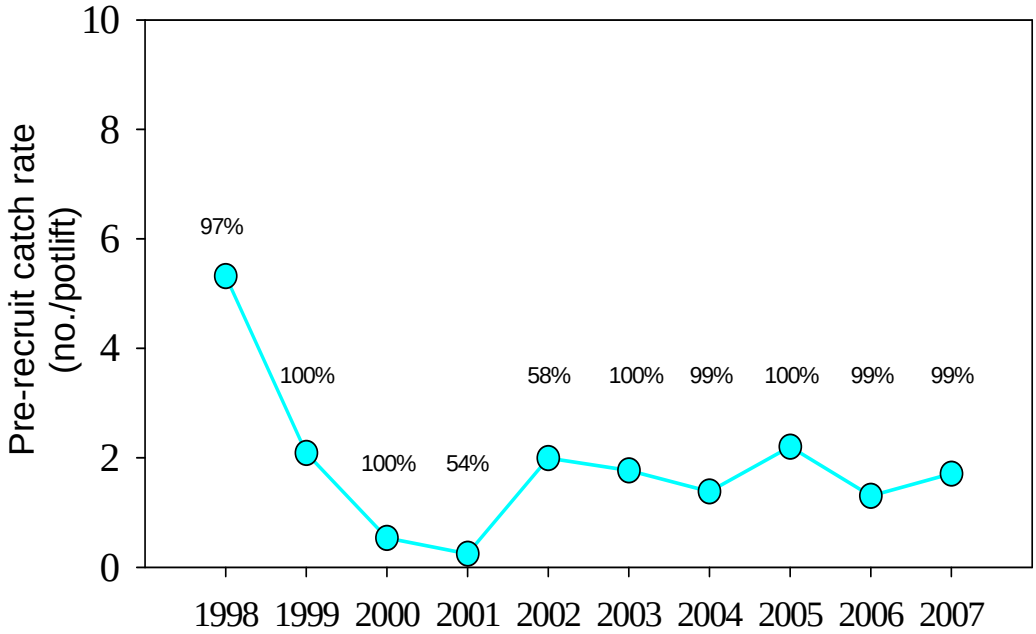


Figure 4.5 Annual trends in pre-recruit CPUE (no./potlift) in GSV from 1998 to 2007. Labels indicate the % of days where pre-recruit data were recorded in logbooks.

4.1.4 Sex ratio

Commercial logbooks require the provision of data on the daily catch weight by sex. However, these data were often unreported or reported incorrectly. Data on catch weight by sex were only included in sex ratio analyses when the reported total catch weight was equal to the reported catch weight of male plus female crabs.

Differences in the catch weight of crabs between sexes can arise from a number of factors that may include: differences in abundance between sexes on the fishing grounds; differences in catchability between sexes; fishers returning legal-sized crabs to the water for management requirements (e.g. berried females), or; fishers targeting a specific sex due to marketing demands. This latter factor may be particularly important for fishery management if targeting results in a disproportionate catch of mature female crabs.

In Gulf St Vincent, appropriate data on catch weight by sex were available for 3,416 of 5,064 days fished (67%) from 1997/98 to 2006/07. Relative reporting rates varied substantially among fishers and consequently, these data may not be fully representative of the annual commercial harvest.

The weight of male crabs dominated the catch on an annual and daily basis (Figure 4.6). The percentage of female crabs in the total annual catch varied from 11–43% (annual mean=23%) between 1997/98 and 2006/07. Generally, daily catches were dominated by male crabs, however in 1997/98 and 2003/04 female crabs outweighed males on 36% and 33% of days, respectively. In 2000/01, female crabs comprised 43% of the total catch, yet daily catches of females outweighed males on only 6 of 200 occasions.

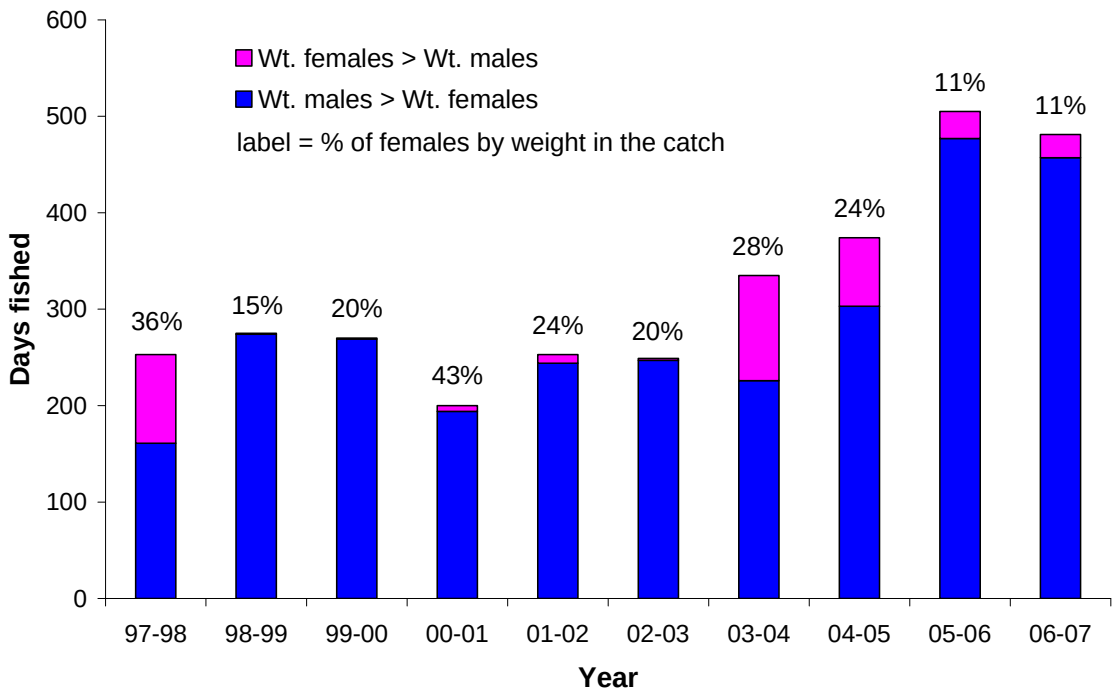


Figure 4.6 The number of days fished when the retained weight of male crabs exceeded the weight of females (blue bars) and when the retained weight of females exceeded males (pink bars) in Gulf St Vincent. Labels indicate the percentage of females in the annual catch by weight.

Generally, catches of female crabs were highest between July and September in Gulf St Vincent (Figure 4.7). Few female crabs were retained from January to April in any year. The low percentage of females observed in the catch in the last two years reflects (11%, Figure 4.6) appears to have resulted from an increased proportion of the catch being harvested from January to April compared to previous years.

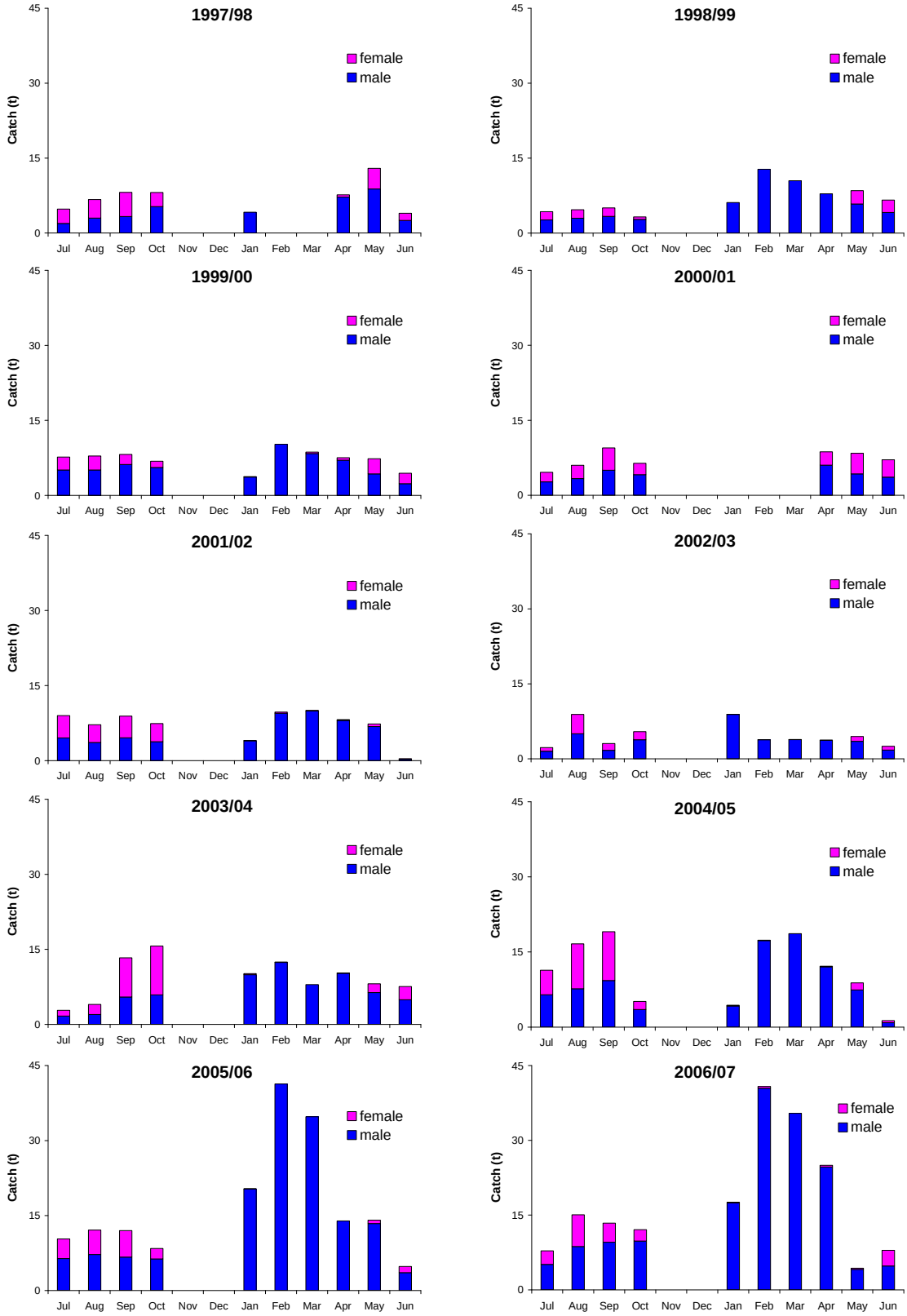


Figure 4.7 Reported monthly catch weights of male and female crabs in Gulf St Vincent from 1997/98 to 2006/07.

4.2 COMMERCIAL POT SAMPLING

Three fishers provided pot sampling data from July 2006 to October 2007 for Gulf St Vincent (Table 4.1). These data were provided from one research and one commercial pot on 5% of days fished. Whilst the proportion of days sampled was low, there was a considerable spread of blocks sampled (64% of all fished). During the sampling period, 2,200 crabs were measured, with 532 pre-recruit crabs measured from research pots.

Table 4.1 Statistics on pot sampling data collected in Gulf St Vincent from July 2006 to October 2007.

Number of fishers providing data	3
Number of boat days during the sampling period	1,052
Number (and % of total) of boat days sampled	48 (5%)
Number (and % of total fished) of blocks sampled	9 (64%)
Number of crabs measured from all pots	2,200
Number of pre-recruit crabs measured from research pots	532

Catches of up to 40 pre-recruit crabs per research pot were observed in Gulf St Vincent between July 2006 and October 2007 (Figure 4.8). Generally, catches were slightly higher after June 2007. Seasonal trends were not clearly evident in the available data.

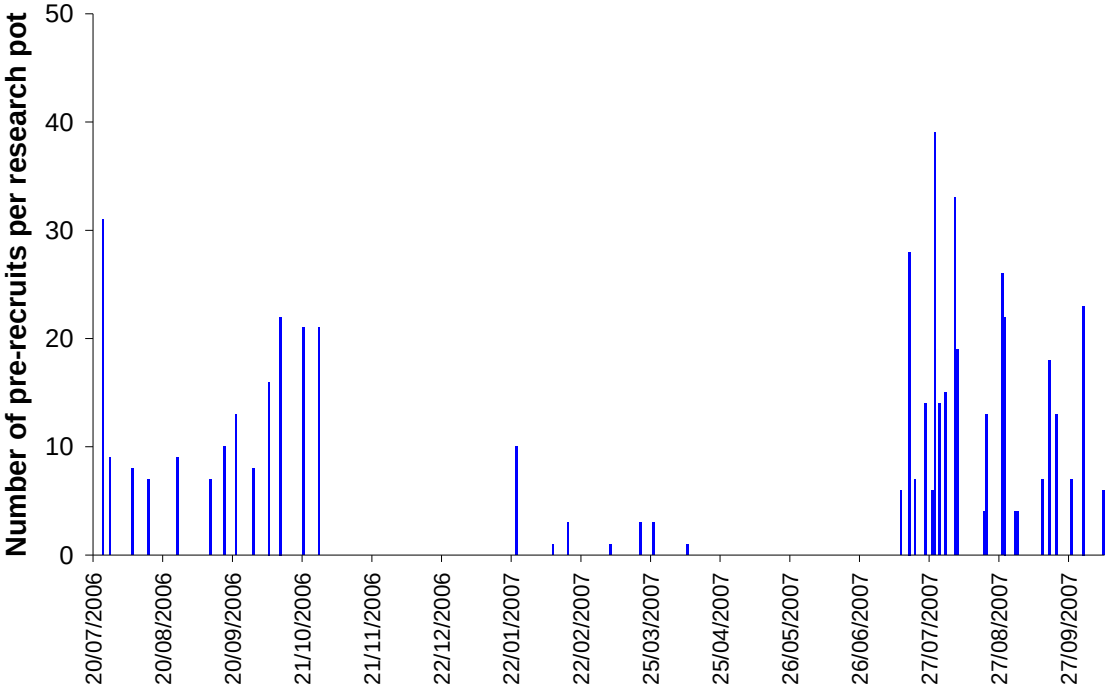


Figure 4.8 The number of pre-recruit crabs caught in research pots sampled from Gulf St Vincent between July 2006 and October 2007.

4.3 FISHERY-INDEPENDENT SURVEYS

4.3.1 Differences between research and commercial pots

Differences in mesh size between research (55 mm) and commercial (90 mm) pot types are likely to result in substantial variation in the size distributions of crabs captured during surveys. Determining these differences is paramount for interpretation of trends in crab size and abundance. The balanced design of fishery independent surveys enabled a robust visual comparison of pot types, by accumulating data from all years and regions for each pot type (Figure 4.9).

Between 2002 and 2007 in Gulf St Vincent, 23,839 crabs measured from research and commercial pots during fishery-independent surveys (Figure 4.9). The abundance of crabs in research and commercial pots was almost identical at all sizes above 110 mm. In total, 6,244 legal size crabs were caught and measured from commercial pots, while 5,921 pre-recruit crabs were caught and measured from research pots.

Abundance in commercial pots was lower than that of research pots at all size increments below 107 mm. As size reduced, the divergence between capture frequencies increased. In commercial pots, <1% of crabs were caught below 92 mm, whereas in research pots <1% of crabs were caught below 78 mm.

These differences between pot types indicate that commercial pots will provide biased estimates of abundance for pre-recruit crabs in Gulf St Vincent and thus, future indices of pre-recruit abundance from surveys should only consider data from research pots. Whilst there is no difference in selectivity for legal size crabs, suggesting that data from both commercial and research pots could be used, analyses of legal size abundance in this report will only consider data from research pots for simplicity.

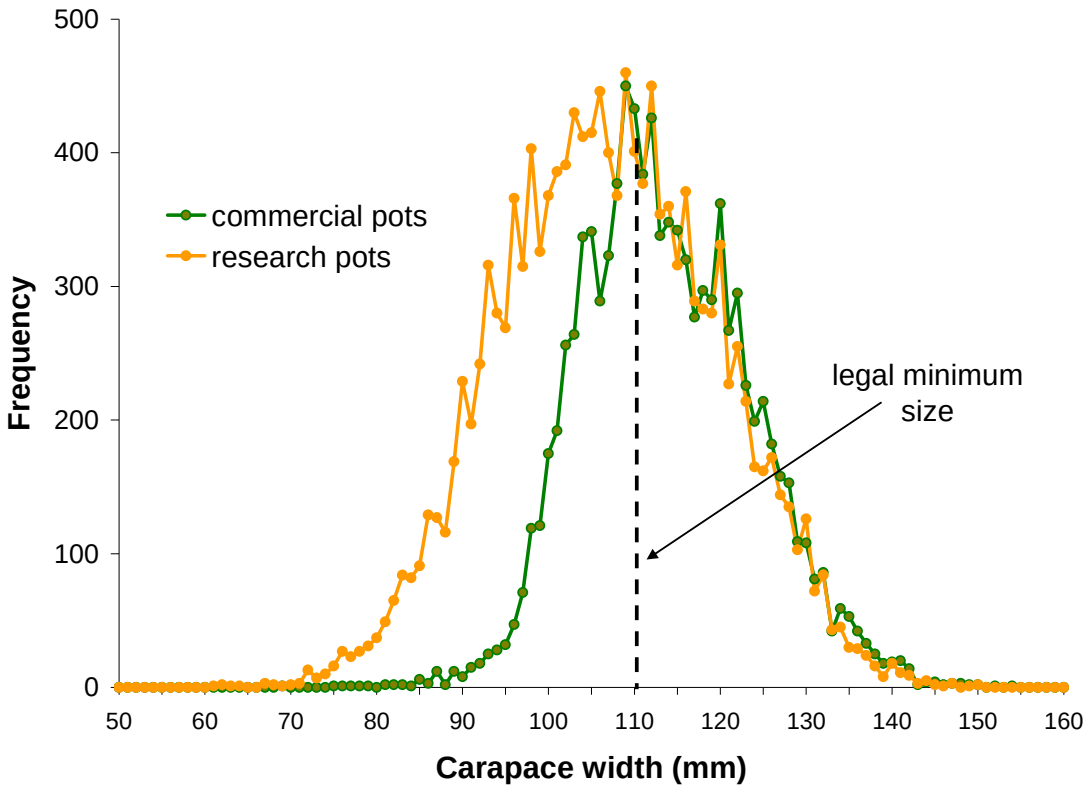


Figure 4.9 Size distribution (carapace width, mm) of crabs measured during surveys conducted in Gulf St Vincent between 2002 and 2007 from research and commercial pots.

4.3.2 Relative abundance

Annual trends

Relative abundance was represented by survey CPUE, and was calculated here as the mean number of pre-recruit and legal sized crabs caught per pot (research pots only) for each fishery-independent survey (Figure 4.10). The number of potlifts done during 2002 surveys was 42% fewer than subsequent years.

From 2002 to 2004, pre-recruit abundance in Gulf St Vincent declined from 2.5 to 0.3 crabs per potlift (Figure 4.10). Abundance then increased sharply to reach 7.1 crabs per potlift in 2006. Although abundance decreased substantially during 2007 to 3.8 crabs per potlift, this was still the second highest recorded. The abundance of legal size crabs was more stable, ranging from 1.1 to 3.2 crabs per potlift throughout the survey period. Whilst there were few temporal trends evident between 2002 and 2005, it is noteworthy that legal size abundance was highest during 2006 and 2007.

There are substantial sources of uncertainty in estimates of survey CPUE. These include, but are not exclusive to: the employment of different fishers and gear types between and within years; differences in the timing and duration of surveys; extrinsic factors such as weather and water temperature, and; differences in the spatial distribution of survey pots.

Figure 4.10 Mean catch per unit effort (CPUE, crabs per potlift, and SE) of legal size and pre-recruits from fishery independent surveys conducted in Gulf St Vincent between 2002 and 2007.

Spatial distribution of legal size

Abundance of legal size crabs sampled during fishery-independent surveys showed substantial variation, both spatially and temporally, in Gulf St Vincent (Figure 4.11). Whilst abundance was patchily distributed, there was a general trend of increasing abundance from north to south.

Very high abundance (>10 crabs per potlift) was only observed during 2006 and 2007 in blocks 13, and 27 and 34, respectively. There were no blocks with high abundance north of Pine Point during any year. Abundance was consistently highest in blocks near Port Vincent and Port Adelaide.

Abundance was low (<2 crabs per potlift) on at least five of the six survey occasions in blocks 89, 3, 5 ,7, 8, 9, 10, 11, 12, 14, 20 and 23. No legal size crabs were caught in blocks 23 and 11 on three and two survey occasions, respectively.

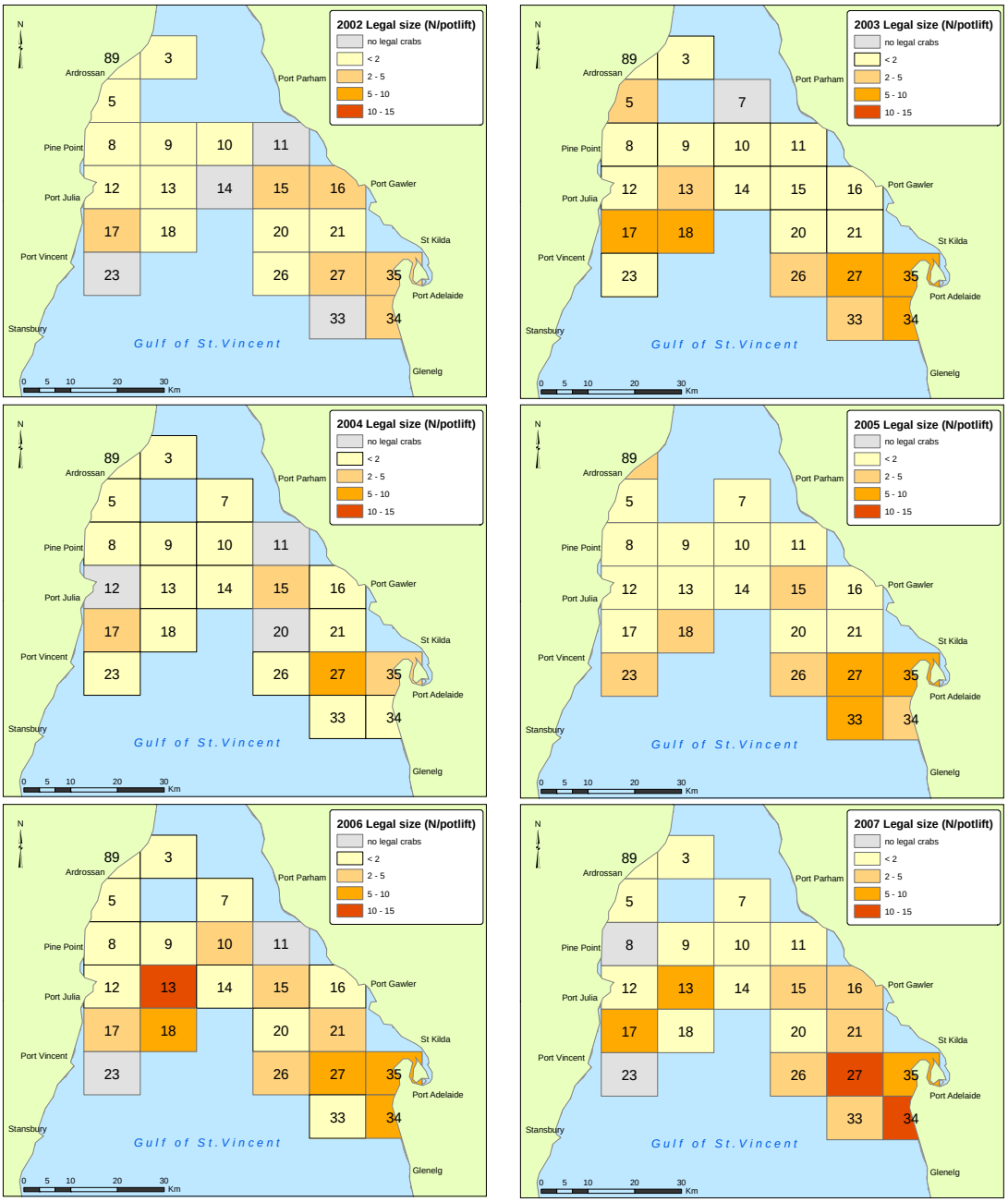


Figure 4.11 Spatial distribution of legal size CPUE during fishery independent surveys conducted in Gulf St Vincent during June or July from 2002 to 2007.

Spatial distribution of pre-recruits

The abundance of pre-recruit crabs sampled during fishery-independent surveys also varied substantially, both spatially and temporally, in Gulf St Vincent (Figure 4.12).

The abundance of pre-recruits was generally low from 2002 to 2004, particularly during 2004 when <2 crabs per potlift were observed in all surveyed blocks. Abundance was highest during 2006, with blocks of moderate (2–5 crabs per potlift) to very high (20–40 crabs per potlift) abundance distributed throughout the surveyed region.

The highest abundance was observed in blocks 13, 27 and 35. Each of these blocks had 20–40 crabs per potlift during 2006, and 5–20 crabs per potlift on at least two other survey occasions.

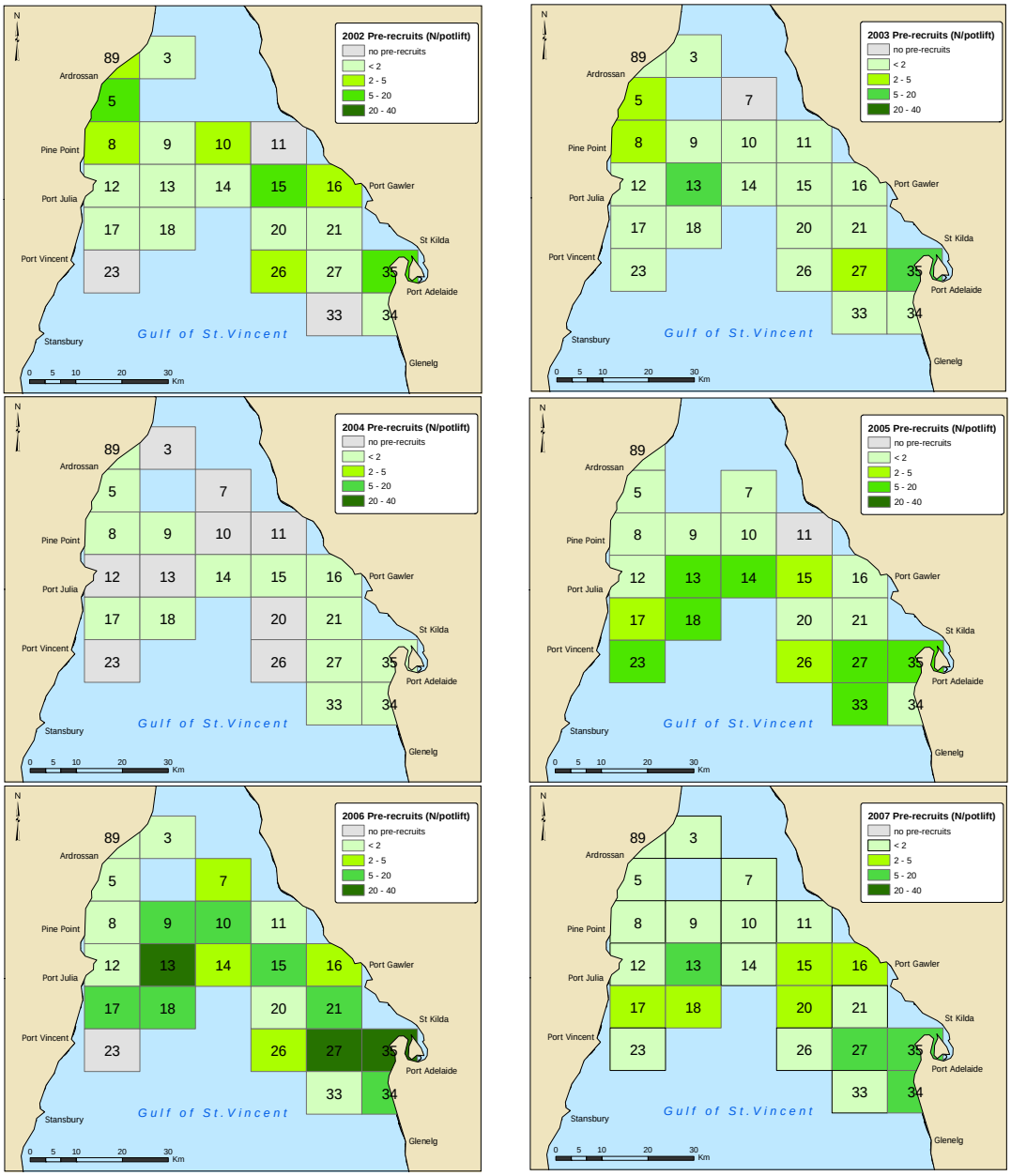


Figure 4.12 Spatial distribution of pre-recruit CPUE during fishery independent surveys conducted in Gulf St Vincent during June or July from 2002 to 2007.

4.3.3 Crab size

Annual trends in size distribution

Annual size distributions of surveyed crab populations in Gulf St Vincent were determined from research pots only (Figure 4.13).

The size distribution of surveyed crabs was generally similar among years (Figure 4.13). The modal size of crabs was 100–109 mm in all years except 2003 and 2004 (110–119 mm). The abundance of pre-recruit crabs was clearly highest during 2006, and lowest during 2004, when very few pre-recruit crabs were caught. The abundance of very large crabs (>130 mm) was clearly highest during 2006. In all years crabs larger than 129 mm were rare, as were crabs less than 79 mm.

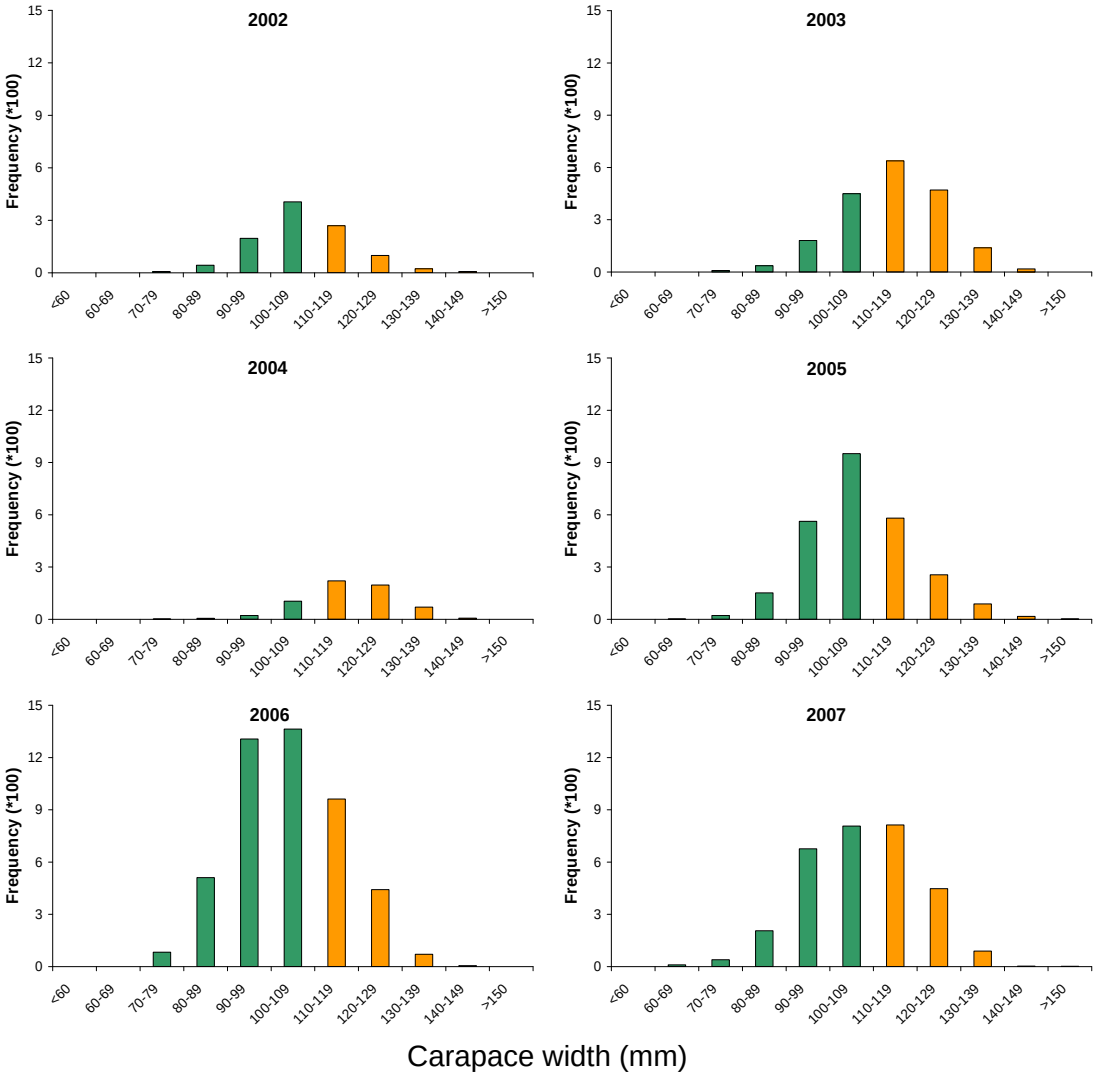


Figure 4.13 Size distributions of crabs caught during surveys conducted in Gulf St Vincent from 2002 to 2007. Green bars denote pre-recruits, orange bars denote legal size. Note, 42% fewer pots were surveyed during 2002 than all other years.

4.4 DISCUSSION

Effort patterns in the Gulf St Vincent pot fishery were generally consistent from 1996/97 to 2004/05, with the number of boat days fished and the number of potlifts reflecting the number of licensed fishers. During the past two seasons there has been a marked increase in the number of potlifts per boat day, probably the result of a change in the conversion value (the ratio of the number of quota units held on a licence per number of pots that may be used).

Seasonal catch and effort patterns have been relatively stable since 1996/97 in Gulf St Vincent, with catch and effort being highest around February immediately after the closure and lowest during June prior to the end of the quota season.

Annual commercial catch per potlift ($CPUE_L$) was stable between 1997/98 and 2006/07, varying by <20% among years and showing no clear trends. In contrast, seasonal patterns in $CPUE_L$ were quite variable. Seasonal $CPUE_L$ was generally highest during February and March each year, however there were large differences in the magnitude of inter-annual variation. There is considerable uncertainty in the factors that affect $CPUE_L$. These include but are not exclusive to: changes in fisher experience, gear and vessel technology, and; temporal and regional shifts in catch and effort.

Data on pre-recruits were collected consistently in commercial logbooks by Gulf St Vincent fishers from 1998. These data indicate that catch rates of pre-recruit crabs were high during 1998, were low during 2000 and 2001 and have been generally consistent since 2002. Interpretation of trends in pre-recruit catch rates from commercial logbooks is impeded as commercial pots provide biased indices of pre-recruit abundance.

Interpretation of data gathered by Gulf St Vincent fishers on sex-ratio and commercial pot sampling is substantially impeded by inconsistent reporting. Since 1997/98, data on sex-ratio were recorded on 55% of days fished, while commercial pot sampling data were only collected on 5% of days fished between May 2006 and December 2007. Relative reporting rates varied substantially among fishers and consequently, these data may not be fully representative of the annual commercial harvest.

The available data on sex-ratio suggest that male crabs dominate the commercial catch, although high proportions of females are caught on some occasions. Informative assessments were unable to be determined from the available commercial pot sampling data.

Fishery-independent surveys were conducted annually in Gulf St Vincent during July from 2002 to 2004 and June thereafter. The effect of seasonal differences on survey catch rates is unknown. Surveys were conducted north of a line Port Vincent to Port Adelaide in Gulf St Vincent. An inability to present data on the spatial distribution of commercial catches prevents assessment of how well the surveyed blocks represents the commercial fishery.

Comparisons of length frequency data collected from research and commercial pots during surveys in Gulf St Vincent demonstrated that fishing efficiency changed at sizes below legal minimum length (110 mm carapace width). Whilst the catch rates of legal size crabs are almost identical at all size increments above the size limit, commercial pots provide substantially biased under-estimates of pre-recruit abundance. As a consequence, only data from research pots was considered for analyses of survey data.

The relative abundance of pre-recruit and legal size crabs on surveys was determined as the catch rate from research pots. The abundance of both pre-recruit and legal size crabs were at their lowest during 2004, were at their highest during 2006 and remained relatively high during 2007. Whilst the temporal trends in abundance were similar between legal and pre-recruit crabs, the magnitude of the variation in pre-recruit abundance was considerably higher.

Legal size crabs were patchily distributed throughout Gulf St Vincent, however there was a general trend of increasing abundance from north to south. Highlighting this, abundance did not exceed 5 crabs per potlift during any year in the seven blocks surveyed north of Pine Point, whilst abundance was consistently highest in blocks near Port Vincent and Port Adelaide. Abundance of legal size crabs was low (<2 crabs per potlift) on at least five of the six survey occasions in 12 of the 23 surveyed blocks.

The abundance of pre-recruit crabs was highly variable throughout time. Whilst the distribution of pre-recruits was also variable, three blocks (13, 27 and 35) consistently produced high to very high abundances of pre-recruits, particularly in the last three years.

Assessment of size composition data (from research pots) indicated that the size of crabs observed on surveys was highly variable among years in Gulf St Vincent, with modal size varying from 100–109 mm to 120–129 mm among years. The variability was particularly evident for pre-recruits, with almost no pre-recruit crabs caught during 2004, yet two years later the abundance of pre-recruit crabs was the highest recorded.

Whilst there is considerable uncertainty in many of the sources of data available for assessment of the Gulf St Vincent pot fishery, all available evidence indicates that the fishery is currently being harvested within sustainable limits. This includes: data from fishery-independent surveys (collected from 2002–2007) that indicate the abundance of pre-recruit and legal sized crabs in Gulf St Vincent was the highest and second highest recorded during 2006 and 2007, respectively; commercial $CPUE_L$ was similar to previous years, and; $CPUE_L$ of recruit sized crabs from commercial logbook data were similar to the previous five fishing seasons.

5 PERFORMANCE INDICATORS

This section provides a report on the performance of the fishery against the interim performance indicators (PIs), target and limit reference points defined in the Management Plan (Table 5.1).

Table 5.1. Assessment against the Performance Indicators of the Management Plan for the blue crab fisheries of Spencer Gulf and Gulf St Vincent.

Area	Performance Indicator	Data source	Target ref.	Limit ref.	2006/07
GSV & SG	Catch	Commercial	TACC	80% of TACC	98.3%
SG	Relative exploitation rate	No data	40% of 1994	80% of 1994	N/A
	Pre-recruitment (% undersized in June & July)	Commercial	30%	15%	42.0%
		FIS			43.5%[1]
	Sex ratio (% female in June & July)	Commercial	30%	15%	35.8%
		FIS			29.4%[1]
GSV	Relative exploitation rate	No data	50% of 1994	100% of 1994	N/A
	Pre-recruitment (% undersized in June & July)	Commercial	10%	5%	17.3%
		FIS			33.1%[1]
	Sex ratio (% female in June & July)	Commercial	30%	15%	38.8%
		FIS			47.1%[1]

FIS – Fishery-Independent Survey
N/A –Not Assessed
[1] *Estimate determined from catches in commercial pots only.*

During 2006/07, a total of 616.1 t of the 626.8 t allocated as TACC was harvested. This catch was lower than the previous year (619.3 t). The harvested fraction (98.3%) exceeds the limit reference point for the fishery (80%), but does not meet the target (100%).

The relative exploitation rate could not be calculated from the available data.

Pre-recruits (<110 mm CW) comprised 42.0% and 43.5% of the commercial and fishery-independent survey catch, respectively, in Spencer Gulf during June and July 2006. Pre-recruits (<110 mm CW) comprised 17.3% and 33.1% of the commercial and fishery-independent survey catch, respectively, in Gulf St Vincent during the same period. Each of these percentages exceeded the target reference point.

Female crabs comprised 35.8% and 29.9% of the commercial and fishery-independent survey catch, respectively, in Spencer Gulf during June and July 2006. Female crabs comprised 38.8% and 47.1% of the commercial and fishery-independent survey catch, respectively, in Gulf St Vincent during the same period. Each of these percentages exceeded the target reference point, except for fishery-independent surveys in Spencer Gulf (29.4%) which was just below the target of 30%.

6 GENERAL DISCUSSION

6.1 STATUS OF THE BLUE CRAB FISHERY

The 2005/06 stock assessment report for the Blue Crab Fishery identified assessment of each Gulf separately as a high prioirty. With the consent of commercial fishers, this report provides analysis of commercial logbook data at a finer spatial scale than recent reports. Combined with analyses of fishery-independent survey data, the overall assessment suggests that blue crab populations in each gulf are currently being fished within sustainable limits.

For Spencer Gulf, evidence of a healthy resource status includes: data from fishery-independent surveys (collected from 2002–2007) that indicate the abundance of recruit sized crabs in Spencer Gulf was the highest recorded during 2007, whilst the abundance of legal sized crabs remained stable; commercial $CPUE_L$ was similar to previous years, and; $CPUE_L$ of recruit sized crabs from commercial logbook data were the highest observed since 1998.

For Gulf St Vincent, evidence of a healthy resource status includes: data from fishery-independent surveys (collected from 2002–2007) that indicate the abundance of pre-recruit and legal sized crabs in Gulf St Vincent was the highest and second highest recorded during 2006 and 2007, respectively; commercial $CPUE_L$ was similar to previous years, and; $CPUE_L$ of recruit sized crabs from commercial logbook data were similar to the previous five fishing seasons.

However, there is considerable uncertainty associated with each of the data sources available for assessment. Confidentiality issues impede assessment of commercial catch and effort data at appropriate spatial scales (i.e. fishing blocks), which in turn prevents assessment of how well the surveyed region represents the commercial fishery. Specifically, if surveyed regions do not cover the full spatial extent of the fishery, then the precision of survey results is reduced. Also, improved temporal replication of surveys and improved consistency in survey methodologies (e.g. gear, GPS location) would further reduce uncertainty in the assessment of survey data.

Commercial $CPUE_L$ data have been very stable since the introduction of TACC. With the exception of Spencer Gulf during 2001/02, annual $CPUE_L$ has varied by <20% within each Gulf during this period. The lack of sensitivity in annual $CPUE_L$ is problematic for its use as a measure of abundance of legal size crabs, particularly in the absence of an understanding of changes in fishing efficiency and catch and effort distribution of this highly evolving fishery. Standardisation of $CPUE_L$ data may reduce the uncertainty associated with these indices, but it may not alter their sensitivity and therefore usefulness as a performance measure.

Pre-recruit data from commercial logbooks were collected inconsistently from Spencer Gulf between 1998 and 2007, with relative reporting rates highly variable among fishers. Consequently, these data may not be fully representative of the annual commercial harvest. Further, issues regarding the selectivity of pre-recruit crabs in commercial pots suggest that an alternate data source for commercial catches of pre-recruit crabs is needed for performance assessment of the fishery.

Whilst available commercial pot sampling data currently provide little insight into the status of the fishery, representative pot sampling data can provide an excellent opportunity to capture reliable and appropriately scaled information on the catch rate of pre-recruit crabs throughout the year. These data should be collected each day, by each fisher and be representative of fished blocks. If these conditions are met, pot sampling data would be a reliable index of recruitment throughout the year, augmenting information collected during fishery-independent surveys. Further, pot-sampling data could provide an unbiased index of the sex ratio of the fished population throughout the year. Currently, pot sampling data are provided for one commercial and one research pot each day of sampling. It is likely that data from one research pot only would provide sufficient information for robust assessment.

6.2 CURRENT PERFORMANCE INDICATORS

As discussed in previous stock assessment reports, the Performance Indicators (PIs) for the fishery need to be reviewed. Currently, there are PIs for commercial catch, sex ratio, relative exploitation rate and proportion of pre-recruits.

Commercial catch should be maintained as a PI, but should be reported separately for each gulf. Furthermore, the appropriateness of the current limit reference point (80% of the TACC) should be reconsidered. Whilst a performance measure for sex ratio is important, its current form (% females in June and July) does not provide significant insights into the status of the fishery. The usefulness of the PIs relative exploitation rate and proportion of pre-recruits is limited. Relative exploitation rate cannot be calculated reliably. Proportion of pre-recruits is not a useful measure of pre-recruit abundance as it is confounded by the effects of changes in adult abundance.

A summary of potential performance indicators for the fishery is provided in Table 6.1. These include the primary measures of abundance of legal size and pre-recruit crabs, and secondary measures of sex-ratio and commercial catch. Each of these measures should be assessed separately for each gulf.

The abundance of legal size crabs would be best assessed by measuring the catch rate of legal size crabs during fishery independent surveys to provide a "snapshot" of abundance across the entire fishery. This should be augmented by assessment of monthly CPUE data from the commercial fishery throughout the year.

The abundance of pre-recruits is best assessed from a combination of measures including catch rate from fishery-independent surveys and commercial pot sampling. The use of commercial logbook data for assessment of pre-recruit abundance is limited by substantial biases associated with the capture efficiency of commercial pots.

Estimates of sex ratio that are representative of the population should be determined from a combination of fishery-independent survey and commercial pot sampling data. Estimates of sex ratio from commercial logbooks should be assessed against these population estimates to inform on harvest practices of the fishery e.g. release of berried females, targeting specific sexes for market purposes.

Combining fishery-independent survey data and commercial catch effort and pot sampling data would provide a robust and complimentary framework for assessment of the fishery. Survey data provide independent estimates from a "snapshot" that should cover the full extent of the fishery at a time of year that coincides with recruitment to the fishery. Commercial pot sampling and catch effort data provide temporal information that augments and overlaps with independent survey data. Together, these data sources cover the full temporal and spatial extent of the fishery.

6.3 FUTURE RESEARCH NEEDS

There are several aspects of the assessment that require urgent refinement to ensure a reduction in their associated uncertainty. In particular, catch and effort data need to be analysed at finer spatial scales i.e. fishing block. This would also enable assessment of the extent to which surveyed regions represent the fishery. Following these analyses, the inclusion of additional surveyed fishing blocks may need to be considered. The costs associated with additional sites could be offset by the rationalisation of the use of commercial pots during surveys.

There is an urgent need to establish the commercial pot-sampling program as an integral component of the assessment, with the catch from one research pot measured each boat day. Also, there is a need for obtaining up-to-date information on the magnitude of the recreational catch. Finally, standardisation of commercial $CPUE_L$ data may reduce the uncertainty associated with the current estimates, particularly the spatial and temporal changes in effort distribution that are associated with the regular changes in fisher demographics.

Table 6.1 Potential performance indicators for assessment of the pot fishery in Spencer Gulf and Gulf St Vincent.

PI	Data source	Measure	Comments
Legal size abundance	Fish. Ind. Surveys	Catch (legal)/potlift	Independent "snapshot" of legal size abundance across the entire fishery. Based on research pots. Surveys conducted since 2002. Data available now to determine reference points.
	Comm. logbook	Daily catch (legal) /daily pot effort	Annual CPUE is an insensitive measure of abundance. Long history of data collection. Monthly CPUE may be a useful measure to augment independent survey legal size abundance estimates.
Pre-recruit abundance	Fish. Ind. Surveys	Catch (pre-rec.)/potlift	Independent "snapshot" of pre-recruit abundance across the entire fishery. Based on research pots. Surveys conducted since 2002. Data available now to determine reference points.
	Pot sampling	Catch (pre-rec.)/potlift	Based on research pots. Should be consistent daily coverage from all fishers. Available data not suitable for performance assessment. Monthly data would augment survey data by providing comparisons.
	Comm. logbook	Daily catch (pre-rec.) /daily pot effort	Incomplete data records in Spencer Gulf. Useful data available for GSV. Issues of bias with estimates of pre-recruit abundance from commercial pots. Not the preferred measure.
Sex ratio	Fish. Ind. Surveys	% of females in the catch	Independent "snapshot" of legal size abundance across the entire fishery. Based on research pots.
	Pot sampling	% of females in the catch	Based on research pots. Should be consistent daily coverage from all fishers. Available data not suitable for performance assessment. Monthly data would augment survey data.
	Comm. logbook	% of females in the catch	Incomplete data records in both gulfs. Uncertainty associated with retention of berried females etc.
Commercial catch	Comm. logbook	% of the TACC	Useful indicator of fishery performance, not a robust indicator of biomass.

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8 APPENDICES

8.1 VOLUNTARY POT SAMPLING DATA SHEET.

Blue Swimmer Crab Voluntary Pot Sampling

Licence No:			
Block no:		*Date:*	/ /
Datum:		*Region:*	SG GSV
Latitude:	- -	*Depth (m) :*	
Longitude:	- -	*Water temp (C°) :*	

Commercial Pot					***Research Pot***			
Measure crabs to nearest mm - Carapace width					*Measure crabs to nearest mm - Carapace width*			
MALES	**FEMALES**	**By Catch - Species**	***No:***		***MALES***	**FEMALES**	**By Catch - Species**	***No:***
				1				
				2				
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PLACE All ADDITIONALCRABS MEASURED ON BACK OF SHEET WITH POT LABEL (C or R)