

South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2013/14



L. McLeay

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Fishery Status Report to PIRSA Fisheries and Aquaculture

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EXECUTIVE SUMMARY

This report provides an assessment of the status of the Giant Crab (*Pseudocarcinus gigas*) resource in 2015, utilising data to the end of the 2013/14 fishing season (Northern Zone (NZ): 1 November 2013 to 31 May 2014; Southern Zone (SZ): 1 October 2013 to 30 April 2014). It is reliant on fishery-dependent data. Data are analysed at the scale of the whole fishery, the NZ and SZ, and among commercial fishing sectors.

The three commercial fishing sectors that contribute to the fishery are the (1) Miscellaneous Fishery licence holders; (2) Rock Lobster licence holders with Giant Crab quota (RL-quota) and; (3) remaining Rock Lobster licence holders entitled to catch Giant Crab as a by-product (RL by-product). In this report, reference to the fishing season refers to the first year of the start of the season (e.g. 2013 refers to the 2013/14 fishing season).

In 2013, the Total Allowable Commercial Catch (TACC) was 22.1 t (NZ 13.4 t and SZ 8.7 t) and has remained unchanged since 2000. Total catch has been relatively stable since the introduction of sectorial quotas in 2002. However, in 2013, the total catch was the lowest recorded since 1996 at 17.3 t, with 77% and 75% of the zonal TACCs harvested in the NZ and SZ, respectively.

In 2013, the distribution of catch among sectors was 65.4% (11.3 t) in the Miscellaneous Fishery sector, 32.2% (5.6 t) in the RL-quota sector and 2.4% (0.4 t) harvested as by-product by Rock Lobster fishers. The distribution of catch among sectors has changed little since the previous assessment in 2012 (71%, 27% and 2%, respectively) and is similar in the NZ and SZ.

Total effort has generally declined through time, and in 2013 was the second lowest value of effort recorded since 1994 (2013: 15,248 potlifts). This trend is primarily due to substantial decreases in effort in the RL by-product sector.

Relatively stable catches combined with reduced effort have resulted in steady increases in catch rates (CPUE) across the fishery since 2009. The last four fishing seasons (2010: 1.86 kg.potlift⁻¹; 2011: 1.25 kg.potlift⁻¹; 2012: 1.43 kg.potlift⁻¹; 2013: 1.13 kg.potlift⁻¹) have recorded some of the highest estimates of CPUE since 1993 (2.03 kg.potlift⁻¹). From 2000 to 2013, CPUE in the Miscellaneous Fishery sector in the NZ (range: 2.2 - 4.3 kg.potlift⁻¹) and SZ (range: 2.1 - 4.1 kg.potlift⁻¹) has consistently been more than double that of the RL-quota sector and ten times that of the RL by-product sector.

The extent to which any of the current performance indicators reflect a change in stock status of Giant Crab in South Australia is unclear. Data were available to assess fishery

performance against six of the seven interim PIs in each zone in 2013. There were no data for the PI relating to spawning female abundance. In both the NZ and SZ, three PIs (effort, catch rate (CPUE) and sex ratio) were **within** the ranges prescribed by the upper and lower reference points. The PIs for catch (percentage of TACC caught), mean weight of crabs harvested and pre-recruit abundance were **below** the lower reference points defined for these PIs in both zones. Catch reduced by at least 20% in both zones between 2012 and 2013. Mean weight of crabs remains near, but below, the lower reference point for this PI in both zones. In 2013, pre-recruit abundance for the NZ was the lowest on record while in the SZ pre-recruit abundance was also among the lowest on record. Pre-recruit abundance has been below the reference point in the NZ and SZ for the past four and five seasons, respectively, indicating that future recruitment to the fishable stock may be reduced.

Catch rate (CPUE), pre-recruit abundance and effort are unlikely to be reliable proxies for determining trends in the abundance of Giant Crab due to (1) the inclusion of data from the South Australian Rock Lobster Fishery (SARLF) that are subject to historical inconsistencies in the reporting of targeted fishing effort; and (2) the limited number of dedicated Giant Crab fishers that impedes estimation of PIs from this sector of the fishery alone.

Refinements in the methods used to define and calculate PIs and reference points are required. The PIs described in this report do not align with those listed for Giant Crab under the nationally agreed framework for assessing fish stock sustainability (Flood et al. 2014) and some of the current reference points do not reflect the range of temporal variation shown by a PI. Inclusion of new PIs, based on levels of egg production and the proportion of the spawning stock protected by minimum size limits, could be estimated through the collection of representative length-frequency data. These data would also align with PIs calculated for Giant Crab in other States, aid interpretation of current PIs, particularly CPUE and mean weight, and increase the reliability of the overall assessment of Giant Crab stock status in South Australia and nationally.

Given the uncertainty surrounding the reliability of some data and the contrast in inference of stock status among PIs, using the national framework for stock status reporting, the status of the SA Giant Crab stock would be classified as undefined¹.

¹ The stock status classification 'undefined stock' is described in Flood et al. (2014) as indicating that not enough information exists to determine stock status.

1. INTRODUCTION

This status report for the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery (GCF) updates previous stock assessment and status reports for this species (Currie and Ward 2005; Currie *et al.* 2006; Currie 2008; Currie and Ward 2009; Currie 2010; Currie 2011a, b; Chick 2013; Stobart 2014) and is part of the SARDI Aquatic Science's ongoing assessment program for this fishery. This document summarises information collected from commercial logbook returns from 1 November 1987 to 31 May 2014.

A detailed description of the history and management arrangements for the fishery, and the biological information available for its assessment are provided in Sloan (2002, 2003) and previous stock assessment and status reports. In summary, in 1997, the GCF was separated into two zones, the Southern Zone (SZ) and Northern Zone (NZ) that are consistent with those designated for the South Australian Rock Lobster Fishery (SARLF). Fishing in each zone is subject to a seasonal closure. The fishing season in the SZ is between 1 October and 30 April, while fishing in the NZ is between 1 November and 31 May. In this report, reference to a fishing season refers to the year the fishing season started (e.g. SZ fishery-dependent data reported for 2013 includes data from 1 October 2013 to 30 April 2014; NZ includes those data from 1 November 2013 to 31 May 2014).

An annual Total Allowable Commercial Catch (TACC) of 26 t was implemented for the GCF in 1999 (NZ: 13.4 t and SZ: 12.6 t). From 2000 onwards, this TACC was reduced to 22.1 t (NZ: 13.4 t and SZ: 8.7 t) and has since remained unchanged (PIRSA 2009 and Table 1). In 2013, the TACC was allocated among 16 licence holders: two in the South Australian Miscellaneous Fishery and 14 in the SARLF. Within the SARLF, Giant Crab quota is allocated to licence holders as a unit holding (RL-quota). Remaining SARLF licence holders have an entitlement to land up to five individual Giant Crabs per fishing trip as bycatch (RL by-product).

2. METHODS

Fishery-dependent data are collected from the three commercial fishing sectors (Miscellaneous Fishery, RL-quota and RL by-product). Historical data are unavailable to accurately identify SARLF licence holders that held Giant Crab quota between 1999 and 2005. Based on previously applied decision rules (SARDI unpublished data) fishery-dependent data within this period was allocated to the RL-quota sector by referencing SARLF licence holders who held Giant Crab quota in 2006 and an additional SARLF licence holder (between 1999 and 2002). From 2006, PIRSA has

provided information to SARDI to identify licence holders among each fishing sector with Giant Crab entitlement. All other fishery-dependent data from SARLF licence holders without allocated Giant Crab quota is assigned to the RL by-product sector.

Effort is reported as the total number of potlifts recorded against Giant Crab catch across all sectors of the fishery, including all SARLF potlifts (unless otherwise stated). This decision rule for effort is applied to maintain consistency with previous stock assessment and status reports, and due to the fact that Giant Crab catch in the SARLF has not always been segregated by the specific pots used to target Rock Lobster or Giant Crab. Historical inconsistencies in reporting the numbers of pots used to catch Giant Crabs by RLF licence holders have resulted in measures of effort and CPUE from these sectors to be less reliable than those data from Miscellaneous Fishery licence holders. To aid the interpretation of trends in catch, effort and CPUE in this report, fishery-dependent data are presented separately for each sector that contribute to the catch of Giant Crab.

In addition, from 2011, previously unreported historical data were made available through data-entry corrections (equating to <550 kg difference in catch in each zone per year). Consequently, there are small discrepancies between the fishery-dependent data reported previously and this report.

Performance indicators (PIs) for this fishery are detailed in Sloan (2003) and have been calculated using fishery-dependent data from the Miscellaneous Fishery and RL-quota sectors only. Further, the PI for 'pre-recruit abundance' is the number of undersize (<150 mm) Giant Crabs per potlift (undersize crabs.potlift⁻¹), where the PI measure of effort was the number of Giant Crab pots lifted, not total effort (that includes RL pots).

3. RESULTS

3.1. Catch

The total annual catch of Giant Crab landed by all three commercial sectors (i.e. Miscellaneous Fishery, RL-quota and RL by-product) varied considerably prior to the introduction of TACC in 1999 (Figure 1). The annual catch reached a historical high of 34.7 t in 1997. Subsequently, catches declined and, after the introduction of the TACC in 1999, remained relatively stable (17-22 t) following higher catches in 1999 (24.6 t) and 2000 (24.6 t). In 2013, 17.3 t of Giant Crab were landed by commercial fishers, representing the lowest level of catch recorded since 1996 (Figure 1A; Table 1).

3.2. Effort

Total fishing effort by the commercial sector has generally declined since it peaked in 1994 (74,997 potlifts; Figure 1A) and in 2010 (10,392 potlifts) was at the lowest level since the TACC was introduced in 1999. In 2013, effort was 12,819 potlifts, the second lowest since the introduction of the TACC.

3.3. Catch rate (CPUE)

Relatively stable catches combined with reduced effort have resulted in increased catch rates (catch per unit effort; CPUE) across the fishery (all sectors combined) since 2009 (Figure 1B). The last four fishing seasons (2010: 1.86 kg.potlift⁻¹; 2011: 1.25 kg.potlift⁻¹; 2012: 1.43 kg.potlift⁻¹; 2013: 1.13 kg.potlift⁻¹) have recorded some of the highest estimates of CPUE since 1993 (2.03 kg.potlift⁻¹).

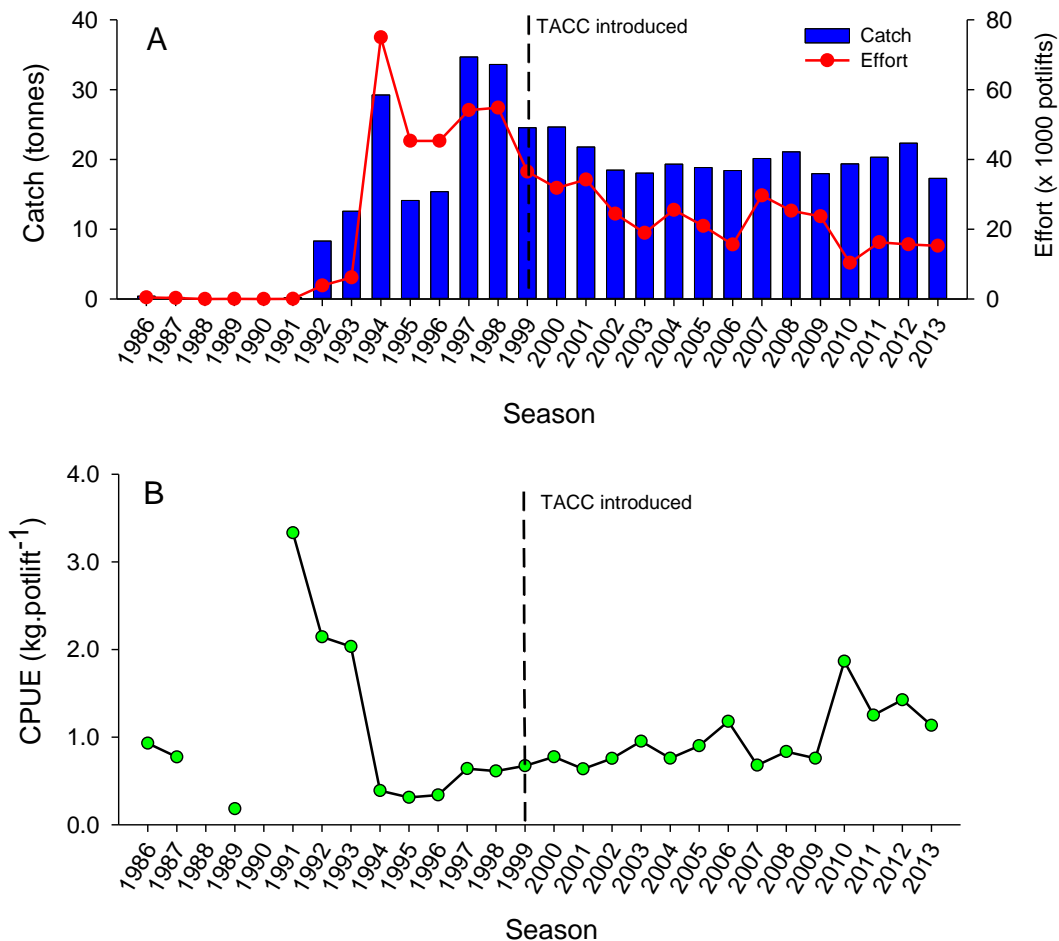


Figure 1. Levels of (A) total catch (blue bars) and fishing effort (total potlifts; red line) and; (B) catch per unit effort (CPUE; kg potlift⁻¹) in the Giant Crab Fishery.

3.4. Catch, Effort and CPUE by Fishing Sector

Of the three commercial fishing sectors harvesting Giant Crab since 2000, the Miscellaneous Fishery sector has consistently landed over 55% and 66% of the total annual catch in the NZ and SZ, respectively (Table 1 and Figure 2A). In 2013, 61% (6.3 t) of Giant Crab landed in the NZ and 73% (5 t) in the SZ were caught by Miscellaneous Fishery licence holders.

Catch by the RL-quota sector has also increased in recent years, both in the NZ and SZ. In the NZ, the average catch between 2007 and 2013 (3.8 t) was approximately double that reported between 2000 and 2006 (2.0 t) and has increased since this time to 4.0 t in 2012 and 2013. In the SZ, the catch harvested by the RL-quota sector was less than 1.0 t from 2002 to 2009, after which it increased to a maximum of 2.0 t in 2012. In 2013, the catch from the SZ was 1.5 t (Table 1 and Figure 2A).

In contrast, since 2005 in the NZ and 2002 in the SZ, the RL by-product sector has harvested <10% of the total annual catch. In 2013, the catch of Giant Crab taken as a by-product of the RLF in the NZ and SZ was 0.1 and 0.31 t, respectively (Table 1 and Figure 2A).

The level of effort (potlifts) in the Miscellaneous Fishery sector has remained relatively stable since 1999 compared to effort in the RL-quota and RL by-product sectors which has varied (Figure 2B). Since 1999, annual effort in the Miscellaneous Fishery sector has ranged between 1,737 and 4,600 potlifts.yr⁻¹ (2013: 1,971 potlifts) in the NZ, and 1,684 and 3,290 potlifts.yr⁻¹ (2013: 1,996 potlifts) in the SZ. Since 2009, effort targeting Giant Crab has been consistently higher in the NZ RL-quota sector compared to the other two sectors. In contrast for the same time period, effort in the SZ RL-quota sector has been consistently lower compared to the other two fishing sectors. In 2013, effort of the RL-quota sector in the NZ was 3,689 potlifts compared to 1,334 potlifts in the SZ (Figure 2B). Annual effort in the RL by-product sector in both the NZ and SZ has generally decreased since 2000 and in 2013, was 1,565 and 4,693 potlifts, respectively. With the exception of the period between 2009 and 2013 in the NZ, and the 2006 and 2013 seasons in the SZ, the highest annual effort has been recorded in the RL by-product sector. This is due primarily to the reporting of Giant Crab catch against all pots used in fishing operations, including all rock lobster pots.

CPUE (kg.potlift⁻¹) in the Miscellaneous Fishery sector has been consistently greater in both zones compared to that recorded in the other two sectors (Figure 2C). Since 1999, CPUE in the NZ of the Miscellaneous Fishery sector has ranged between 2.2 and 4.3 kg.potlift⁻¹ reaching its peak in 2008. CPUE in the SZ has ranged between 1.8

and $4.1 \text{ kg.potlift}^{-1}$ with a peak in CPUE also recorded in 2008 (Figure 2C). These levels of CPUE are generally more than double that of the RL-quota sector and commonly an order of magnitude greater than that of the RL by-product sector. In 2013, CPUE in the Miscellaneous Fishery sector was 3.21 and $2.50 \text{ kg.potlift}^{-1}$ in the NZ and SZ, respectively. In the RL-quota sector CPUE has steadily increased in the NZ since 2005 and in the SZ since 2008. The CPUE recorded by the RL-quota sector in 2013 was the third highest on record in the NZ ($1.10 \text{ kg.potlift}^{-1}$) and second highest on record in the SZ ($1.14 \text{ kg.potlift}^{-1}$).

Table 1. Total catch (kg) in the Giant Crab Fishery in each fishing zone and sector since the establishment of TACCs in 1999. Season refers to the first year of the fishing season (SZ: 1 October to 30 April; NZ 1 November to 31 May). Note that no sectoral quotas are allocated prior to 2002 because the fishery was operated under a fully competitive TACC. From 2000 to the present season (2013) the TACC has been 22.1 t (NZ 13.4 t and; SZ 8.7 t).

SEASON	SECTOR	Catch (NZ)	Catch (SZ)	Total catch (kg)	TACC (kg)	SEASON	SECTOR	Catch (NZ)	Catch (SZ)	Total catch (kg)	TACC (kg)
1999	Miscellaneous	12,040	3,493	15,533		2007	Miscellaneous	6,660	7,857	14,517	16,151
	RL-quota	811	4,081	4,892			RL-quota	3,558	59	3,618	4,844
	RL by-product	1,081	3,042	4,123			RL by-product	1,151	851	2,002	1,105
	Total	13,932	10,616	24,548	26,000		Total	11,368	8,768	20,136	22,100
2000	Miscellaneous	11,600	7,176	18,776		2008	Miscellaneous	8,454	7,137	15,591	16,151
	RL-quota	1,862	1,442	3,304			RL-quota	3,676	7	3,684	4,844
	RL by-product	1,595	969	2,564			RL by-product	1,107	721	1,829	1,105
	Total	15,057	9,587	24,644	22,100		Total	13,238	7,866	21,103	22,100
2001	Miscellaneous	9,016	5,514	14,530		2009	Miscellaneous	6,386	6,160	12,546	16,151
	RL-quota	2,478	1,329	3,807			RL-quota	3,680	695	4,375	4,844
	RL by-product	1,984	1,457	3,441			RL by-product	313	740	1,053	1,105
	Total	13,478	8,300	21,778	22,100		Total	10,379	7,595	17,974	22,100
2002	Miscellaneous	7,473	6,421	13,894	14,069	2010	Miscellaneous	7,613	6,429	14,042	16,151
	RL-quota	1,203	799	2,002	6,926		RL-quota	3,958	1,085	5,043	4,844
	RL by-product	1,880	710	2,590	1,105		RL by-product	211	84	295	1,105
	Total	10,556	7,930	18,486	22,100		Total	11,782	7,598	19,379	22,100
2003	Miscellaneous	7,811	6,407	14,218	14,565	2011	Miscellaneous	7,166	7,132	14,298	16,151
	RL-quota	2,031	150	2,181	6,430		RL-quota	3,967	1,381	5,348	4,844
	RL by-product	1,288	364	1,652	1,105		RL by-product	323	350	673	1,105
	Total	11,130	6,921	18,051	22,100		Total	11,456	8,863	20,319	22,100
2004	Miscellaneous	7,057	6,312	13,369	14,565	2012	Miscellaneous	9,001	6,815	15,816	16,151
	RL-quota	3,214	9	3,223	6,430		RL-quota	4,042	1,979	6,021	4,844
	RL by-product	2,511	231	2,742	1,105		RL by-product	139	356	495	1,105
	Total	12,782	6,552	19,334	22,100		Total	13,182	9,150	22,332	22,100
2005	Miscellaneous	7,175	8,919	16,094	16,065	2013	Miscellaneous	6,333	4,983	11,317	14,342
	RL-quota	1,522	14	1,535	4,930		RL-quota	4,042	1,525	5,566	6,653
	RL by-product	805	415	1,219	1,105		RL by-product	100	312	412	1,105
	Total	9,502	9,348	18,849	22,100		Total	10,476	6,819	17,295	22,100
2006	Miscellaneous	7,756	8,573	16,329	16,151						
	RL-quota	1,423	12	1,434	4,844						
	RL by-product	500	156	656	1,105						
	Total	9,679	8,741	18,420	22,100						

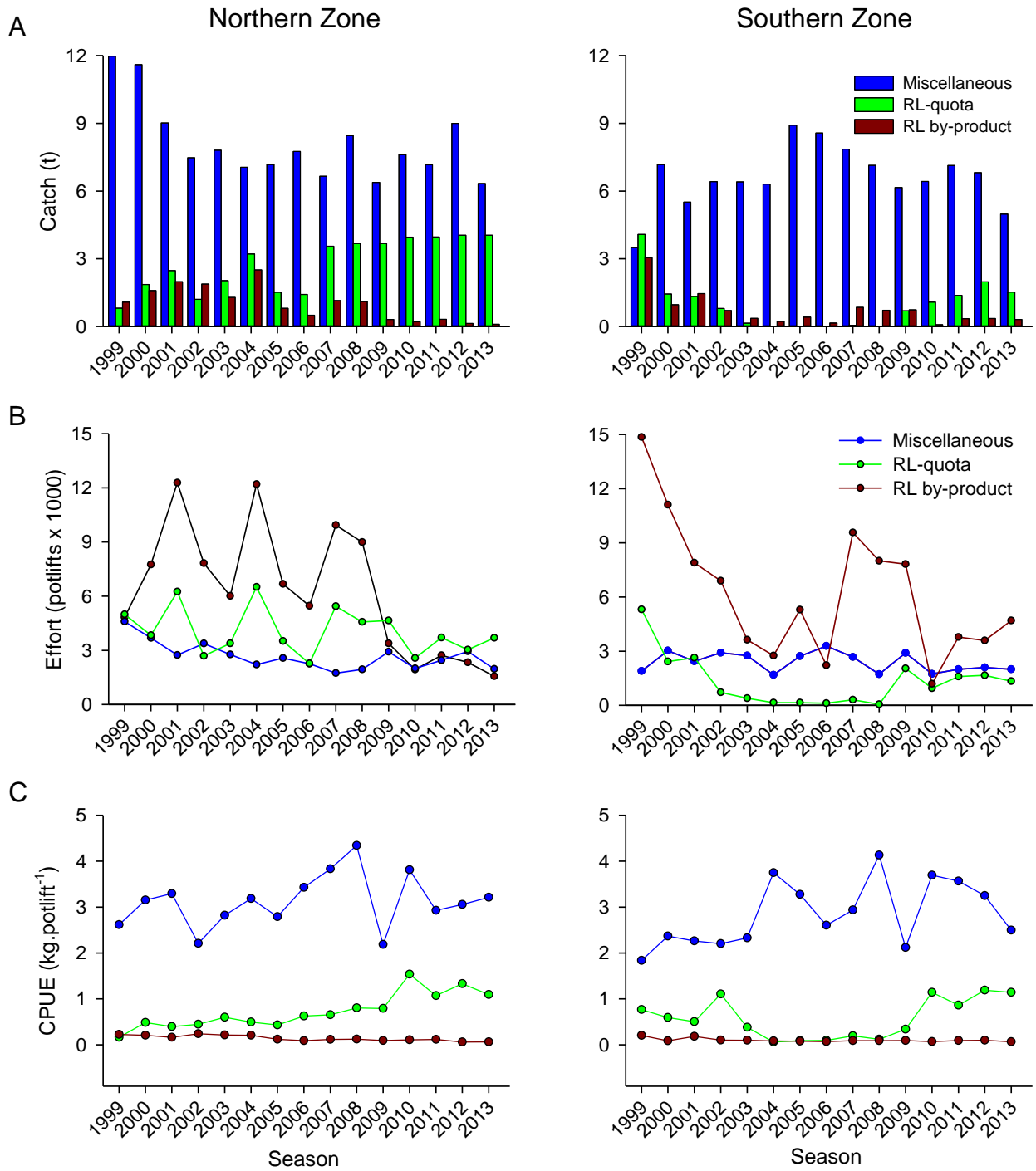


Figure 2. Annual (fishing season) measures of (A) total catch; (B) fishing effort; and (C) catch per unit effort (CPUE) for each sector in the Northern and Southern Zones of the Giant Crab Fishery.

3.5. Performance Indicators

This section provides a report on the performance of the fishery against the interim performance indicators (PIs) and reference points for the Giant Crab Fishery (see PIRSA 2009). There are seven biological PIs specified for Giant Crabs in the NZ and SZ (Table 2; Figure 3). In each zone, data are available to assess fishery performance against six PIs. Insufficient data are available to assess the abundance of spawning females. Values of each PI in 2013 were derived from data provided by the Miscellaneous Fishery and Rock Lobster quota licence holders only. The unit of measure for the PI on 'pre-recruit abundance' is the number of undersize (<150 mm) Giant Crabs per potlift (number of undersize crabs.potlift⁻¹), where the measure of effort was the number of Giant Crab pots lifted, not total effort (that includes RL pots). Under current management arrangements for the fishery, no reference points are defined for fishing effort (number of potlifts) or sex ratio (Sloan 2003, PIRSA 2009). In line with previous reporting, provisional upper and lower reference points are calculated and presented for these two indicators based on maximum and minimum values, respectively for the period 2000–2009.

3.5.1. Northern Zone

The PIs for effort (potlifts), catch rate (kg.potlift⁻¹) and sex ratio (F:M) in the NZ in 2013 were all within their reference ranges (Table 2). Three performance indicators fell below their lower reference points. These were catch (percentage of TACC caught: 77%); mean weight of crabs harvested (kg: 2.93 kg); and pre-recruit abundance (number of undersize crabs.potlift⁻¹: 0.77) (Table 2).

3.5.2. Southern Zone

Similar trends in performance to those observed in the NZ were seen in the SZ. Performance indicators for effort (potlifts), catch rate (kg.potlift⁻¹) and sex ratio (F:M) in the NZ in 2013 were all within their reference ranges (Table 2). Three PIs fell below their lower reference points. These were catch (percentage of TACC caught: 75%); mean weight of crabs harvested (kg: 2.84 kg); and pre-recruit abundance (number of undersize crabs.potlift⁻¹: 1.39; Table 2).

Table 2. Performance indicators, upper and lower reference points and their values for the NZ and SZ of the South Australian Giant Crab Fishery in 2013. Note, all estimates presented are derived from the Miscellaneous Fishery and Rock Lobster licence holders with Giant Crab quota-entitlement only and do not include information obtained from the Rock Lobster by-product sector. Upper and lower reference points for effort and sex ratio are not defined in PIRSA (2009) and have been calculated as upper and lower values measured for the period 2000–2009. Values below the lower reference point are highlighted in red, while values exceeding the upper reference point are highlighted in green.

Zone	Performance Indicator	Upper ref. point	Lower ref. point	Value in 2013
NZ	Catch (tonnes)	TACC	85% of TACC	77% of TACC
	Effort (potlifts)	8,987	4,537	5,660
	Catch rate (kg.potlift ⁻¹)	3	1.5	1.83
	Mean weight (kg)	3.65	2.96	2.93
	Pre-recruit abundance (number of undersize per potlift ⁻¹)	1.7	1.6	0.77
	Sex ratio (F:M)	1 : 3.13	1 : 0.60	1 : 1.59
	Spawning female abundance	Not defined	Not defined	No data
SZ	Catch (tonnes)	TACC	85% of TACC	75% of TACC
	Effort (potlifts)	5,458	1,787	3,330
	Catch rate (kg.potlift ⁻¹)	3	1.5	1.95
	Mean weight (kg)	3.65	2.96	2.84
	Pre-recruit abundance (number of undersize per potlift ⁻¹)	1.7	1.6	1.39
	Sex ratio (F:M)	1 : 3.13	1 : 0.60	1 : 1.55
	Spawning female abundance	Not defined	Not defined	No data

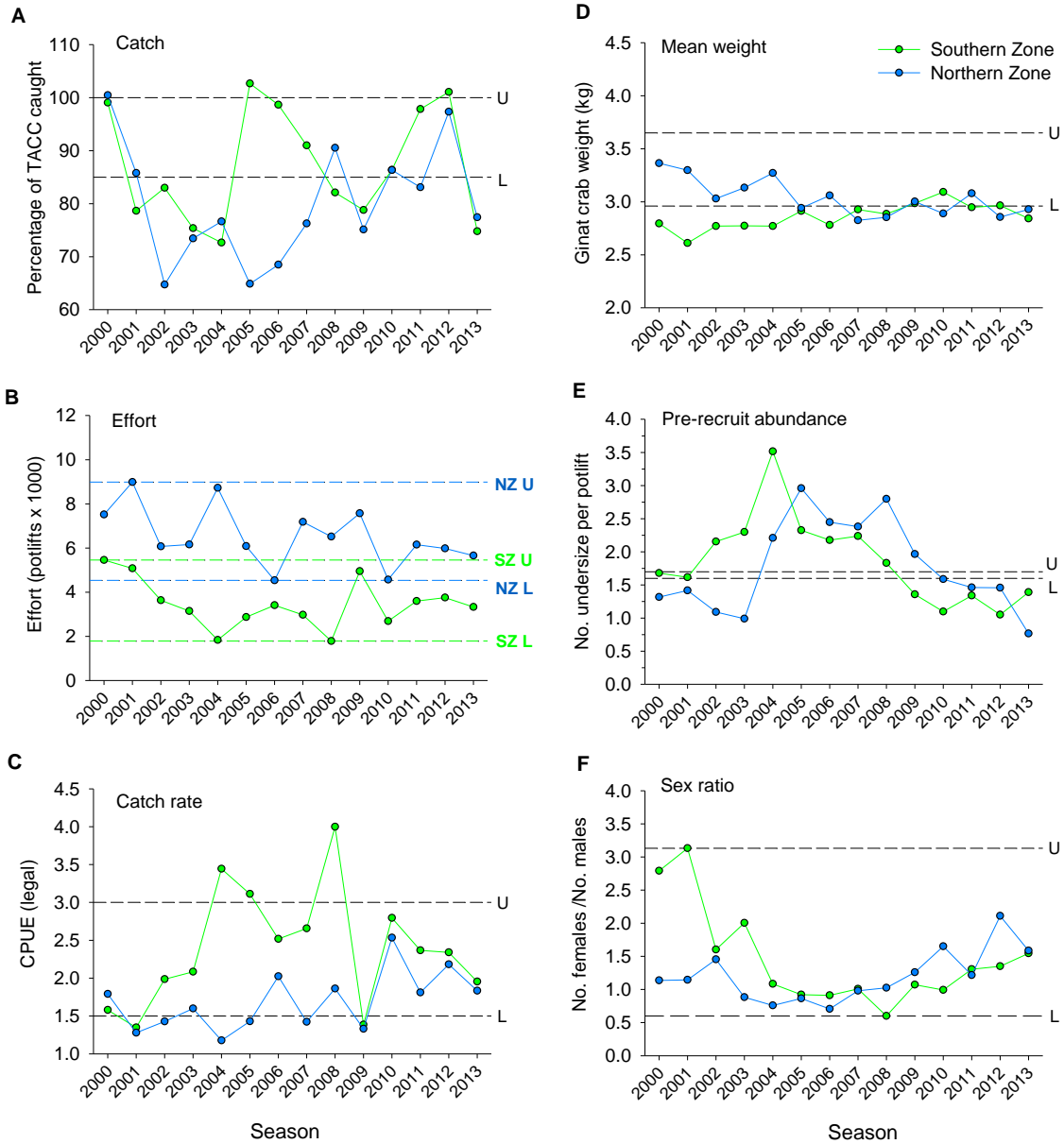


Figure 3. Annual (fishing season) measures of the six performance indicators for the NZ (blue lines) and SZ (green lines) Giant Crab Fishery: A. Catch (as percentage of the TACC caught); B. Effort; C. Catch rate (CPUE) (kg.potlift^{-1}); D. Mean weight; E. Pre-recruit abundance i.e. number of of undersize ($<150\text{mm}$) crabs per potlift and; F. Sex ratio. Horizontal lines indicate the upper (U) and lower (L) reference points for each measure, as described in Table 2. Note that all estimates presented are derived from combined Miscellaneous Fishery and Rock Lobster quota data only (i.e. they do not include information obtained from the Rock Lobster by-product sector). Data for the performance indicator *spawning female abundance* are not available.

4. DISCUSSION

4.1. Information, data gaps and uncertainty in the assessment

Assessment of the South Australian Giant Crab Fishery is supported by fishery-dependent data collected since 1986 and information on the species fisheries biology and stock structure (Levings et al. 2001). Interpretation of the available data is complicated by historical inconsistencies in the reporting of data within and among sectors, especially the RLF prior to 2006. The small number of dedicated Giant Crab fishers participating in the fishery also means that changes in the behaviour of a single fisher can have a substantial influence on the data, performance indicators and their interpretation.

The current PIs for the fishery are all based on fishery-dependent data. The lack of any PI based on fishery-independent data reflects the small size and relatively low value of the fishery. The extent to which any of the current PIs reflect a change in stock status of Giant Crab in South Australia is unclear. PIs for catch rate (CPUE), pre-recruit abundance and effort may not be reliable proxies for the abundance of Giant Crab due to (1) the inclusion of data from the RLF that are subject to historical inconsistencies in reporting of targeted fishing effort; and (2) the limited number of dedicated Giant Crab fishers which impedes estimation of these indices from this sector of the fishery alone.

As previously recommended in PIRSA (2009) refinements in the methods used to define and calculate PIs and reference points are required. The PIs described in this report do not completely align with those listed for Giant Crab under the nationally agreed framework for assessing fish stock sustainability (Flood et al. 2014) and some of the current reference points do not reflect the range of temporal variation shown by the PI. For example, estimates of pre-recruit abundance range from 1.17 to 4.0 $\text{undersize.potlift}^{-1}$ across the fishery between 2000 and 2013. This compares to the relatively narrow range defined for this indicator's reference point (1.6 to 1.7 $\text{undersize.potlift}^{-1}$). Additionally, inclusion of new PIs based on egg production and proportion of spawning stock protected by minimum size limits could be estimated through the acquisition of representative length-frequency data. These data would augment interpretation of other PIs, particularly CPUE, pre-recruit abundance and mean weight, and increase the reliability of the overall assessment of Giant Crab stock status.

In the absence of this information, the use of a historical reference period, when the fishery was performing well, may provide a range within which more informative reference points could be defined. One option would be to generate upper and lower quantiles (e.g. 10-25%) of the historical data (PIRSA 2012a). Alternatively, triggers could include measures for PIs describing greatest variation or maximum rates of change

within the reference period (PIRSA 2012b). Finally, as Giant Crab pots are not always hauled daily, soak time is likely to have an effect on catch rate. Research into the effect of soak time on catch rate is being investigated by SARDI and may be built into future data collection protocols and assessments of the fishery.

4.2. Status of the Giant Crab Fishery

There is no index yet established that unambiguously defines stock status for this fishery. Consequently, a weight-of-evidence approach is applied which involves interpretation of data with potentially contrasting inferences of stock status. The contrast in this assessment lies between (1) the PIs for catch rate (CPUE), effort and sex ratio lying within the range described by the upper and lower reference points and; (2) declines in the PIs for catch, mean weight and pre-recruit abundance to levels below their lower reference points.

In the NZ, the PIs for effort, catch rate (CPUE) and the sex ratio of the catch were within the ranges prescribed by the upper and lower reference points described in PIRSA (2009). However, the PIs for catch, mean weight and pre-recruit abundance were below the lower reference point. The high pre-recruit abundance observed from 2004 to 2008 is likely to have resulted in strong recruitment to the fishery and increases in CPUE to among the highest levels on record in 2010, 2011, 2012 and 2013. These relatively higher recruitment levels may also explain the historically low mean weight recorded between 2005 and 2013. Subsequently, pre-recruit abundance has declined (since 2005) to the lowest level ever recorded in 2013, suggesting recruitment to the fishery over the next few years may be limited.

In the SZ, PIs for effort, catch rate (CPUE) and sex ratio of the catch were within the upper and lower reference points range described in PIRSA (2009). However, the PIs for catch, mean weight and pre-recruit abundance were below their lower reference points. The PI for pre-recruit abundance has been at historically low levels and below the lower reference point for the last five fishing seasons, with the value for 2013 among the lowest on record. Given the similar decline in this PI in the NZ, this trend in the SZ supports the inference of a fishery-wide reduction in future recruitment to the fishable stock.

The limitations of the data described in Section 4.1 result in a high level of uncertainty in the assessment of the current stock status of Giant Crabs in South Australia. Therefore, under the national framework for reporting of stock status (Flood et al. 2014), the SA Giant Crab Fishery is classified as an undefined stock¹. However, the recent declines in

¹ The stock status classification 'undefined stock' is described in Flood et al. (2012) as indicating that not enough information exists to determine stock status.

catch, CPUE and pre-recruit abundance, coupled with the low mean weight of crabs across the fishery, indicate that future assessments of stock status will require careful consideration. This should include assessing the reliability of CPUE as an index of abundance and the degree to which the PIs, especially pre-recruit abundance and mean weight are reflective of stock status.

5. REFERENCES

Chick, R.C (2013). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Status Report 2011/2012. Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-3. SARDI Research Report Series No. 691. 20p.

Currie, D.R. and Ward, T.M. (2005). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Fisheries Assessment Report to PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. RD04/0215-2. 27p.

Currie, D.R., Mayfield, S., McGarvey, R. and Gardner, C. (2006). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Fisheries Assessment Report for PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. RD04/0215-3. SARDI Research Report Series 137.

Currie, D.R. (2008). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Status Report for PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2008/000067-1. SARDI Research Report Series 268.

Currie, D.R. and Ward, T.M. (2009). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Fisheries Assessment Report for PIRSA. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000698-2. SARDI Research Report Series 345.

Currie, D.R. (2010). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2008/09. Status Report to PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000698-3. SARDI Research Report Series 427.

Currie, D.R. (2011a). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2009/10. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-1. SARDI Research Report Series 568.

Currie, D.R. (2011b). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2010/11. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-2. SARDI Research Report Series 591.

Flood, M., Stobutzki, I., Andrews, J., Begg, G., Fletcher, W., Gardner, C., Kemp, J., Moore, a., O'Brien, A., Quinn, R., Roach, J., Rowling, K., Saunders, T., Ward, T. and Winning, M. (2012). Status of key Australian fish stocks reports 2012. Fisheries Research and Development Corporation, Canberra.

Levings, A., Mitchell, B.D., McGarvey, R., Mathews, J., Laurenson, L., Austin, C., Heeron, T., Murphy, N., Miller, A., Rowsell, M. and Jones, P. (2001). Fisheries Biology of the Giant Crab *Pseudocarcinus gigas*. Final report to the Fisheries Research and Development Corporation, Australia, for projects 93/220 & 97/132. Deakin University.

PIRSA. (2009). Ecological Assessment of the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Re-assessment report prepared for Commonwealth Department of the Environment, Water Heritage and the Arts, for the purposes of part 13 and 13 (A) of the *Environment Protection and Biodiversity Conservation Act 1999*.

Sloan, S. (2002). A report prepared for Environment Australia on the Management of the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. For the purposes of section 303FN (Approved Wildlife Trade Operation) of the *Environment Protection and Biodiversity Conservation Act 1999*.

Sloan (2003). Ecological Assessment of the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery. Assessment Report Prepared for the Commonwealth Department of the Environment and Heritage, against the 'Guidelines for the ecologically sustainable management of fisheries'. For the purposes of Part 13 and 13(A) of the *Environment Protection and Biodiversity Conservation Act 1999*.

Stobart, B. (2014). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2012/13. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-4. SARDI Research Report Series No. 763. 15p.