

South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2014/15



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 South Australian Giant Crab Fishery using data to the end of the 2014 fishing season. It is reliant on fishery-dependent data that are analysed at the scale of the whole fishery, the Northern Zone (NZ) and Southern Zone (SZ), and among the commercial fishing sectors that contribute to the fishery: (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 2014, 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. In 2014, the total catch was one of the lowest recorded since 1996 at 17.3 t, with 83% and 67% of the zonal TACCs harvested in the NZ and SZ, respectively. The distribution of catch among sectors in 2014 was 68% (11.8 t) in the Miscellaneous Fishery sector, 30.2% (5.2 t) in the RL-quota sector and 1.8% (0.3 t) harvested as by-product by Rock Lobster fishers. Total effort across the fishery has generally declined through time, and in 2014 was the second lowest recorded value of effort since the introduction of the TACC in 1999 (2014: 11,547 potlifts).

Relatively stable catches combined with reduced effort have resulted in steady increases in catch rates across the fishery since 2009. Since 1999, catch rates in the Miscellaneous Fishery sector in the NZ and SZ have consistently been more than double that of the RL-quota sector and ten times that of the RL by-product sector.

Of the three primary Performance Indicators (PIs) (catch rate, effort and catch - percentage of TACC caught) used to assess the fishery's status in 2014, catch rate and effort were within the range of their upper and lower reference points in both zones. The PI for catch (percentage of TACC caught) was below the lower reference point in both zones and reflects effort reductions in both zones. Three secondary PIs (mean weight, sex ratio, pre-recruit abundance) are assessed in this report. Sex ratio was within the range prescribed by the upper and lower reference points. Estimates of mean weight and pre-recruit abundance were below their lower reference points in both zones.

There is currently no agreed index to define stock status for the SA Giant Crab Fishery. Consequently, a weight-of-evidence approach is applied in determining stock status. The contrasting inferences of stock status between performance indicators results in a high level of uncertainty in the assessment. 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. A review to refine performance indicators and reference points used in the fishery is planned for 2017.

¹The stock status classification 'undefined stock' is described in Flood *et al.* (2012) 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; McLeay 2015) 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 2015.

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 2014 includes data from 1 October 2014 to 30 April 2015; NZ data are inclusive of 1 November 2014 to 31 May 2015).

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, 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 2014, the TACC was allocated among 15 licence holders: one 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. Data within this period were 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 SARLF licence holders have resulted in measures of effort and CPUE from this sector 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. This equated to <550 kg difference in catch in each zone per year and results in small discrepancies between the fishery-dependent data reported previously and this report.

A review of the performance indicators (PIs) used in the fishery is planned following the 2015 fishing season. PIs currently used for this fishery are detailed in Sloan (2003) and are 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 1A). The annual catch reached a historical high of 34.7 t in 1997 before declining to 24.6 t in 1999. Since the introduction of a TACC in 1999, catches have remained relatively stable, ranging from 17.3 to 24.6 t. In 2014, 17.3 t of Giant Crab were landed by commercial fishers, representing one of the lowest levels 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 at 74,997 potlifts (Figure 1A). In 2010, 10,392 potlifts were recorded, which is the lowest

level of effort recorded since the introduction of a TACC in 1999. In 2014, a total of 11,547 potlifts were recorded. This is the second lowest level of effort since 1999.

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 five 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; 2014: 1.49 kg.potlift⁻¹) have recorded some of the highest estimates of CPUE since 1993 (2.03 kg.potlift⁻¹).

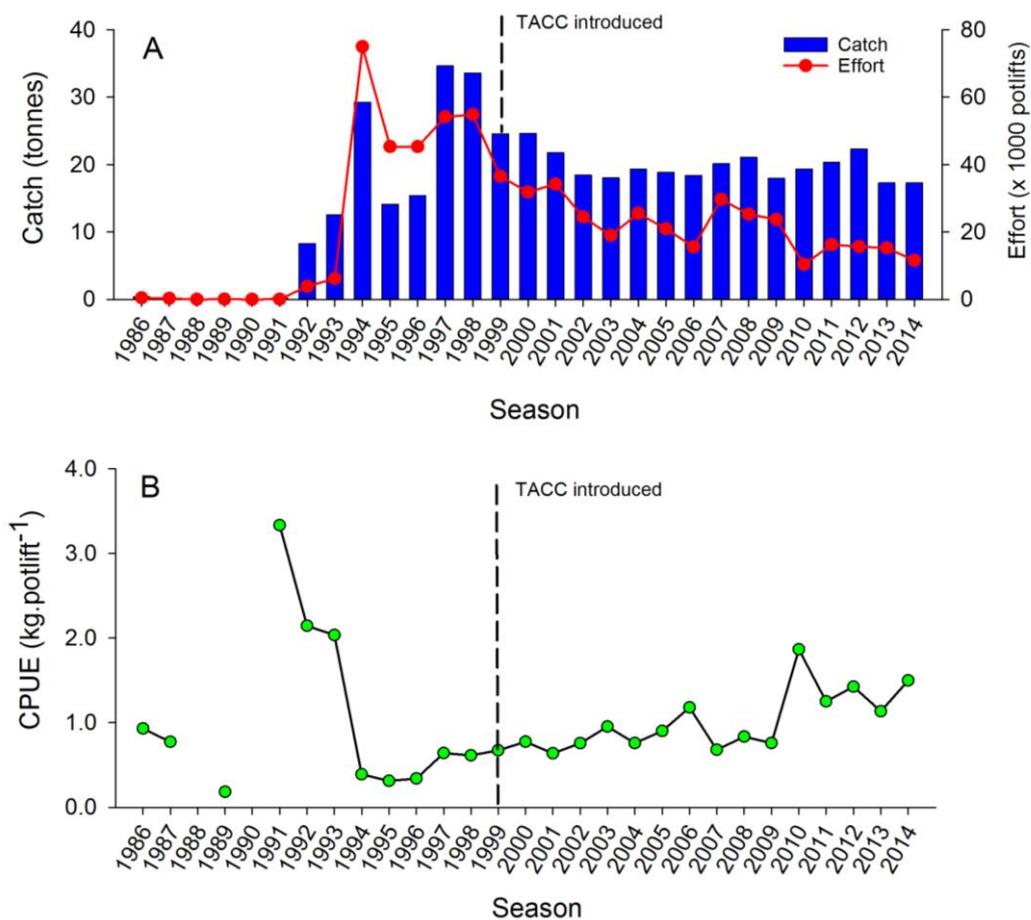


Figure 1. Levels of (A) total catch (blue bars) and fishing effort (total potlifts; red line) and; (B) catch per unit effort (CPUE; kg potlift⁻¹) in the Giant Crab Fishery.

3.4. Catch, Effort and CPUE by Fishing Sector

Of the three commercial fishing sectors harvesting Giant Crab, the Miscellaneous Fishery sector has landed at least 51% of the TACC since its introduction in 1999. In 2014, 62%

(7.0 t) of Giant Crab landed in the NZ and 79% (4.7 t) in the SZ were caught by the one Miscellaneous Fishery licence holder (Table 1 and Figure 2A).

Catch by the RL-quota sector has increased in recent years in both the NZ and SZ. In the NZ, the average catch between 2007 and 2014 (3.9 t) was approximately double that reported between 1999 and 2006 (1.8 t). In 2014, the catch in the NZ RL-quota sector was 4.1 t. In the SZ, the catch harvested by the RL-quota sector was less than 1.0 t from 2002 to 2009 and increased to 2.0 t in 2012. In 2014, the catch from the SZ was 1.2 t (Table 1 and Figure 2A).

The RL by-product sector has harvested $\leq 10\%$ of the total annual catch since 2005 in the NZ and since 2002 in the SZ. In 2014, the level of catch of Giant Crab taken as a by-product of the SARLF was 0.23 t in the NZ and 0.08 t in the SZ (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 (Figure 2B). Since 1999, annual effort in the Miscellaneous Fishery sector has ranged between 1,737 and 4,600 potlifts.yr⁻¹ in the NZ (2014: 2,113 potlifts) and from 1,684 to 3,290 potlifts.yr⁻¹ in the SZ (2014: 2,000 potlifts).

Effort in the RL-quota sector towards Giant Crab in the NZ has been consistently higher than the other two fishing sectors since 2009. In contrast, over the same period, effort in the RL-quota sector in the SZ has been consistently lower than the other two fishing sectors. In 2014, effort of the RL-quota sector in the NZ was 3,298 potlifts, while effort in the SZ was 657 potlifts (Figure 2B).

Annual effort of the RL by-product sector has generally decreased since 1999, and in 2014 was 2,296 and 1,183 potlifts, in the NZ and SZ, respectively. The relatively high annual effort recorded in this sector compared to other sectors is primarily due 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, peaking in 2008. CPUE in the SZ also peaked in 2008 and has ranged between 1.8 and 4.1 kg.potlift⁻¹ since 1999 (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 those recorded from the RL by-product sector. In 2014, CPUE in the NZ and SZ of the Miscellaneous Fishery sector was 3.33 and 2.35 kg.potlift⁻¹, respectively. In the RL-quota sector, CPUE has steadily increased since 2005 in the NZ and since 2008 in the SZ. In 2014, CPUE recorded by the RL-quota sector was the second

highest on record in the NZ ($1.24 \text{ kg.potlift}^{-1}$) and the highest on record in the SZ ($1.75 \text{ kg.potlift}^{-1}$).

Table 1. Total catch (kg) in the Giant Crab Fishery from 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). From 2000 to the present season (2014) 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	26,000	2007	Miscellaneous	6,660	7,857	14,517	22,100
	RL-quota	811	4,081	4,892			RL-quota	3,558	59	3,618	
	RL by-product	1,081	3,042	4,123			RL by-product	1,151	851	2,002	
	Total	13,932	10,616	24,548			Total	11,368	8,768	20,136	
2000	Miscellaneous	11,600	7,176	18,776	22,100	2008	Miscellaneous	8,454	7,137	15,591	22,100
	RL-quota	1,862	1,442	3,304			RL-quota	3,676	7	3,684	
	RL by-product	1,595	969	2,564			RL by-product	1,107	721	1,829	
	Total	15,057	9,587	24,644			Total	13,238	7,866	21,103	
2001	Miscellaneous	9,016	5,514	14,530	22,100	2009	Miscellaneous	6,386	6,160	12,546	22,100
	RL-quota	2,478	1,329	3,807			RL-quota	3,680	695	4,375	
	RL by-product	1,984	1,457	3,441			RL by-product	313	740	1,053	
	Total	13,478	8,300	21,778			Total	10,379	7,595	17,974	
2002	Miscellaneous	7,473	6,421	13,894	22,100	2010	Miscellaneous	7,613	6,429	14,042	22,100
	RL-quota	1,203	799	2,002			RL-quota	3,958	1,085	5,043	
	RL by-product	1,880	710	2,590			RL by-product	211	84	295	
	Total	10,556	7,930	18,486			Total	11,782	7,598	19,379	
2003	Miscellaneous	7,811	6,407	14,218	22,100	2011	Miscellaneous	7,166	7,132	14,298	22,100
	RL-quota	2,031	150	2,181			RL-quota	3,967	1,381	5,348	
	RL by-product	1,288	364	1,652			RL by-product	323	350	673	
	Total	11,130	6,921	18,051			Total	11,456	8,863	20,319	
2004	Miscellaneous	7,057	6,312	13,369	22,100	2012	Miscellaneous	9,001	6,815	15,816	22,100
	RL-quota	3,214	9	3,223			RL-quota	4,042	1,979	6,021	
	RL by-product	2,511	231	2,742			RL by-product	139	356	495	
	Total	12,782	6,552	19,334			Total	13,182	9,150	22,332	
2005	Miscellaneous	7,175	8,919	16,094	22,100	2013	Miscellaneous	6,333	4,983	11,317	22,100
	RL-quota	1,522	14	1,535			RL-quota	4,042	1,525	5,566	
	RL by-product	805	415	1,219			RL by-product	100	312	412	
	Total	9,502	9,348	18,849			Total	10,476	6,819	17,295	
2006	Miscellaneous	7,756	8,573	16,329	22,100	2014	Miscellaneous	7,042	4,707	11,749	22,100
	RL-quota	1,423	12	1,434			RL-quota	4,077	1,151	5,228	
	RL by-product	500	156	656			RL by-product	231	77	309	
	Total	9,679	8,741	18,420			Total	11,351	5,936	17,286	

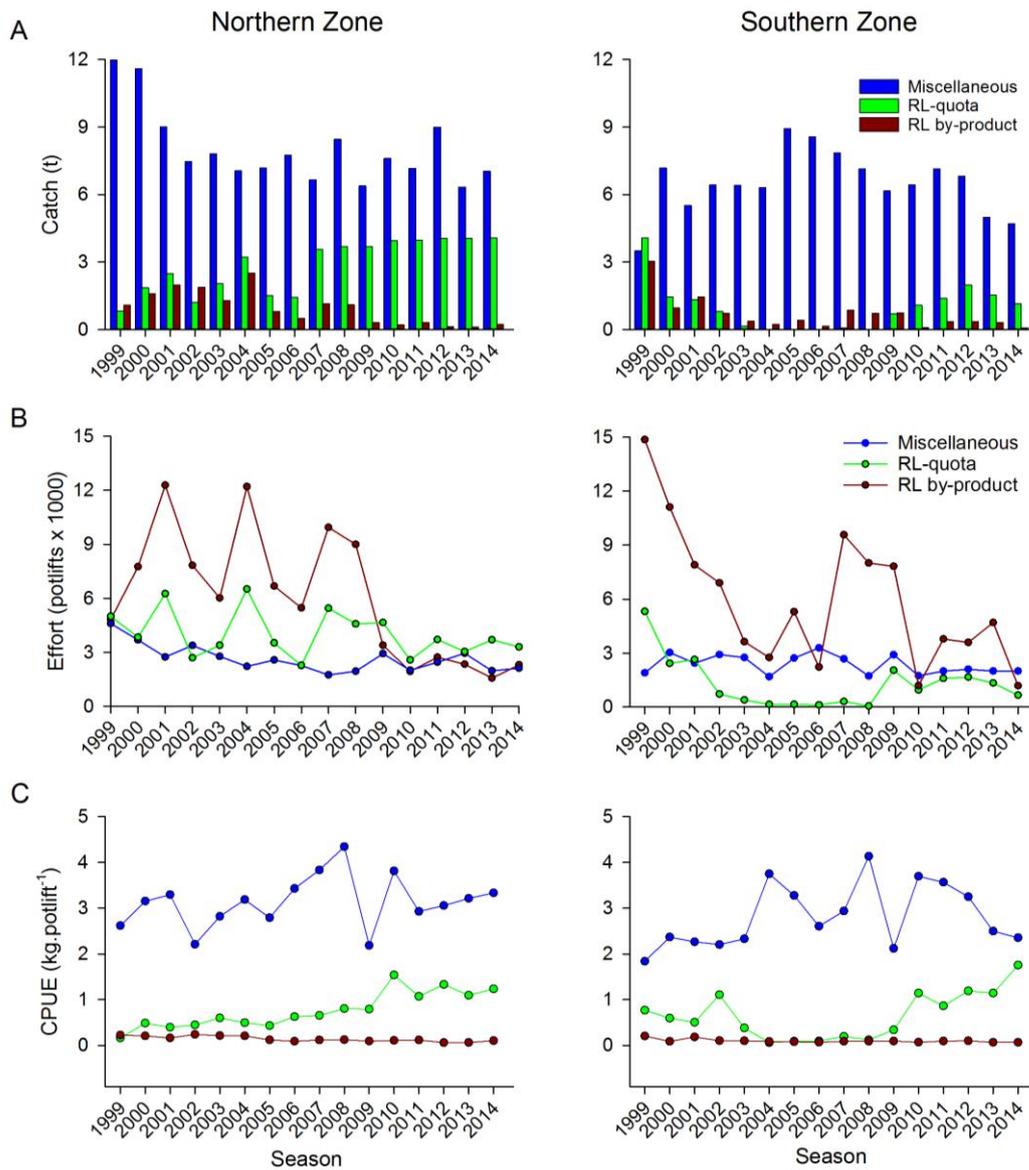


Figure 2. Annual (fishing season) measures of (A) total catch; (B) fishing effort; and (C) catch per unit effort (CPUE) for each sector in the Northern and Southern Zones of the Giant Crab Fishery.

3.5. Performance Indicators

This section provides a report on the performance of the fishery against the performance indicators (PIs) and reference points for the GCF (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 performance indicator relating to the abundance of spawning females. Values of each PI for the 2014 season 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 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 2014 were all within their reference ranges (Table 2). Three performance indicators fell below their lower reference points (LRPs). The value for catch for the 2014 season (83% of TACC caught) was below the LRP for this PI (85%) but 5% above the 10 year average of 78% (2000–2009). In 2014, mean weight in the NZ was 2.92 kg, marginally below the LRP for this PI (2.96 kg) and has fluctuated around the LRP since 2005. Pre-recruit abundance (number of undersize crabs.potlift⁻¹) in 2014 (0.82 undersize crabs.potlift⁻¹) was nearly half the LRP for this PI (1.6 undersize crabs.potlift⁻¹) (Table 2).

3.5.2. Southern Zone

Similar trends in performance to those observed in the NZ were seen in the SZ. PIs for effort (potlifts), catch rate (kg.potlift⁻¹) and sex ratio (F/M) in the SZ during 2014 were all within their reference ranges (Table 2). Three PIs fell below their lower reference points. The value for catch for the 2014 season (67% of TACC caught) was below the LRP for this PI (85%) and also below the 10 year average of 86% (2000–2009). Mean weight in 2014 (2.79 kg) was also below the LRP for this PI (2.96 kg) and similar to the NZ, has fluctuated around the LRP since 2005. Pre-recruit abundance (number of undersize crabs.potlift⁻¹) in 2014 was also lower (1.19 undersize crabs.potlift⁻¹) than the LRP for this PI (1.6 undersize crabs.potlift⁻¹) (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 the 2014 season. Average values for each performance indicator for the 10 year period between 2000 and 2009 are also provided. Note, all estimates presented are derived from the Miscellaneous Fishery and Rock Lobster RL-quota sectors 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 from maximum and minimum values, respectively, measured during the period 2000–2009. Values below the lower reference point are highlighted in red.

Zone	Performance Indicator	Upper ref. point	Lower ref. point	2000-2009 average	Value in the 2014/15 season
NZ	Catch (tonnes)	TACC	85% of TACC	78%	83% of TACC
	Effort (potlifts)	8,987	4,537	6,937	5,441
	Catch rate (kg.potlift ⁻¹)	3	1.5	1.53	2.06
	Mean weight (kg)	3.65	2.96	3.08	2.92
	Pre-recruit abundance (number of undersize per potlift ⁻¹)	1.7	1.6	1.96	0.82
	Sex ratio (F/M)	3.13	0.60	1.02	1.89
	Spawning female abundance	Not defined	Not defined	No data	No data
SZ	Catch (tonnes)	TACC	85% of TACC	86%	67% of TACC
	Effort (potlifts)	5,458	1,787	3,516	2,657
	Catch rate (kg.potlift ⁻¹)	3	1.5	2.41	2.21
	Mean weight (kg)	3.65	2.96	2.82	2.79
	Pre-recruit abundance (number of undersize per potlift ⁻¹)	1.7	1.6	2.12	1.19
	Sex ratio (F/M)	3.13	0.60	1.51	1.29
	Spawning female abundance	Not defined	Not defined	No data	No data

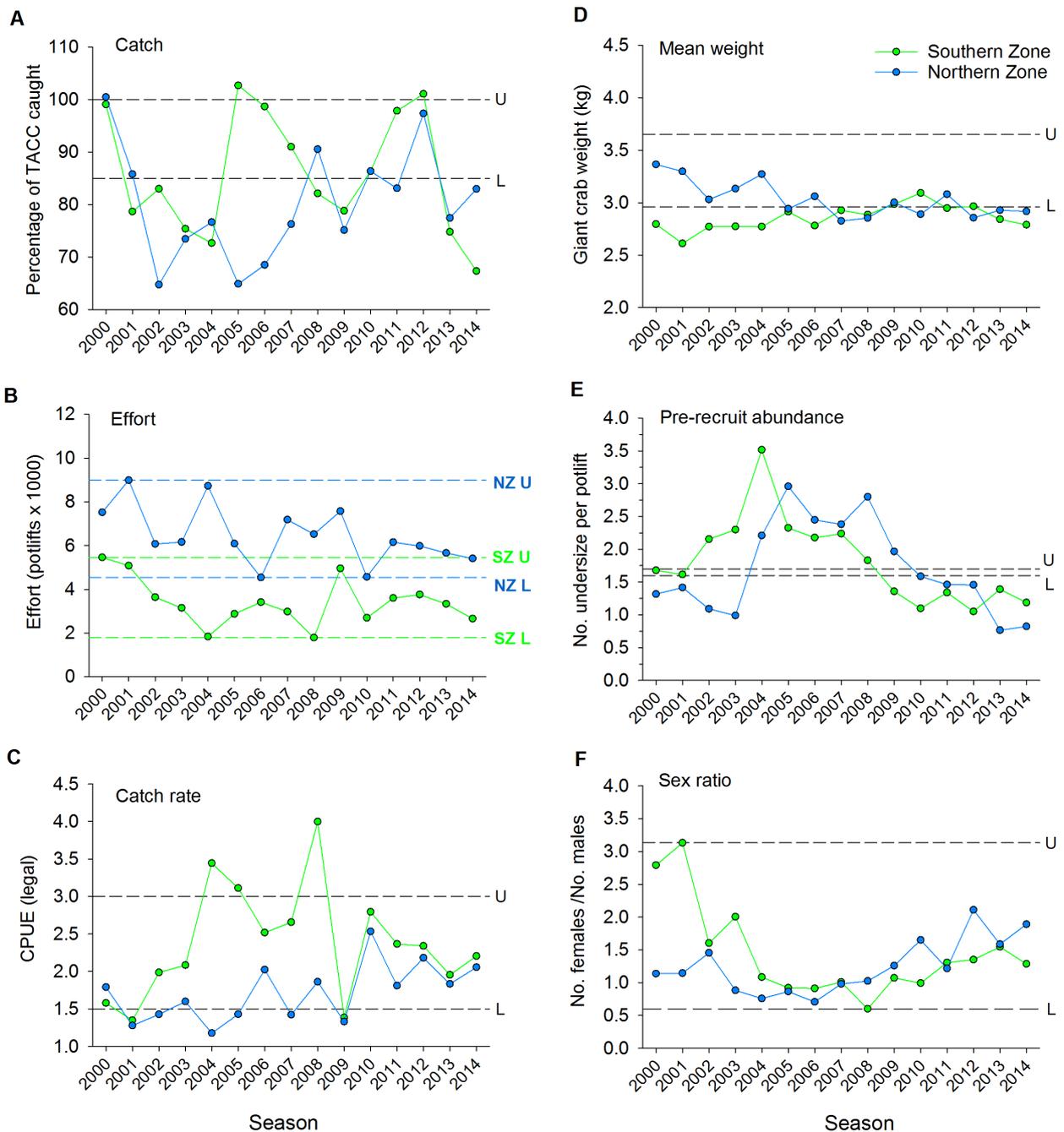


Figure 3. Annual (fishing season) measures of the six performance indicators for the NZ (blue lines) and SZ (green lines) Giant Crab Fishery: A. Catch (as percentage of the TACC caught); B. Effort; C. Catch rate (CPUE) (kg.potlift⁻¹); D. Mean weight; E. Pre-recruit abundance i.e. number of of undersize (<150mm) 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 data combined from the Miscellaneous Fishery and RL-quota sectors 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

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). The extent to which the available data and current PIs reflect a change in stock status of Giant Crab in South Australia is uncertain. Interpretation is complicated by (1) the inclusion of data from the SARLF, especially prior to 2006, which are subject to historical inconsistencies in the reporting of targeted fishing effort; (2) the small number of dedicated Giant Crab fishers (e.g. one licence in the Miscellaneous Fishery sector in 2014) that impedes interpretation of stock status from the Miscellaneous Fishery sector alone; and (3) the likely, but poorly understood and unquantified potential impact of biological, physical and fishery-related factors (e.g. high grading) on PI interpretation.

There are three primary PIs for assessment of the fishery's status: catch rate (kg.potlift⁻¹), effort (potlifts) and catch (percentage of TACC caught) (PIRSA 2009). In both zones of the fishery in 2014, two of the primary PIs, catch rate (kg.potlift⁻¹) and effort (potlifts) were within the range of their upper and lower reference points, while catch (percentage of TACC caught) was below the lower reference point.

Catch rate is a commonly used indicator of stock abundance in crustacean fisheries worldwide and has generally improved in the Giant Crab Fishery since the introduction of a TACC in 1999. Between 2013 and 2014, catch rates (kg.potlift⁻¹) increased 12% and 13% in the NZ and SZ, respectively. However, catch rate is known to vary according to the length of time that traps are left fishing or 'soak time' (Kennelly 1989; Miller 1990; Zhou and Shirley 1997; Briand *et al.* 2001). Soak time data are not currently collected for the South Australian Giant Crab Fishery. Collection of these data are seen as a priority to account for any changing fishing operations that alter pot soak times. Standardising estimates of catch rate for soak time would also help facilitate a more standardised approach to estimating Giant Crab abundance across all Australian jurisdictions where it is targeted (South Australia, Western Australia, Victoria and Tasmania).

Effort has continued to decline since 2012 in both zones. In 2014, effort in both zones was within the defined upper and lower reference points, but 22% and 24% below the 10 year average (2000–2009) for effort in the NZ and SZ, respectively. The PI for catch (percentage of TACC caught) was also below the lower reference point in both zones and reflects the reductions in effort in both zones.

Mean weight (kg), sex ratio (F/M), pre-recruit abundance (number of undersize crabs.potlift⁻¹), and relative abundance of mature females (no data available) in the population are considered secondary PIs for management of the South Australian Giant Crab Fishery (PIRSA 2009). Estimates of mean weight were slightly below the LRP in both

zones in 2014 but mean weight has fluctuated near the LRP since 2005. The influence on the mean weight data of 'high grading' by fishers is unknown. High grading may occur where smaller crabs are preferentially retained over larger crabs due to their higher market value (PIRSA 2009). If high grading is common in the fishery, annual estimates of catch rate would also potentially be lower due to not accounting for the discarded catch of larger crabs.

Estimates of sex ratio (F/M) were within the ranges prescribed by the upper and lower reference points, however the ideal sex ratio harvest to sustain Giant Crab biomass is unknown. Sex ratio is known to be highly variable in crustacean fisheries due to sex-specific seasonal patterns of moulting and reproductive behaviour (Cobb and Caddy 1989). In South Australia, the proportion of females in the catch increases in spring and summer before decreasing in autumn and winter when moulting and egg extrusion occurs (Levings *et al.* 2001). Consequently, seasonal patterns of fishing effort are likely to be a key factor in determining the proportions of each sex landed. Higher proportions of female crabs in the catch have been observed in the fishery since 2009. This may reflect more catch taken in the spring and summer months. Alternatively, the retention of smaller crabs through high grading, may skew sex ratios towards females due to the high degree of sexual-size dimorphism in Giant Crabs. Consequently, the value of sex-ratio as a PI remains uncertain without more detailed analyses of the biological, physical and fishery-related factors that influence the sex ratios of Giant Crabs.

Estimates of pre-recruit abundance (number of undersize crabs.potlift⁻¹) provide an indication of the strength of future recruitment to the fishery. Estimates of pre-recruit abundance have been below the LRP in both zones since 2010 and have been in decline since 2008. Although this indicates that future recruitment to the fishery may be limited, the suitability of pre-recruit data as a PI for Giant Crab stock assessment is also unclear. The size of Giant Crabs landed varies according to depth and season, with larger crabs (>150 mm carapace length) caught between depths of 110 to 140 m in summer and 190 to 260 m in winter (Levings and Gill 2010). Consequently, changes in the depth targeted by fishing operations may influence trends in pre-recruit abundance.

The current PIs for the fishery were developed in 2003 (Sloan 2003) and do not align directly with those listed for Giant Crab under the nationally agreed framework for assessing fish stock sustainability (i.e. 1. egg production; and 2. proportion of spawning stock protected by minimum size limits; Flood *et al.* 2014). As recommended in previous stock status reports (Currie 2011b; Chick 2013; Stobart 2014; McLeay 2015) and Commonwealth Ecological Assessments (PIRSA 2009), refinements in the methods used to define and calculate PIs and reference points are required. A review to refine PIs and reference points used in the fishery is planned for 2017.

This report highlights where improvements in the methods used to assess Giant Crab stock status can be made. Firstly, the collection of soak time data are seen as a priority to standardise estimates of catch rate across the fishery. Secondly, quantification of the rates of discarding in the fishery would help refine the precision of both the mean weight and catch rate PIs. Thirdly, the use of sex ratio and pre-recruit abundance as PIs needs to account for the temporal and spatial patterns of fishing operations. Further, 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 also augment interpretation of other PIs, particularly catch rate, 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 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. Alternatively, triggers could include measures for PIs describing greatest variation or maximum rates of change within the reference period.

There is no agreed index to define stock status for the SA Giant Crab Fishery. Consequently, a weight-of-evidence approach is applied in determining stock status. The limitations and contrasting inferences in the available data result in a high level of uncertainty in the assessment. The contrast 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. Therefore, under the national framework for reporting of stock status (Flood *et al.* 2014), the SA Giant Crab Fishery is classified as an undefined stock².

²The stock status classification 'undefined stock' is described in Flood *et al.* (2014) as indicating that not enough information exists to determine stock status.

5. REFERENCES

Briand, G., Matulich, S.C., Mittelhammer, R.C. (2001). A catch per unit effort – soak time model for the Bristol Bay red king crab fishery, 1991–1997. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 334–341.

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.

Cobb, J.S. and Caddy J.F. (1989). The Population Biology of Decapods. In, Marine Invertebrate Fisheries: Their Assessment and Management. J.F Caddy (Ed). p.327-374. John Wiley & Sons, New York.

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.

Flood, M., Stobutzki, I., Andrews, J., Ashby, C., Begg, G., Fletcher, R., Gardner, C., Georgeson, L., Hansen, S., Hartmann, K., Hone, P., Horvat, P., Maloney, L., McDonald, B., Moore, A., Roelofs, A., Sainsbury, K., Saunders, T., Smith, T., Stewardson, C., Stewart, J. and Wise, B. (eds) (2014). Status of key Australian fish stocks reports 2014, Fisheries Research and Development Corporation, Canberra.

Kennelly, S.J. (1989). Effects of soak-time and spatial heterogeneity on sampling populations of spanner crabs *Ranina ranina*. *Marine Ecology Progress Series* 55: 141–147.

Levings, A.H. and P.C. Gill. (2010). Seasonal Winds Drive Water Temperature Cycle and Migration Patterns of Southern Australian Giant Crab *Pseudocarcinus gigas*. In, *Biology and Management of Exploited Crab Populations under Climate Change* (Eds.) G.H. Kruse, G.L. Eckert, R.J. Foy, R.N. Lipcius, B. Sainte-Marie, D.L. Stram, and D. Woodby. Alaska Sea Grant, University of Alaska Fairbanks.

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.

McLeay, L. (2015). South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2013/14. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-5. SARDI Research Report Series No. 834. 17pp.

Miller, R.J. (1990). Effectiveness of crab and lobster traps. *Canadian Journal of Fisheries and Aquatic Sciences* 47: 1228–1251.

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, S. (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.

Zhou, S. and Shirley, T. C. (1997). A model expressing the relationship between catch and soak time for trap fisheries. *North American Journal of Fisheries Management* 17: 482–487.