

South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery Status Report 2011/12



R.C. Chick

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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 resource in 2013, utilising data to the end of the 2011/12 fishing season (NZ: 1 November 2011 to 31 May 2012; SZ: 1 October 2011 to 30 April 2012). It is reliant on fishery-dependent data. Data are analysed at the scale of the whole fishery, the Northern Zone (NZ) and Southern Zone (SZ) and among commercial fishing sectors. The three commercial fishing sectors that contribute to the fishery are (1) Miscellaneous Fishery licence holders (Misc.); (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. 2011 refers to the 2011/12 fishing season.

Total catch has remained relatively stable since the introduction of sectorial quotas in 2002. However, the total allowable commercial catch (TACC) has not been harvested by >15% in eight of the last 10 years in the NZ and five of the last 10 years in the SZ. In 2011, 83% and 98% of the TACC was harvested in the NZ and SZ, respectively.

In 2011, 20.3 t of Giant Crab were harvested, of which the Misc. sector harvested 70% (14.3 t); the RL-quota sector accounted for 26% (5.3 t) with the remaining ~4% (0.7 t) harvested as by-product by Rock Lobster fishers. This proportional distribution of catch among sectors is similar in the NZ and SZ.

Total effort has generally declined through time, and in the last two seasons (2010: 10,392; 2011: 16,259 pot lifts) has been at or among the lowest level since 1993. This is due to substantial decreases in effort by the RL-by-product sector. The Misc. sector has commonly expended the least effort in the NZ, whereas in the SZ, the RL-quota sector has commonly reported the lowest levels.

Catch-per-unit-effort (CPUE; kg pot lift⁻¹) for all sectors combined has increased through time (due to stable catches and decreases in effort). The levels of CPUE in the last two seasons (2010: 1.86 kg.pot lift⁻¹; 2011: 1.25 kg.pot lift⁻¹) have been the highest in 18 years. From 2000 to 2011, CPUE in the Misc. sector in the NZ (range: 2.2-4.3 kg.pot lift⁻¹) and SZ (range: 2.1-4.1 kg.pot lift⁻¹) has consistently been more than double that of the RL-quota sector and ten times that of the RL-by-product sector.

In 2011, CPUE in the Misc. sector was 8% and 10% lower than levels in 2010, in the NZ (2.93 kg.pot lift⁻¹) and SZ (3.57 kg.pot lift⁻¹), respectively.

Data were available to assess fishery performance against six of the seven interim performance indicators (PI) in each zone – there are no data for the PI for spawning female abundance.

In both the NZ and SZ, four PIs were within the ranges prescribed by the upper and lower reference points. The PI for catch (in the NZ) and that for the average weight of legal-size Giant Crabs (in the SZ), were below their respective lower reference points. In both zones the PI for pre-recruit abundance was below the lower reference point. In the SZ the PI for pre-recruit abundance has been below the lower reference point for the last 3 fishing seasons.

The data provided in this report does not provide consistent evidence regarding the sustainability of current catches. Substantial decreases in the PI for pre-recruit abundance in both zones suggest future recruitment may not be sufficient to support current catch levels. Close monitoring of CPUE and other PIs is required in coming fishing seasons. If CPUE declines and levels of pre-recruit abundance do not increase, management action may be required to prevent recruitment overfishing.

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 undefined.

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) and is part of the SARDI Aquatic Science's ongoing assessment program for this fishery. This document summarises information collected in commercial logbook returns over the period 1 November 1987 to 31 May 2012.

A detailed description of the history and management arrangements for the fishery, as well as information available for its assessment, are provided in Sloan (2002, 2003) and the assessment and status reports described above, respectively. In summary, in 1997, the GCF was separated into two zones, consistent with those of the SA Rock Lobster Fishery (RLF) i.e. Southern Zone (SZ) and Northern Zone (NZ; Sloan 2003). Fishing in each zone is subject to a seasonal closure. The fishing season in the SZ extends from 1 October to 30 April, whereas that in the NZ extends from 1 November to 31 May. In this report, reference to the fishing season refers to the first year of the start of the season (e.g. SZ fishery-dependent data reported for 2011 includes data from 1 October 2011 to 30 April 2012; NZ includes those data from 1 November 2011 to 31 May 2012).

An annual Total Allowable Commercial Catch (TACC) of 26 t was implemented in 1999 (26 t TACC: NZ (13.4 t) and SZ (12.6 t); Sloan 2003; Table 3.1). This TACC was reduced in 2000 to 21.1 t (NZ 13.4 t and SZ 8.7 t) and has remain unchanged. The TACC is allocated among licence holders in the SA Miscellaneous Fishery (Misc.) and the RLF. Within the RLF there is an allocation to RLF licence holders with a Giant Crab quota unit holding (RL-quota) and all other RLF licence holders, who have an entitlement to land up to 5 individual Giant Crabs per fishing trip (RL-by-product).

2. METHODS

Fishery-dependent data are defined within the three commercial fishing sectors (Misc., RL-quota and RL-by-product). Historical data are unavailable to accurately identify RLF licence holders that held Giant Crab quota between 1999 and 2005. As such the allocation of fishery-dependent data to the RL-quota sector, within this period, was made against RLF licence holders who held Giant Crab quota in 2006 and an additional RLF licence holder (between 1999 and 2002), based on anecdotal evidence and previously applied decision rules (SARDI unpublished data). All other fishery-dependent data from RLF licence holders was allocated to the RL-by-product sector.

Effort is reported as the total number of pot lifts recorded against Giant Crab catch across all sectors of the fishery, including all RLF pot lifts (unless otherwise stated). This decision rule for effort is applied to maintain consistency between previous reports of total effort and because Giant Crab catch in the RLF was historically not segregated by specific pots (Rock Lobster or Giant Crab pots). Historical inconsistencies in reporting the numbers of pots used to catch Giant Crabs by RLF licence holders has resulted in measures of effort and CPUE from these sectors to be less reliable than those data from Miscellaneous Fishery licence holders. These issues compromise the reliability of the fishery-dependent data and reduce the confidence of the assessments.

To mitigate some of these issues fishery-dependent data are presented in this report, as in others, among the different sectors. Previous Giant Crab assessment and status reports have reported annual fishery-dependent data aggregated at the temporal scale of financial years. Data in this report is aggregated at the temporal scale of fishing season. This is to provide continuity between TACC allocation and reported fishery-dependent data, including total catch. In addition, in this report, previously unreported historical data have been made available through data entry corrections (<550 kg difference in zonal catch per year). As such, there are small discrepancies between measures of fishery-dependent data provided in this report and those previously published.

Performance Indicators (PIs) for this fishery 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 pot lift (undersize crabs.pot lift⁻¹), where the measure of effort was the number of Giant Crab pots lifted, not total effort (that includes RL pots).

3. FISHERY STATISTICS

3.1. Catch

The total annual catch of Giant Crab landed by the three commercial sectors (i.e. Misc., RL-quota and RL-by-product) varied considerably prior to the introduction of a TACC in 1999 (Figure 3.1a). Annual catch reached a historical high of 34.7 t during 1997. Catches declined following the introduction of quotas in 1999 but have remained relatively stable (18-21 t) over the last ten seasons (2002-2011). In 2011, 20.3 t of Giant Crab were harvested by commercial fishers from South Australian waters (Figure 3.1a; Table 3.1).

3.2. Effort

Total fishing effort by the commercial sector has generally declined since it peaked in 1994 (74,997 pot lifts; Figure 3.1b), to the lowest level in 2010 (10,392 pot lifts) since the TACC was introduced. In 2011, effort was 16,259 pot lifts, reflecting a 56% increase from 2010, but still the third lowest since the introduction of quota in 1999.

3.3. CPUE

Relatively stable catches combined with reduced effort over at least the last decade has seen levels of CPUE for the fishery (all sectors combined) increase (Figure 3.1c). In the last two seasons, CPUE has been at the highest levels for 18 years. In 2011, CPUE was 1.25 kg.pot lift⁻¹, 33% below that in 2010 (1.86 kg.pot lift⁻¹).

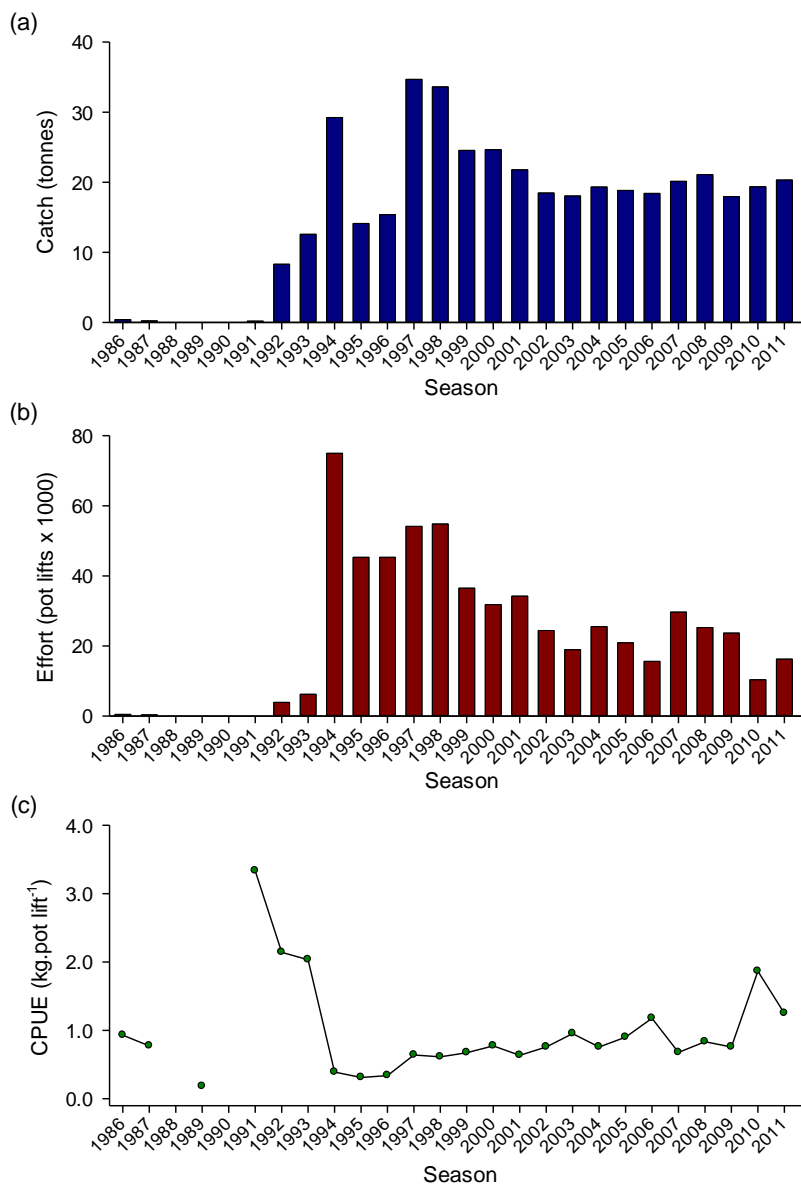


Figure 3.1 Levels of (a) total catch (t); (b) fishing effort (total pot lifts) and; (c) catch per unit effort (CPUE; kg pot lift⁻¹) in the Giant Crab Fishery.

Table 3.1 Total catch (kg) in the Giant Crab Fishery in each fishing zone since the establishment of TACCs in 1999. Season refers to the first year of the fishing season (SZ extends from 1 October to 30 April, whereas that in the NZ extends from 1 November to 31 May). Note that no sectoral quotas are allocated prior to 2002, as the fishery was operated under a fully competitive TACC. From 2000 to the present (2011) the TACC has been 22.1 t (NZ 13.4 t and; SZ 8.7 t).

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

3.4. Catch, Effort and CPUE by Fishing Sector

Of the three commercial fishing sectors harvesting Giant Crab, the Miscellaneous Fishery sector has consistently harvested greater than 55% and 67% of the total annual catch in the NZ and SZ, respectively (Table 3.1 and Figure 3.2a). In 2011, 63% (7.2 t) of all Giant Crab landed in the NZ and 81% (7.1 t) of that landed in the SZ were caught by licence holders in the Miscellaneous Fishery. The catch by the RL-quota sector has increased in recent years, both in the NZ and SZ. In the NZ, in 2007, the level of catch harvested by the RL-quota sector (3.6 t), was more than double that in either of the previous two seasons and has since remained above 3.5 t. In 2011, catch by the RL-quota sector in the NZ and SZ was 4 t and 1.4 t, respectively, the highest catches since at least 2000, and the second consecutive year where total sector catch exceeded its allocation (Table 3.1 and Figure 3.2a). In contrast, since at least 2005, the proportion of total catch harvested by the RL-by-product sector has been relatively small ($\leq 10\%$ of either the NZ or SZ annual catches). In 2011, the catch of Giant Crab taken as a by-product of the RLF in the NZ and SZ was 0.32 and 0.35 t, respectively.

The level of effort (pot lifts) among the three commercial fishing sectors has varied substantially through time (Figure 3.2b). However, in the NZ and SZ prior to 2009 and 2010, respectively, the majority of annual effort has been expended by the RL-by-product sector, due primarily to small catches of Giant Crab reported against the total number of pots used for fishing (including all Rock Lobster pots). In 2011, annual effort reported by the RL-by-product sector in the NZ and SZ was 2,727 and 3,785 pot lifts, respectively. This reflects a 40% and 217% increase from levels in 2010 (NZ: 1,941 pot lifts; SZ: 1,193 pot lifts), which were the lowest since 2000. In the NZ, from 2009, the RL-quota sector has consistently expended more effort than either of the other two sectors. In 2011, effort in the NZ was 3,703 pot lifts and in the SZ it was 1,597 pot lifts. Within the Misc. sector, levels of effort among years have varied less than other sectors. In the NZ and SZ since 2000, annual effort has ranged between 1,737 and 3,681 pot lifts.yr⁻¹ (2011: 2,447 pot lifts) and 1,684 and 3,290 pot lifts.yr⁻¹ (2011: 2,000 pot lifts), respectively.

Levels of CPUE (kg.pot lift⁻¹) in the Misc. sector (NZ and SZ), have been consistently greater than those of the other two sectors (Figure 3.2c). Since 2000, in the NZ and SZ, levels of CPUE in the Misc. sector have ranged between 2.2 and 4.3 kg.pot lift⁻¹ and 2.1 and 4.1 kg.pot lift⁻¹, respectively. These levels are 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 2011, CPUE in the Misc. sector was lower than levels in 2010, in both the NZ (2.93 kg.pot lift⁻¹) and SZ (3.57 kg.pot lift⁻¹).

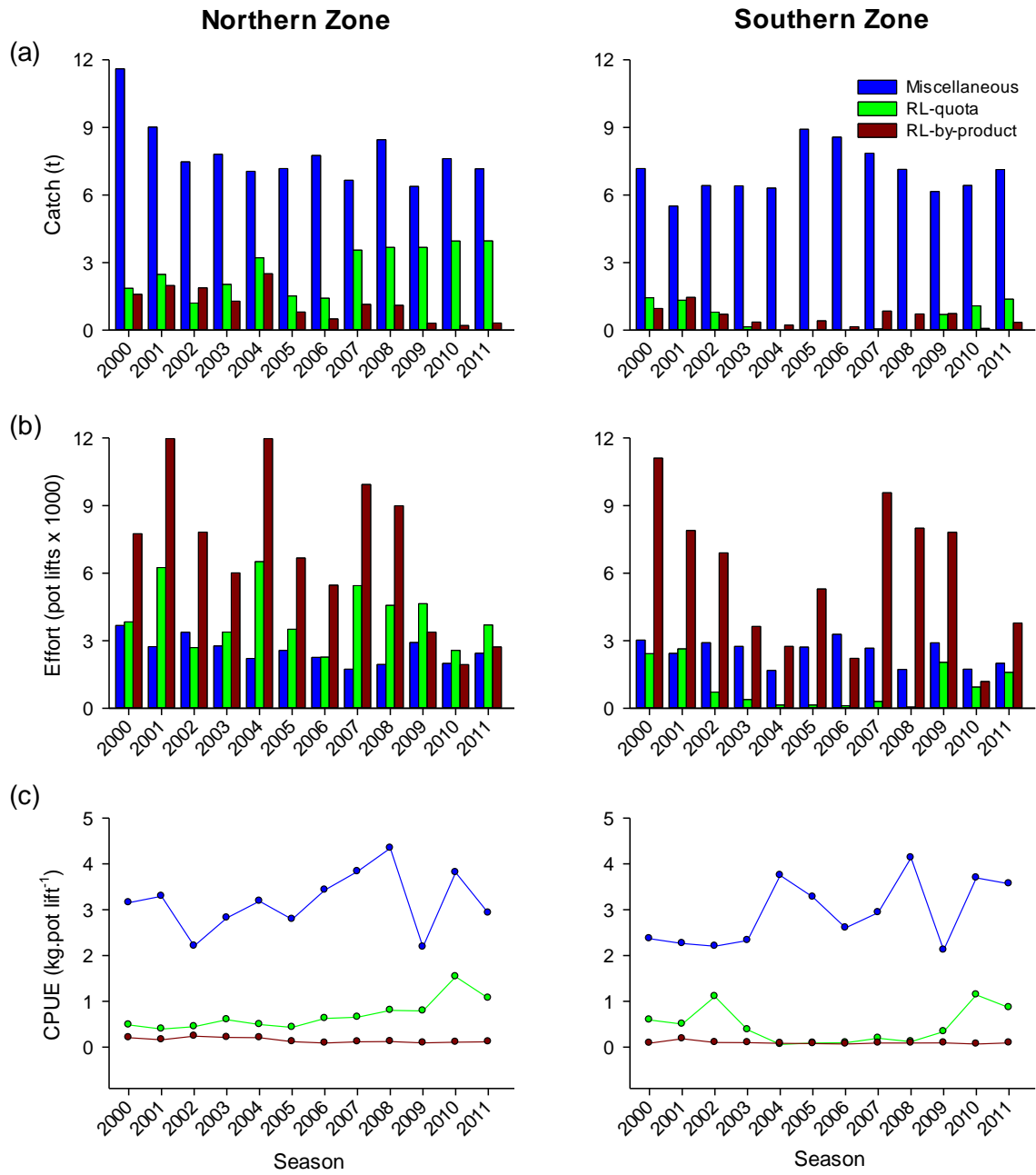


Figure 3.2 Annual (fishing season) measures of (a) total catch; (b) fishing effort; and (c) catch per unit effort (CPUE) for Giant Crab in NZ and SZ of the Giant Crab Fishery.

4. 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 defined in Sloan (2003). As no reference points are defined under the management plan for fishing effort or sex ratio, provisional upper and lower reference points are presented for the period 2000–2009. Insufficient data were available to assess the abundance of spawning females. Values of each PI in 2011 were derived from data provided by the Miscellaneous 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 pot lift (undersize crabs.pot lift⁻¹), where the measure of effort was the number of Giant Crab pots lifted, not total effort (that includes RL pots). There are seven biological PIs specified for Giant Crabs in the NZ and SZ (Table 4.1; Figure 4.1). In each zone, data are available to assess fishery performance against six PIs.

4.1. Northern Zone

The targeted catch (Misc. + RL-quota) in the NZ in 2011 was 11.1 t (Table 3.1). This represented 83% of the TACC (13.4 t). This value was below the lower reference point of 85%. Total effort in the NZ was 6,150 pot lifts in 2011. This value was within the reference range (4,537-8,987 pot lifts). In 2011, the catch rate in the NZ was 1.81 kg.pot lift⁻¹. This value was within the reference range (1.5-3 kg.pot lift⁻¹). The mean weight of crabs harvested in the NZ in 2011 was 3.08 kg. This value was within the reference range (2.96-3.65 kg). In 2011, the measure of pre-recruit abundance in the NZ was 1.46 undersize crabs.pot lift⁻¹. This value was below the lower reference point (1.6 undersize crabs.pot lift⁻¹), but not by >15%. The sex ratio (males:females) in the NZ in 2011 was 1:1.22. This value was within the reference range (1:0.60 – 1:3.13).

4.2. Southern Zone

The targeted catch in the SZ in 2011 was 8.5 t (Table 3.1). This represented 98% of the TACC (8.7 t). This value was within the reference range (85-100% of the TACC). Total effort in the SZ was 3,597 pot lifts in 2011. This value was within the reference range (1,787-5,458 pot lifts). In 2011, the catch rate in the SZ was 2.37 kg.pot lift⁻¹. This value was within the reference range (1.5-3 kg.pot lift⁻¹). The mean weight of crabs harvested in the SZ in 2011 was 2.95 kg. This value was below the lower reference point (2.96 kg). In 2011, the measure of pre-recruit abundance in the SZ was 1.34 undersize crabs.pot lift⁻¹. This value was >15% below the lower reference point (1.6 undersize crabs.pot lift⁻¹). The sex ratio (males:females) in the SZ in 2010/11 was 1:1.31. This value was within the reference range (1:0.60–1:3.13).

Table 4.1 Performance indicators, upper and lower reference points and their values for the NZ and SZ of the South Australian Giant Crab Fishery in 2011. Note that all estimates presented here are derived from the Miscellaneous and Rock Lobster licence holders with Giant Crab quota fishers only, and do not include information obtained from Rock Lobster by-product sector. Note also that the reference points for fishing effort and sex ratio have been calculated for the period 2000–2009, as they are not defined in the Management Plan. 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 2011
NZ	Catch (tonnes)	TACC	85% of TACC	83% of TACC
	Effort (pot lifts)	8,987	4,637	6,150
	Catch rate (kg.pot lift ⁻¹)	3	1.5	1.81
	Mean weight (kg)	3.65	2.96	3.08
	Pre-recruit abundance (no.pot lift ⁻¹)	1.7	1.6	1.46
	Sex ratio (M:F)	1 : 3.13	1 : 0.60	1 : 1.22
	Spawning female abundance	Not defined	Not defined	No data
SZ	Catch (tonnes)	TACC	85% of TACC	98% of TACC
	Effort (pot lifts)	5,458	1,787	3,597
	Catch rate (kg.pot lift ⁻¹)	3	1.5	2.37
	Mean weight (kg)	3.65	2.96	2.95
	Pre-recruit abundance (no.pot lift ⁻¹)	1.7	1.6	1.34
	Sex ratio (M:F)	1 : 3.13	1 : 0.60	1 : 1.31
	Spawning female abundance	Not defined	Not defined	No data

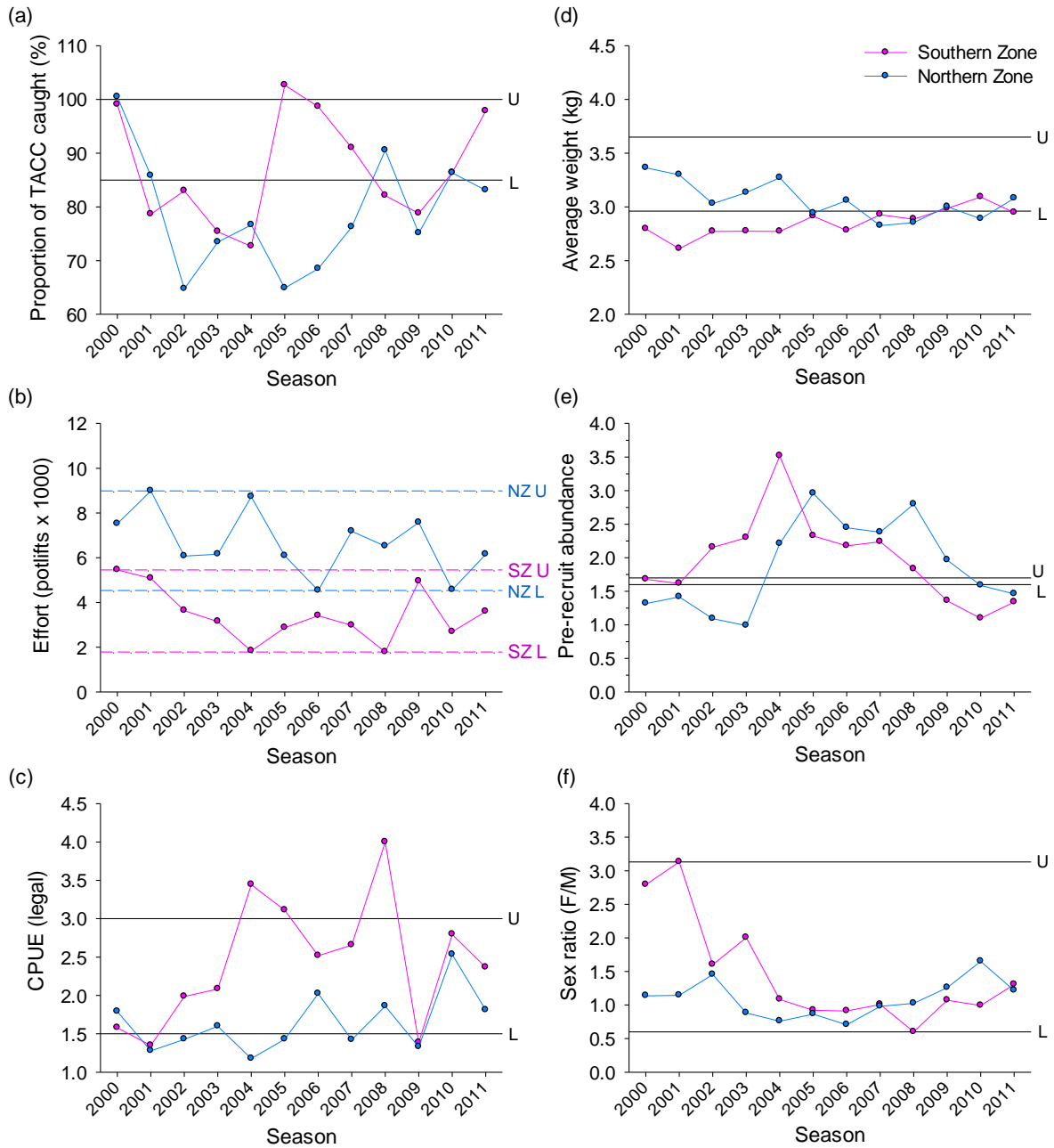


Figure 4.1 Annual (fishing season) measures of the six performance indicators for the NZ (blue lines) and SZ (purple lines) Giant Crab Fishery, of which data are available: (a) Catch as percentage of the TACC; (b) Effort; (c) Catch-per-unit-effort (CPUE; kg.pot lift⁻¹); (d) Average weight; (e) Pre-recruit abundance i.e. number of undersize (<150mm) crabs per pot lift and; (f) Sex ratio. Horizontal lines indicate the upper (U) and lower (L) reference points for each measure, as described in Table 4.1. Note that all estimates presented here are derived from combined Miscellaneous and Rock Lobster quota data only (i.e. they do not include information obtained from the Rock Lobster by-product sector).

5. 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). However, it is hampered by a lack of data describing temporal changes in population length-frequency. Interpretation of the available data is complicated by historical inconsistencies in the reporting of data within and among sectors, especially 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 performance indicators and their interpretation.

The current PIs for the fishery include catch, effort, CPUE, average weight, pre-recruit abundance, sex ratio and abundance of spawning females. The lack of any PI based on fishery-independent data reflects the small size and relatively low value of the fishery. Assessment of the fishery's performance could be improved by more explicitly defining the data (e.g. sector) and methods used to calculate the PIs. The acquisition of representative length-frequency distributions of the catch would provide a robust data series to develop alternative or complementary PIs (e.g. fishing mortality) and inform the assessment. These data would provide greater certainty in the interpretation of PIs, particularly CPUE and average weight. An index that unambiguously defines stock status has not yet been established. Rather, a weight-of-evidence approach is applied which involves interpretation of several PIs that have the potential to trigger in different directions and provide conflicting inferences of stock status.

The current reference points have some limitations and may require revision. Some reference points do not adequately reflect the range of temporal variation in the performance indicator (e.g. pre-recruit abundance). The extent to which any reference point reflects a change in stock status is unclear. Greater certainty in the relationship between resource status and reference points would be gained by developing a time series of length-frequency data for the fishery. In the absence of this information, the use of a historical reference period, when the fishery was performing well, would provide a range within which more informative reference points could be defined. One option would be generate upper and lower quantiles (e.g. 10-25%) of the historical data (PIRSA 2012a). Alternatively, triggers could include measures of PIs describing greatest variation or maximum rates of change within the reference period (PIRSA 2012b).

The data provided in this report does not provide consistent evidence supporting the sustainability of current catches. Although the majority of PIs in the NZ and SZ are within the range described by the upper and lower reference points, the continued decline in

pre-recruit abundance in both zones suggests future recruitment to the fishery may not be sufficient to support current catch levels. The capacity of the current assessment framework to detect declines in abundance is unclear and would be limited if CPUE were hyper-stable (i.e. does not decline proportionally with abundance).

In the NZ, PIs for effort, CPUE, average weight and the sex ratio of the catch were within the ranges prescribed by the upper and lower reference points in the Management Plan. However, the PI for catch was 83% of TACC and below the lower reference point of 85%, and the PI for pre-recruit abundance was also below the lower reference point. The high pre-recruit abundance observed in 2005 probably resulted in strong recruitment to the fishery and the increase in CPUE to levels among the highest on record in 2010 and 2011. This recruitment event may also explain the historically low average weight between 2007 and 2010. Declining levels of pre-recruit abundance since 2005 to the lowest level for seven years in 2011 suggests limited recruitment to the fishery may occur over the next few years.

In the SZ, PIs for catch, effort, CPUE and the sex ratio of the catch were within the ranges prescribed by the upper and lower reference points. However, the PIs for average weight and pre-recruit abundance were below their lower reference point. The PI for pre-recruit abundance has been at historically low levels and below the lower reference point for the last 3 fishing seasons. Given the similar declines in this PI in the NZ, this trend in the SZ supports the inference of a fishery wide reduction in fishable biomass in the future.

Assessment of the status of the SA Giant Crab fishery is complicated by uncertainty surrounding the reliability of some fishery-dependent data and the contrast in inference of stock status from some PIs. Given the limitations of the data and the contrasting information from some PIs, under the national framework for reporting of stock status (Flood *et al.* 2012), the SA Giant Crab Fishery is classified as an undefined stock¹. Future assessments of stock status will require careful consideration of CPUE as an index of abundance and the relationships between the PIs, especially pre-recruit abundance, average weight and CPUE. If CPUE declines and levels of pre-recruit abundance do not increase, management action may be required to reduce the risk of recruitment overfishing.

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.

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