

Status of the Central Zone Greenlip (*Haliotis laevis*) and Blacklip Abalone (*H. rubra*) Fisheries in 2014



S. Mayfield and G. Ferguson

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EXECUTIVE SUMMARY

This report provides an assessment of the current stock status of *Haliotis laevis* (hereafter referred to as 'greenlip') and *H. rubra* (hereafter referred to as 'blacklip') in the Central Zone (CZ) of the South Australian Abalone Fishery.

The assessment is required under the Management Plan for the South Australian Commercial Abalone Fishery which specifies the need for annual application of the harvest strategy to determine stock status and review the Total Allowable Commercial Catch. The harvest strategy is relatively new and several limitations have been identified. These include stock status classifications which are considered over-optimistic (e.g. Mayfield *et al.* 2014; Stobart *et al.* 2014) and the absence of a definition of recruitment overfished, to link the assessment to the National Fishery Status Reporting Framework (NFSRF; Flood *et al.*, 2014). Consequently, the stock status outcome from the harvest strategy was compared to the traditional, weight-of-evidence analysis using the NFSRF framework.

The catch-weighted, zonal stock status score for greenlip from the harvest strategy was 0.56, defining this species in the CZ as 'under fished' in 2014. This zonal stock status score was lower than that in 2013 (0.97) but zonal stock status remained unchanged between years. The 'under fished' outcome from the harvest strategy in 2013 and 2014 is in conflict with much of the data available for the fishery.

The data inconsistent with the harvest strategy include (1) a long-term decline in catch per unit effort (CPUE) across the CZ; (2) recent low abundance estimates and small catches from the Tiparra Reef Spatial Assessment Unit (SAU); (3) declining catch rates in several SAUs where catches have increased over recent years; and (4) re-distribution of catches among mapcodes within SAUs that is indicative of spatial expansion to maintain catch.

Collectively, this evidence suggests that current fishing pressure is too high and has the potential to cause the stocks to become recruitment overfished. Consequently, the CZ greenlip fishery is classified as '**transitional depleting**' under the NFSRF. This was the same as the classification for these stocks in 2013 (Mayfield *et al.* 2014).

The catch-weighted, zonal stock status score for blacklip from the harvest strategy was 0.00, defining this species in the CZ as 'sustainably fished' in 2014 which was identical to the zonal score and stock status in 2013 (Mayfield *et al.* 2014). This outcome from the harvest strategy contrasts with all of the data available for blacklip in the CZ fishery.

The data available demonstrate that the harvestable biomass of blacklip in the CZ is in its weakest position for about 30 years and has continued to decline despite smaller catches since 2002. This evidence includes current catch rates across the zone and in the key SAUs for blacklip being at or among the lowest values on record and there being no indication of recruitment to the fishable stock for several years.

Collectively, this evidence suggests that current fishing pressure is too high. Based on the weight of evidence, the CZ blacklip stocks are classified as '**transitional depleting**' using the NFSRF. This was the same as the classification for these stocks in 2013 (Mayfield *et al.* 2014).

1. INTRODUCTION

The Management Plan for the South Australian Commercial Abalone Fishery (PIRSA 2012) specifies annual application of the harvest strategy to determine stock status and review the Total Allowable Commercial Catch (TACC). The stock status of greenlip abalone (hereafter termed 'greenlip') and blacklip abalone (hereafter termed 'blacklip') in the Central Zone Abalone Fishery (CZ) in 2013 was provided in the most recent stock assessment report for the fishery (Mayfield *et al.* 2014) and will be updated in future, scheduled, stock assessment (2016) and status (2017) reports. These reports form part of the South Australian Research and Development Institute's (SARDI Aquatic Sciences) ongoing assessment program for this fishery. The stock status outcomes from the harvest strategy for both species were compared to the traditional, weight-of-evidence analysis using the National Fishery Status Reporting Framework (NFSRF; Flood *et al.* 2014) because the harvest strategy is relatively new (PIRSA 2012), and being reviewed in 2015/16.

2. METHODS

Methods used to apply the harvest strategy and undertake the weight-of-evidence assessment are described in Mayfield *et al.* (2014) and PIRSA (2012). Briefly, the stock status of greenlip and blacklip in the CZ is derived from (1) categorizing the risk-of-overfishing for each spatial assessment unit (SAU); and (2) assessing the importance of that SAU, by catch, to the zone. Categories for the risk-of-overfishing for each SAU are derived by scoring performance indicators (PIs; six for high importance SAUs and three for medium importance SAUs) against reference points calculated from a 20-year reference period (1990/91-2009/10). To determine the zonal stock status, the risk-of-overfishing score (-2 to +2) for each SAU is multiplied by its proportional contribution to the combined catch, with these values summed. Total zonal status scores range between -2 and +2 and are allocated into one of five categories. These are defined as depleted (score ≤ -1.5), overfished (>-1.5 score ≤ -0.5), sustainably fished (>-0.5 > score ≤ 0.5), under fished (> 0.5 score ≤ 1.5) and lightly fished (score ≥ 1.5).

3. RESULTS

Greenlip

Spatial and temporal patterns in catch, effort and CPUE:

Total catch has been stable at about 47 t.yr⁻¹ since 1994 (Figure 1). Prior to the implementation of a TACC (1990), the average annual catch was 44.3 t, which included the maximum recorded catch of 84.3 t in 1989. Consequently, current catches are about 6% greater than the annual average before implementation of a TACC. Catch per unit effort (CPUE) was stable from 1985 to 1999 (average: 20 kg.hr⁻¹). In 2000, it increased to 28 kg.hr⁻¹ and was at the highest recorded level of 29 kg.hr⁻¹ in 2001. Since 2001, it has decreased and, in 2014, was 23.4 kg.hr⁻¹. The zonal CPUE has been relatively stable since 2011 at 23 kg.hr⁻¹, which was about 10% above the mean CPUE estimate through the 1990s.

Two key changes in the spatial distribution of catch are evident from 1990. The proportion of catch harvested from the Tiparra Reef SAU increased substantially and peaked at 94% in 2001, then declined steadily following the introduction of a 'catch-cap' from 2005 (Figure 1). As the TACC remained static, catches from remaining SAUs – notably West Yorke Peninsula and the South and West Kangaroo Island SAUs – increased (Figures 2-4). There have also been re-distributions of catch among mapcodes within SAUs.

Catch rates in the Tiparra Reef and West Yorke Peninsula SAUs were high in 2014 (Figure 2). For the Tiparra Reef SAU, this was associated with historically low catches. The recent large catches from the West Yorke Peninsula SAU have been obtained at catch rates among the highest recorded for this SAU (Figure 2). In contrast, over recent years, catch rates have declined rapidly in the South Kangaroo Island SAU and moderately in the West Kangaroo Island and East Yorke Peninsula SAUs (Figure 3).

Risk of overfishing in SAUs and zonal stock status:

There were two high- and three medium-importance SAUs for greenlip in 2014 (Table 1). It was possible to determine the risk of overfishing for four of these five SAUs. The lack of an appropriate reference period for CPUE in the East Yorke Peninsula SAU, due to insufficient data, prevented categorising the risk of overfishing for stocks in this SAU (Figure 3; Appendix 1). In addition, for the West Yorke Peninsula SAU, the short time-series of fishery-independent data meant that this high-importance SAU could only be assessed with fishery-dependent PIs (i.e. three of a potential six PIs; Table 1). Summed PI scores ranged between -13 (Tiparra Reef)

and +13 (West Yorke Peninsula; Table 1). Tiparra Reef was assigned to a 'red' (highest risk), West Yorke Peninsula and West Kangaroo Island were assigned 'light blue' (lowest risk) and South Kangaroo Island was assigned a 'green' risk-of-overfishing category (Table 1). The catch-weighted zonal score was 0.56. Under the harvest strategy, this score defines the status of the greenlip fishery in the CZ as 'under fished' (Table 1).

Blacklip

Spatial and temporal patterns in catch, effort and CPUE:

Total catches have been stable at ~8 t.yr⁻¹ since the TACC was reduced in 2006 with decreases in annual catch from 2001 to 2006 reflecting the TACC not being harvested (2002 to 2004) and sequential reductions in the TACC from 14.1 t in 2004 to 9.9 t in 2005 and further to 8.1 t from 2006 (Figure 5). Thus, current catches are at the lowest levels since 1984. Most of the catch (>90%) is harvested from the fishing grounds off Kangaroo Island. The zonal, mean CPUE over the last three years (i.e. 2012-2014) was stable at approximately 19 kg.hr⁻¹. These were the lowest values since 1985.

Since 1979, most of the catch has been harvested from the West and South Kangaroo Island SAUs (Figure 6 and 7). The percentage of catch harvested from West Kangaroo Island has increased since 1991, reaching approximately 80% in 2013 and 2014 (Figure 6). The CPUE in this SAU is similar to that for the whole CZ. Thus, over the last three years, CPUE estimates have been stable at historically low values that were 13% below the mean from 1990 to 2009 and 19% lower than the contemporary maximum in 2009. Annual catches from the South Kangaroo Island SAU have decreased steadily since the late 1980s, with catches in 2013 and 2014 among the lowest on record. The CPUE has generally decreased since 2000 (Figure 7). In 2014, the CPUE was the lowest on record and followed historically low CPUE estimates for 2010 and 2011. For both these SAUs, the proportions of large blacklip in the catch estimated in recent years are at the highest levels on record.

Risk of overfishing in SAUs and zonal stock status:

There was one medium-importance SAU for blacklip in 2014 (West Kangaroo Island; Table 2). The summed PI score for this SAU was 1, aligning with a 'green' risk-of-overfishing category (Table 2; Appendix 1). The catch-weighted zonal score was 0. Under the harvest strategy, this score defines the status of the blacklip fishery in the CZ as 'sustainably fished'.

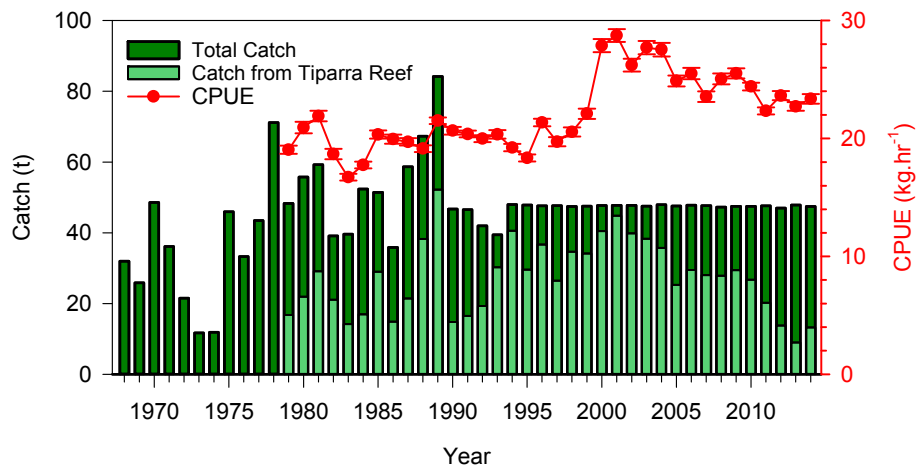


Figure 1 Total reported catch (green bars; t, meat weight) and CPUE ($\text{kg}\cdot\text{hr}^{-1} \pm \text{SE}$; red line) for greenlip in the CZ from 1968 to 2014. From 1979 to 2014, catch from Tiparra Reef (light green bars) is superimposed on total catch; these data were unavailable from 1968 to 1978.

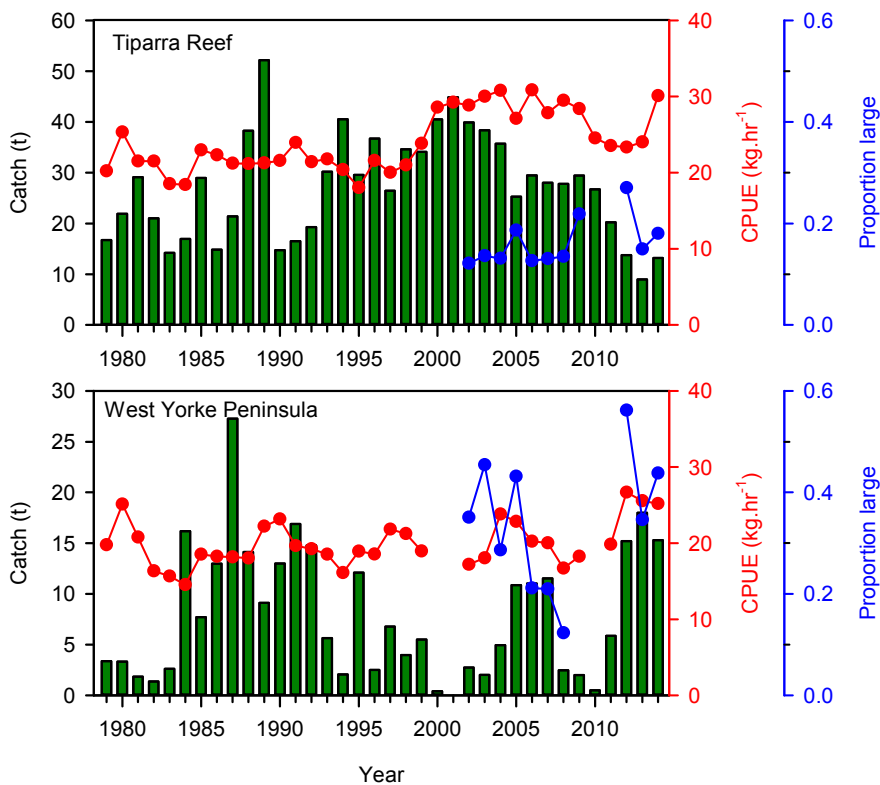


Figure 2 Tiparra Reef and West Yorke Peninsula (high importance). Catch (t, meat weight; green bars), CPUE ($\text{kg}\cdot\text{hr}^{-1} \pm \text{SE}$; red line) and the proportion of large greenlip (>155 mm shell length, blue line) from 1979 to 2014. Gaps in the time series of the CPUE or proportion-large data indicate insufficient data (<10 fisher days or <100 individuals, respectively).

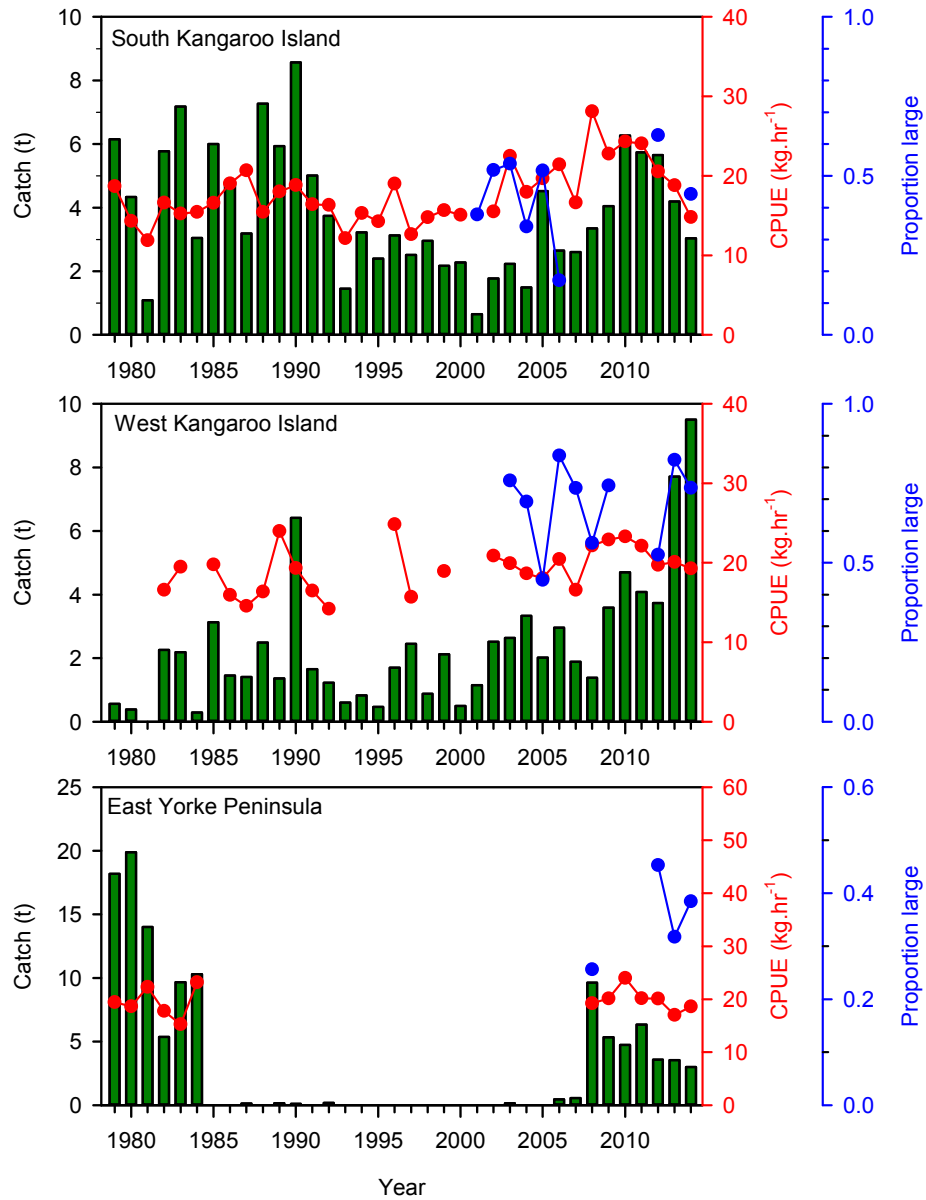


Figure 3 South Kangaroo Island, West Kangaroo Island and East Yorke Peninsula (medium importance). Catch (t, meat weight; green bars), CPUE (kg.hr⁻¹ ± SE; red line) and the proportion of large greenlip (>155 mm shell length, blue line) from 1979 to 2014. Gaps in the time series of the CPUE or proportion-large data indicate insufficient data (<10 fisher days or <100 individuals, respectively).

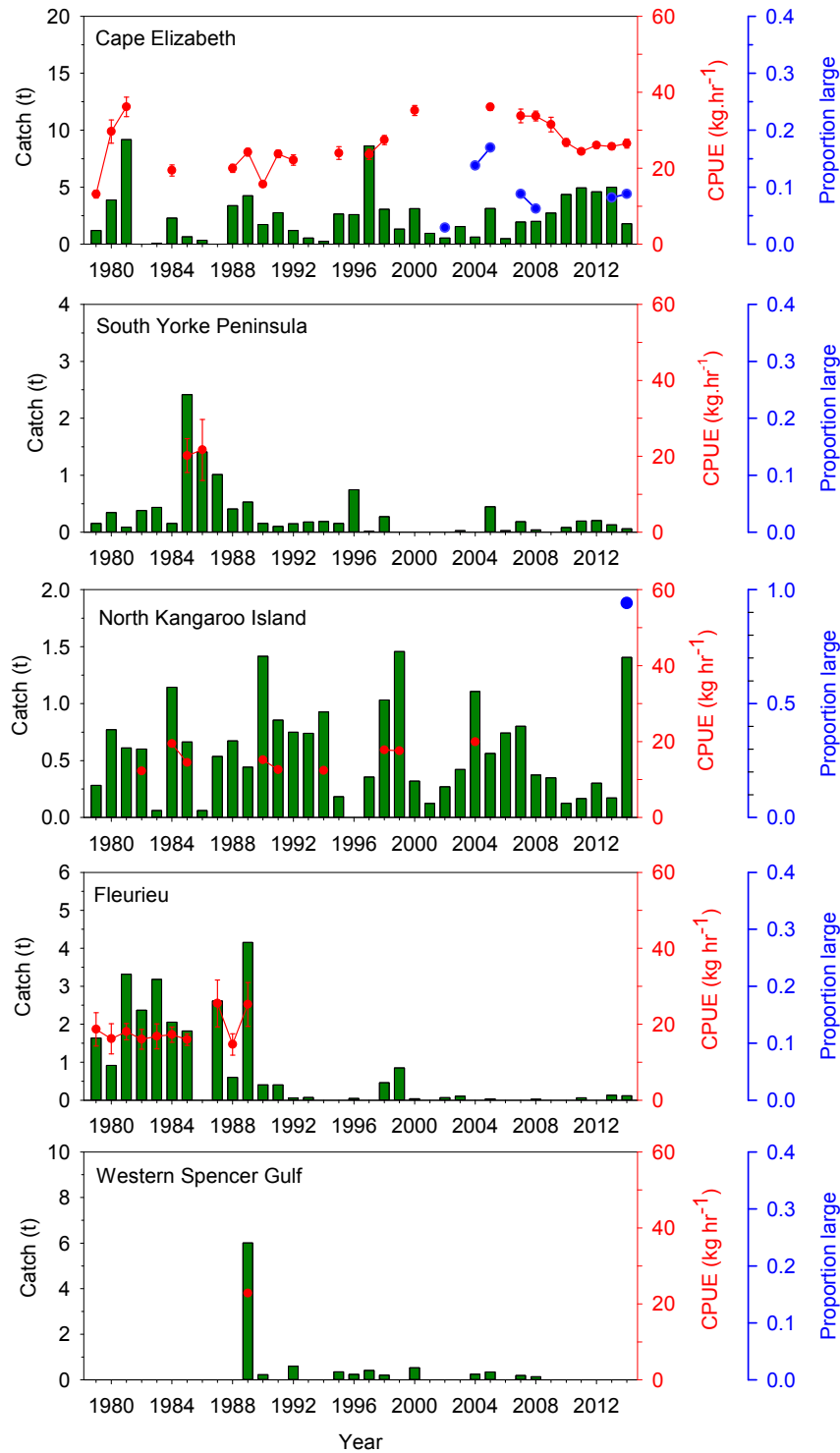


Figure 4 Low importance SAUs. Catch (t, meat weight, green bars), CPUE (kg.hr⁻¹ ± SE; red line) and the proportion of large greenlip (>155 mm shell length, blue line) from 1979 to 2014. Gaps in the time series of the CPUE and proportion-large data indicate insufficient data (<10 fisher days or <100 individuals, respectively).

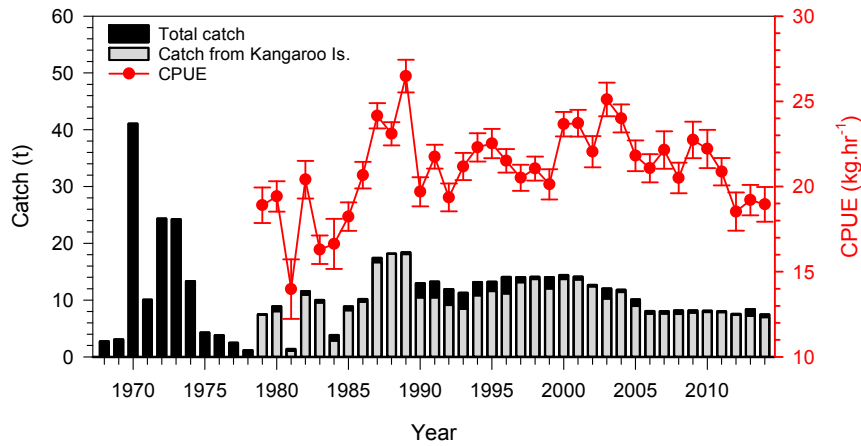


Figure 5 Total reported catch (bars; t, meat weight) and CPUE ($\text{kg}\cdot\text{hr}^{-1} \pm \text{SE}$; red line) for blacklip in the CZ from 1968 to 2014. From 1979 to 2014, catch from Kangaroo Island (grey bars) is superimposed on total catch; these data were unavailable from 1968 to 1978.

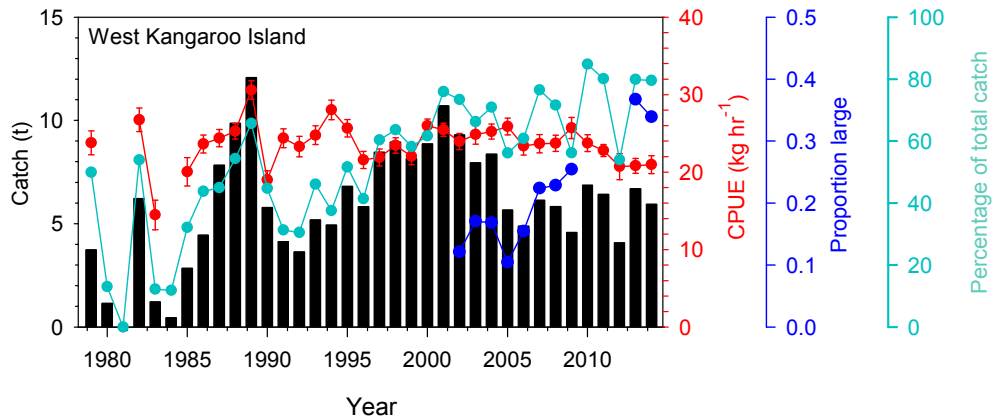


Figure 6 West Kangaroo Island (high importance). Catch (t, meat weight; black bars), proportion of total catch (light blue line), CPUE ($\text{kg}\cdot\text{hr}^{-1} \pm \text{SE}$; red line) and the proportion of large blacklip (>155 mm shell length, blue line) from 1979 to 2014. Gaps in the time series of the CPUE or proportion-large data indicate insufficient data (<10 fisher days or <100 individuals, respectively).

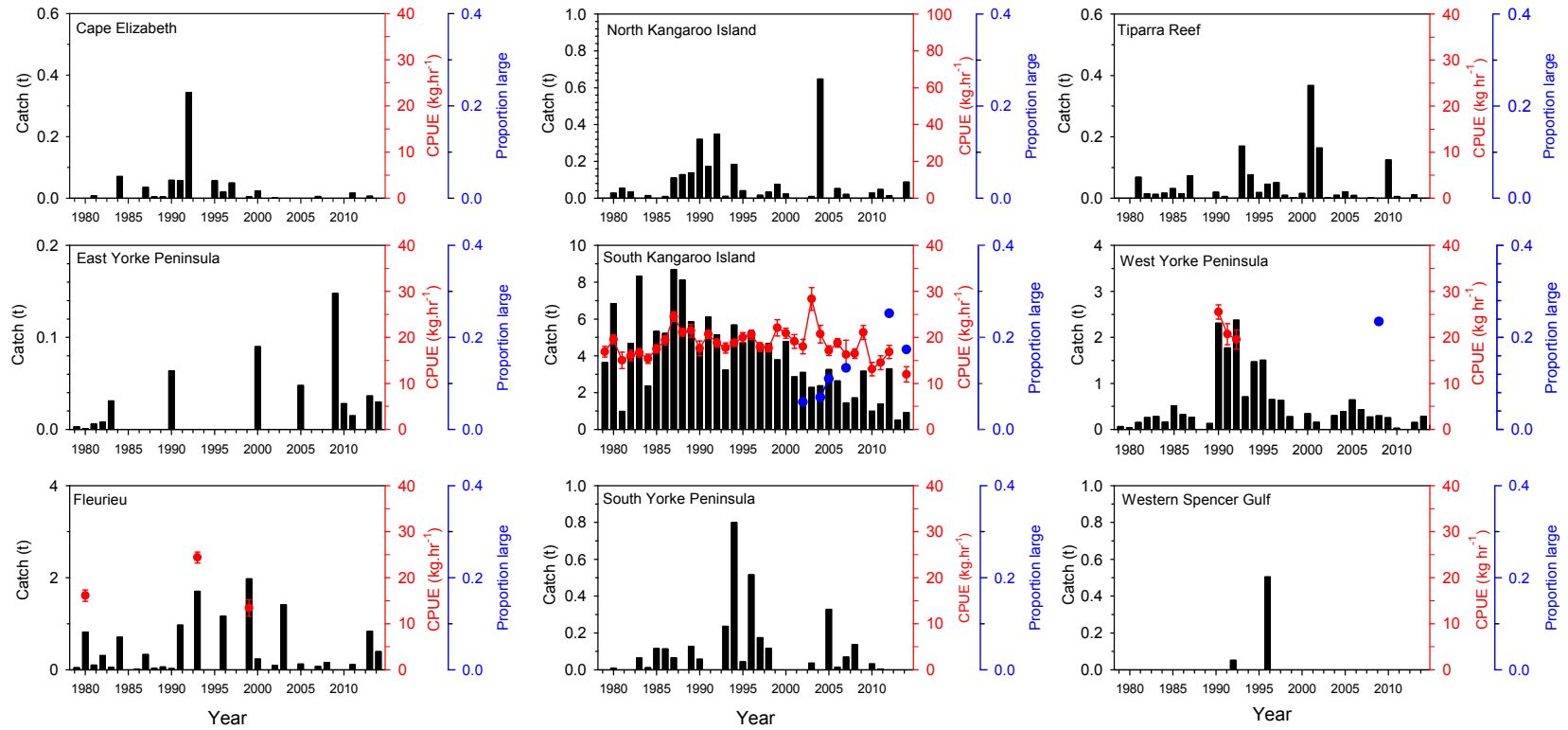


Figure 7 Low importance SAUs. Catch (t, meat weight, black bars), CPUE (kg.hr⁻¹ ± SE; red line) and the proportion of large greenlip (>155 mm shell length, blue line) from 1979 to 2014. Gaps in the time series of the CPUE and proportion-large data indicate insufficient data (<10 fisher days or <100 individuals, respectively).

Table 1 Outcome from application of the harvest strategy described in the Management Plan for the South Australian Commercial Abalone Fishery against the greenlip fishery in the CZ. Grey shading identifies the performance indicators and their respective scores. Colours identify risk of overfishing, ranging from red (highest) to light blue (lowest). ND indicates no data.

Spatial assessment unit	%Contribution to mean total catch (CZ) over last 10 years (05-14)	Importance	%Contribution to catch from high & medium SAU in 2014	CPUE	%TACC	%Large	Pre-recruit density	Legal density	Mortality	Combined PI score	Risk of overfishing	Catch-weighted contribution to zonal score
Tiparra Reef	40.0	High	32.2	2	-8	1	-5	-3	ND	-13	-2	-0.64
West Yorke Peninsula	16.6	High	37.2	6	6	1	ND	ND	ND	13	2	0.74
South Kangaroo Island	7.6	Medium	7.4	-1	0	0	-	-	-	-1	0	0.00
West Kangaroo Island	7.5	Medium	23.1	0	8	0	-	-	-	8	2	0.46
East Yorke Peninsula	6.7	Medium	-	ND	ND	ND	-	-	-	Uncertain	Not assigned	-
Cape Elizabeth	5.6	Low	-	-	-	-	-	-	-	Not assessed	-	-
North Kangaroo Island	0.9	Low	-	-	-	-	-	-	-	Not assessed	-	-
South Yorke Peninsula	0.3	Low	-	-	-	-	-	-	-	Not assessed	-	-
Western Spencer Gulf	0.1	Low	-	-	-	-	-	-	-	Not assessed	-	-
Fleurieu	0.1	Low	-	-	-	-	-	-	-	Not assessed	-	-
Unassigned Central Zone	0.1	Low	-	-	-	-	-	-	-	Not assessed	-	-
Sum	85.3		100.0									
											Zonal stock status	0.56

Table 2 Outcome from application of the harvest strategy described in the Management Plan for the South Australian Commercial Abalone Fishery against the blacklip fishery in the CZ. Grey shading identifies the performance indicators and their respective scores. Colours identify risk of overfishing, ranging from red (highest) to light blue (lowest).

Spatial assessment unit	%Contribution to mean total catch (CZ) over last 10 years (05-14)	Importance	%Contribution to catch from high & medium SAU in 2014	CPUE	%TACC	%Large	Combined PI score	Risk of overfishing	Catch-weighted contribution to zonal score
West Kangaroo Island	10.3	Medium	100.0	-7	4	4	1	0	0.00
South Kangaroo Island	3.5	Low	-	-	-	-	Not assessed	-	-
West Yorke Peninsula	0.4	Low	-	-	-	-	Not assessed	-	-
Fleurieu	0.3	Low	-	-	-	-	Not assessed	-	-
North Kangaroo Island	0.0	Low	-	-	-	-	Not assessed	-	-
South Yorke Peninsula	0.1	Low	-	-	-	-	Not assessed	-	-
East Yorke Peninsula	0.1	Low	-	-	-	-	Not assessed	-	-
Tiparra Reef	0.0	Low	-	-	-	-	Not assessed	-	-
Cape Elizabeth	0.0	Low	-	-	-	-	Not assessed	-	-
Western Spencer Gulf	0.0	Low	-	-	-	-	Not assessed	-	-
Unassigned Central Zone	0.0	Low	-	-	-	-	Not assessed	-	-
Sum	14.7		100.0					Zonal stock status	0.00

4. SUMMARY

The harvest strategy for the South Australian Abalone Fishery (PIRSA 2012) is the current tool for setting TACCs in this fishery. This harvest strategy is designed to monitor abalone stocks using biological performance indicators (PIs) in SAUs of high and medium importance, assess the risk of overfishing in each SAU in relation to their overall fishery importance to determine a stock status for the zone and adjust TACCs in response to changing abalone populations. In 2014, application of the harvest strategy to determine stock status for blacklip and greenlip in the CZ was based on one and four SAUs, respectively, with fished greenlip stocks thus better represented in the assessment. However, this relatively new harvest strategy has several limitations including stock status classifications which are considered overoptimistic (e.g. Mayfield *et al.* 2014; Stobart *et al.* 2014) and the absence of a definition of recruitment overfished, to link the assessment to the NFSRF (Flood *et al.* 2014). The lack of an agreed definition makes determining whether stocks are recruitment overfished problematic. As the harvest strategy is being reviewed in 2015/16, the stock status classifications from the harvest strategy for both species were compared to the traditional, weight-of-evidence analysis using the NFSRF framework. Identification of a definition of recruitment overfished for these fisheries is a key component of that review. A conservative approach is warranted given the documented rapid and substantial declines in abalone stocks elsewhere (Mayfield *et al.* 2012).

Greenlip comprises 85% (47.7 t) of the total abalone TACC in the CZ, which highlights the importance of greenlip to the CZ abalone fishery. The zonal stock status score for greenlip from the harvest strategy was 0.56 in 2014. While this was a lower score than that in 2013 (0.97), the zonal stock status classification remained unchanged between years (i.e. 'under fished'; Mayfield *et al.* 2014). The 'under fished' classification from the harvest strategy is in conflict with much of the data available for the fishery. These data include the (1) long-term decline in CPUE across the CZ which, likely underrepresents the true decline in greenlip abundance (Mayfield *et al.* 2014); (2) substantial recent decreases in greenlip density on Tiparra Reef (Mayfield *et al.* 2014), with catches from the Tiparra Reef SAU at their lowest levels on record; (3) recent decreases in catch rates in four of the five SAUs where catches have increased over recent years; and (4) re-distribution of catches into mapcodes from which historically few greenlip have been harvested. While the latter may reflect 'planned rotational harvest', it is more likely indicative of spatial expansion to maintain catch and CPUE, because such patterns are not evident historically. The extent and location of remaining lightly fished/unfished

reefs in the CZ is unknown. Collectively, this evidence suggests that current fishing pressure is too high and has the potential to cause the stocks to become recruitment overfished. Consequently, the CZ greenlip fishery is classified as '**transitional depleting**' under the NFSRF.

The zonal stock status score for blacklip from the harvest strategy in 2013 and 2014 was 0.00, classifying this species in the CZ as 'sustainably fished' (Mayfield *et al.* 2014). This 'sustainably fished' classification also contrasts with much of the data available for the fishery. This is because these data demonstrate that the harvestable biomass of blacklip in the CZ is at a low level and has continued to decline despite smaller catches from 2002 and TACC reductions from 2004.

Blacklip in the CZ was classified as 'transitional depleting' in 2013 (Mayfield *et al.* 2014). The data supporting this conclusion included (1) most of the catch being harvested from mapcode 26B in the West Kangaroo Island SAU indicating a high reliance on these blacklip stocks; (2) the zonal and West Kangaroo Island SAU CPUEs being at the lowest values in almost 30 years and substantially below the 2009 peaks; (3) catches from the South Kangaroo Island SAU being at the lowest levels on record; and (4) an increasing high proportion of large blacklip in the catch, with no documentation of selective fishing, indicating limited recruitment to the fishable stock.

There are more data for 2014 that indicate stock status is in a weak position. For the third consecutive year, the zonal CPUE estimates were at the lowest values in almost 30 years. Since 2012, the CPUE has been substantially below the recent peaks in 2003 and 2009 and 10% below the mean value through the 1990s. The reductions in CPUE likely underrepresent the true decline in blacklip abundance (Mayfield *et al.* 2014). Similar CPUE trends were evident in the West Kangaroo Island SAU, the most important fishing ground for this species. Catches from mapcodes 27A and 27B in the West Kangaroo Island SAU are also declining, resulting in apparent high reliance on the stocks in mapcodes 26A and 26B. The CPUE in the South Kangaroo Island SAU (the primary alternate fishing ground to the West Kangaroo Island SAU) in 2014 was at the lowest and catch at the second-lowest level on record. The declining frequency of small combined with the increasing proportions of large blacklip in the catch demonstrate recent poor recruitment to the fishable stock. Collectively, this evidence suggests that current fishing pressure is too high but the lack of an agreed definition means there is uncertainty in determining whether the stocks are also recruitment overfished. Consequently, the CZ blacklip stocks in 2014 are classified as '**transitional depleting**'.

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Appendix 1. Harvest Strategy PI Plots

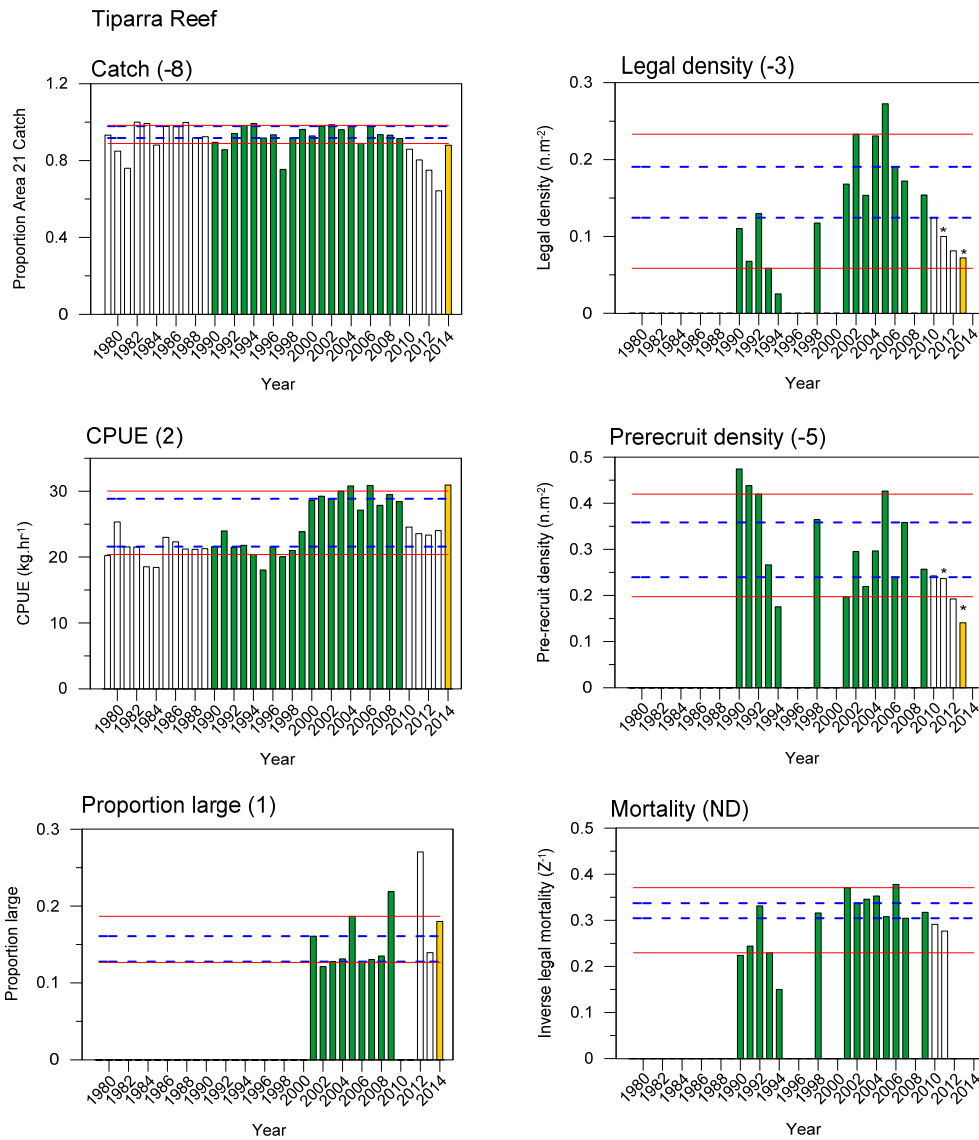


Figure 1 Tiparra Reef (high importance). Performance indicators (and scores from the harvest strategy to determine the risk of being overfished) and upper and lower target (red lines) and limit (blue dashed lines) reference points. Green bars describe the data and time over which the reference points were calculated. Open bars describe measures of the PI outside of the reference period. Orange bars describe the data and year subject to assessment for each PI *i.e.* the score-year.

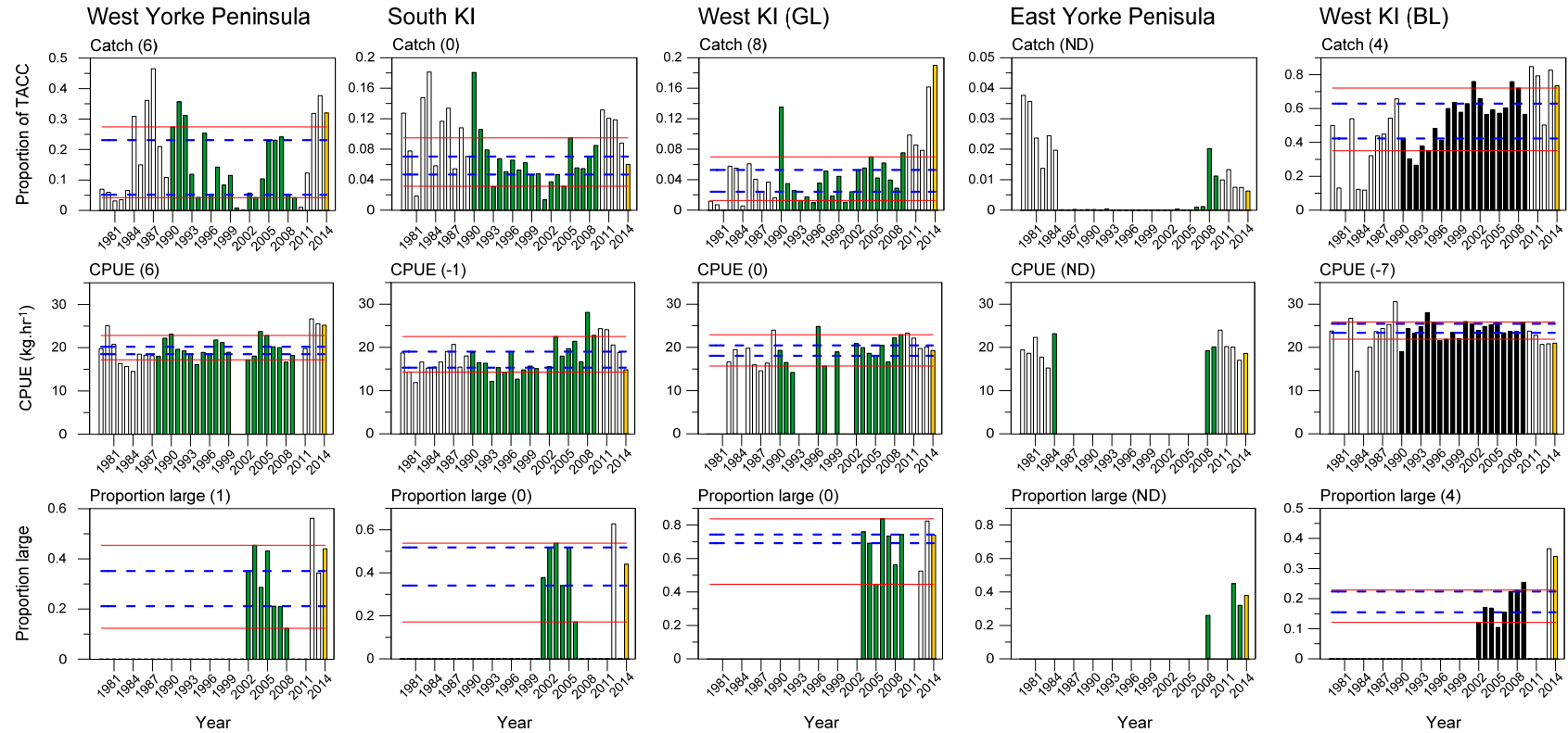


Figure 2 Greenlip: West Yorke Peninsula (high importance) and South Kangaroo Island (KI), West KI and East Yorke Peninsula (medium importance); Blacklip: West KI (medium importance). Performance indicators (and scores from the harvest strategy to determine the risk of being overfished) and upper and lower target (red lines) and limit (blue dashed lines) reference points. Green/black bars describe the data and time over which the reference points were calculated. Open bars describe measures of the PI outside of the reference period. Orange bars describe the data and year subject to assessment for each PI *i.e.* the score-year.