

**Western Australian Marine Stewardship Council
Report Series No. 8**

Western Australian Abalone Managed Fishery

Addendum 2

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1. Background

The Western Australian Abalone Managed Fishery (WAAMF) is a dive and wade fishery that operates in the shallow coastal waters off the west and south coasts of WA. The WAAMF commercially harvests three species, Roe's abalone (*Haliotis roei*), Greenlip abalone (*H. laevigata*) and Brownlip abalone (*H. conicopora*), which also form the Marine Stewardship Council (MSC) three Units of Certification for this fishery.

The fishery achieved MSC certification in 2017 and the assessment was based on information presented in Hart et al. (2017).

http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8.pdf

This report is the second addendum to Hart et al. (2017) and provides catch and effort information for the 2018/19 (2018) fishing season in the WAAMF. It also provides updates on progress made to date to address the MSC conditions placed on the fishery for the criteria where the standard was not quite achieved. The report was prepared for the 2nd MSC Surveillance Audit carried out in August 2019.

1.1 Stock Status

The abalone stocks of WA are assessed annually using a weight-of-evidence approach that considers all available information (see Wise et al. 2007). Catches in the WAAMF are controlled by a Total Allowable Commercial Catch (TACC), set annually for each species and each management area in accordance with the harvest control rule defined in the Abalone Resource of Western Australia Harvest Strategy 2016–21 (DoF 2017). The harvest control rule uses a 3-year moving average of standardised catch per unit effort (SCPUE) as the key performance indicator (PI) against specified limit, threshold and target reference levels. The threshold is a level at which additional management action should be considered to prevent decline towards the limit, while the fishery is defined as depleted if the PI is below the limit reference level. These reference levels are species and management area specific and based on specified reference periods of recruitment stability in the commercial fishery (DoF 2017). Overall weight-of-evidence assessments also consider any additional fishery-dependent and fishery-independent information where available.

2. Unit of Certification – Roe’s abalone

The PI has always been above the target reference level specified for each management area and this has continued for the 2018 season (Figure 2.2, 2.4, 2.6 and 2.8). The decline in SCPUE in all management areas post 2011 has been attributed to adverse environmental conditions, namely the 2011 extreme marine heatwave and the subsequent years of above average sea surface temperature (SST). However, the severity of the decline in SCPUE varied between management areas, but all areas have shown some level of recovery over the last 3 to 5 seasons as a result of reduced catches and cooler seawater temperatures. The effect of the marine heatwave ranged from the catastrophic mortality event in Area 8 and the closure of this area, to the sub-lethal effects such as growth stunting and recruitment impairment in Area 7 (Hart et al. 2018). In Area 7 these effects have been managed through a stock prediction model (Figure 2.10b), which uses a recruitment index (Age 1+) along with an environmental factor (average annual summer SST over 4 years) to predict the density of harvest size animals (≥ 71 mm) that subsequently informs the Total Allowable Catch (TAC) setting. The TAC is then separated into the TACC (commercial) and TARC (recreational) by using the available biomass in each habitat and both sectors pattern of usage (DoF 2017).

Catches of Roe’s abalone were well below the TACC (<50%) in Area 5 and 6 for the 2018 season (Table 2.1). The commercial industry has attributed the reduced catch in regional areas in recent years to several economic and accessibility issues rather than stock biomass levels. These issues include a decline in beach price and overall economic value during the last decade, market competition with hatchery-produced abalone given the similar sized animals, increasing costs of accessing the remote regions, and the prevailing weather conditions. Overall, the Roe’s abalone stock status in WA is considered sustainable.

Table 2.1: Total Allowable Commercial Catch (TACC; kg, whole weight), catch (kg, whole weight) and the percentage of TACC caught (% Catch) for Roe’s abalone during the 2018 season in each Management Area.

	TACC (kg)	Catch (kg)	% Catch
Area 2	12,000	11,523	96
Area 5	15,000	6,483	43
Area 6	12,000	5,612	47
Area 7	24,000	23,393	97

2.1 Area 2 Fishery

In Area 2 the catch of Roe’s abalone was 11.5 t (whole weight) in 2018, which was 96% of the TACC (Table 2.2). The TACC was reduced from 18 to 12 t for the 2018 season given the lower catches over the previous 4 seasons (between 61% and 90% of annual TACC) and the long-term declining trend in SCPUE (Table 2.2 and Figure 2.2). Before 2014 over 90% of the annual TACC was caught with the full allocation generally caught through the 2000’s. The catch rate for all Roe’s abalone divers has fluctuated over the last 5 seasons with the 2018 season being one of the lowest on record (Table 2.2). Catch rates for dedicated Roe’s abalone divers declined in 2018, with the hourly catch rate similar to the historical average

(1989-2018) while the daily catch was the lowest on record (Figure 2.1). The annual SCPUE exhibited a sharp decline after 2012 and reached a historical low in 2015 (Figure 2.2). It increased in 2016 but has declined again over the last 2 seasons, however even at the historical low in 2015 the annual SCPUE and PI were above the target reference level.

Table 2.2: Area 2 Roe’s abalone TACC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota Period	Roe’s TACC (kg)	Roe’s Total Catch (kg whole wt)	Roe’s Total Diver Days	Roe’s Catch Rate (kg/day)
2000	18,000	17,728	161	110
2001	18,000	17,976	160	112
2002	18,000	17,971	161	112
2003	18,000	17,879	155	115
2004	18,000	17,701	141	126
2005	19,800	19,575	124	158
2006	19,800	19,493	152	128
2007	19,800	19,110	145	132
2008	19,800	19,728	134	147
2009	19,800	19,769	103	192
2010	19,800	19,191	115	167
2011	19,800	19,092	120	159
2012	19,800	18,128	119	152
2013	19,800	18,642	154	121
2014	18,000	11,105	89	125
2015	18,000	11,088	128	87
2016	18,000	16,372	113	145
2017	18,000	13,300	110	121
2018	12,000	11,523	119	97

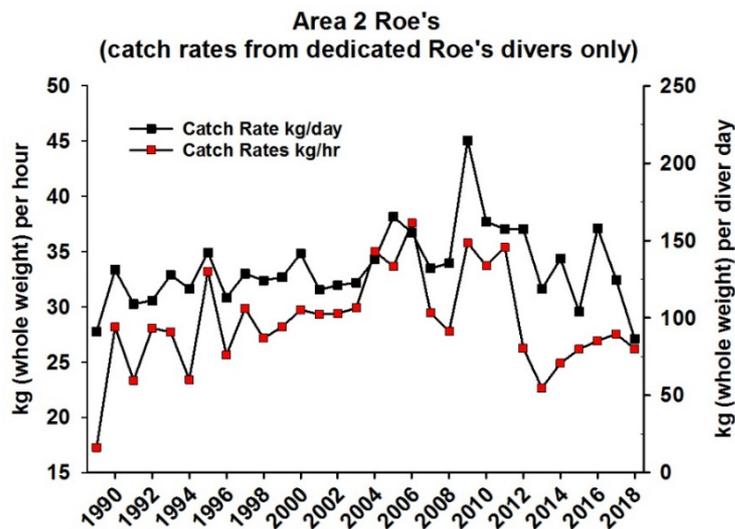


Figure 2.1: Area 2 Roe’s abalone nominal catch rates (kg/hr and kg/day) for dedicated Roe’s abalone divers only.

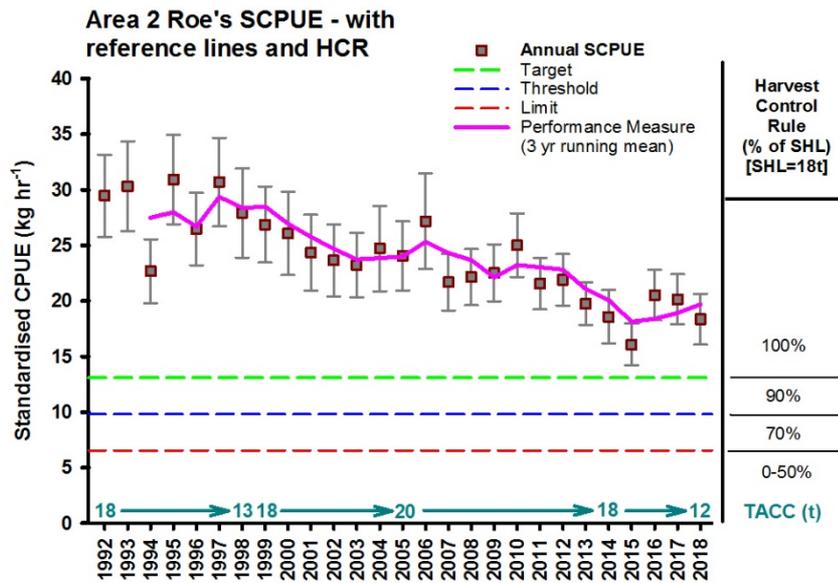


Figure 2.2: The annual standardised CPUE (kg.hr⁻¹) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

2.2 Area 5 Fishery

In Area 5 the catch of Roe's abalone was 6.5 t (whole weight) in 2018, which was 43% of the TACC (Table 2.3). Over the last 5 seasons less than 43% of the annual TACC has been caught, and the full allocation has not been caught since the early 2000's. The TACC was reduced from 20 to 15 t for the 2018 season due to these lower catches and the SCPUE being lower than the historical average over the last 5 seasons (Table 2.3 and Figure 2.4). The catch rate for all divers has fluctuated under 100 kg/day over the last 6 seasons, whereas it was over 100 kg/day for the previous 7 seasons (Table 2.3). The catch rate (kg/hr) for dedicated Roe's abalone divers increased through the 1990's and 2000's. After 2006 the catch rate declined until 2015 but has now increased over the last 3 seasons and in 2018 was at the historical average (1989-2018) (Figure 2.3). The annual SCPUE was relatively stable between 1995 and 2012, declined in 2013 and has remained stable but slightly lower than the historical average over the last 6 seasons (Figure 2.4). The annual SCPUE and PI have always been above the target reference level.

Table 2.3: Area 5 Roe's abalone TACC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota Period	Roe's TACC (kg)	Roe's Total Catch (kg whole wt)	Roe's Total Diver Days	Roe's Catch Rate (kg/diver day)
2000	20,000	19,858	175	113
2001	20,000	18,718	191	98
2002	20,000	19,820	192	103
2003	20,000	17,942	188	95
2004	20,000	19,636	220	89
2005	20,000	19,048	198	96
2006	20,000	18,185	173	105
2007	20,000	16,094	150	107
2008	20,000	17,050	171	100
2009	20,000	16,078	126	128
2010	20,000	15,999	145	110
2011	20,000	14,785	131	113
2012	20,000	12,509	100	125
2013	20,000	10,483	136	77
2014	20,000	4,152	69	60
2015	20,000	5,659	67	84
2016	20,000	7,454	79	94
2017	20,000	7,007	79	89
2018	15,000	6,483	91	71

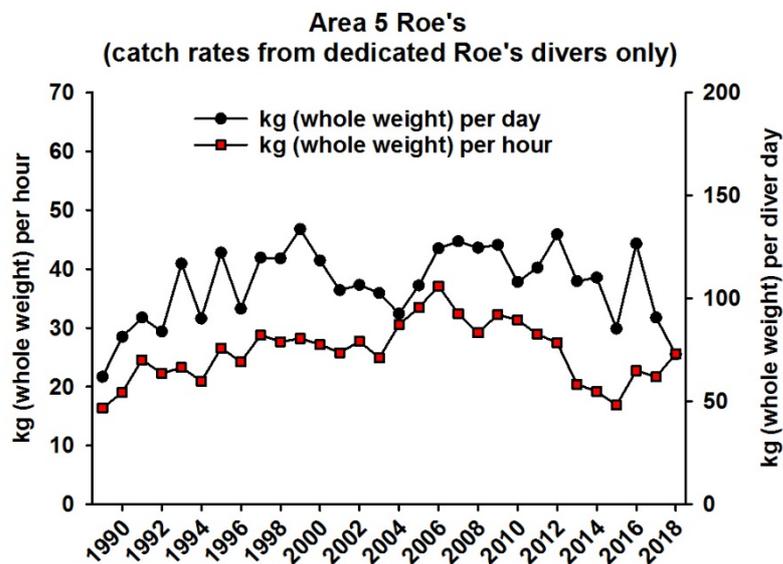


Figure 2.3: Area 5 Roe's abalone nominal catch rates (kg/hr and kg/day) for dedicated Roe's abalone divers only.

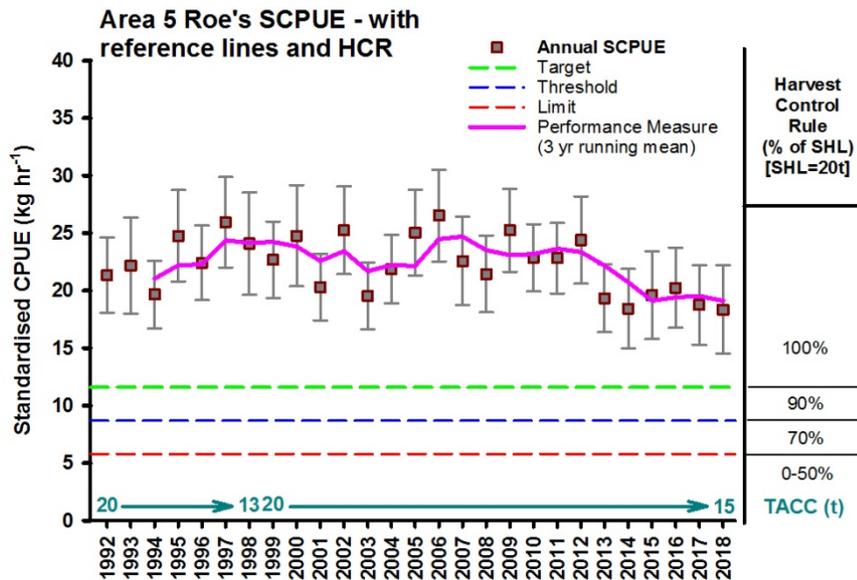


Figure 2.4: The annual standardised CPUE (kg.hr⁻¹) for Roe’s abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 5.

2.3 Area 6 Fishery

In Area 6 the Roe’s abalone catch was 5.6 t (whole weight) in 2018, which was 47% of the TACC (Table 2.4). The TACC has been constant since 1999 (12 t whole weight) and up to and including 2011, 90% or greater of the TACC was caught annually. Since then the catch has declined to less than 6 t annually and remained at this level for the last 5 seasons. The catch rate for all divers has fluctuated greatly since the decline in catch began in 2012, whereas before this the catch rate was relatively stable (Table 2.4). Catch rates for dedicated Roe’s abalone divers were relatively constant between 2001 and 2011, before declining sharply over the next 2 seasons. After this period, the catch rate increased rapidly to historically high levels for 3 seasons until declining in 2018 (Figure 2.5). After a period of relative stability (1998 to 2011) the annual SCPUE declined sharply between 2011 and 2013, to the lowest level on record, but remained just above the target reference level. In 2014 the annual SCPUE increased and since then has remained stable, although with a high degree of uncertainty around the estimate (Figure 2.6). The increase in annual SCPUE and high uncertainty from 2014 onwards resulted from the decline in catch since 2011 and the very low levels of catch between 2014 to 2016. This reduction in catch contributed to the annual SCPUE and PI remaining above the target reference level.

Table 2.4: Area 6 Roe's abalone TACC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota Period	Roe's TACC (kg)	Roe's Total Catch (kg whole wt)	Roe's Total Diver Days	Roe's Catch Rate (kg/diver day)
2000	12,000	12,027	89	135
2001	12,000	12,427	116	107
2002	12,000	12,020	127	95
2003	12,000	12,084	117	103
2004	12,000	11,663	113	103
2005	12,000	11,996	116	103
2006	12,000	11,989	110	109
2007	12,000	11,976	98	122
2008	12,000	11,386	99	115
2009	12,000	12,002	112	107
2010	12,000	10,994	103	107
2011	12,000	12,005	99	121
2012	12,000	8,497	80	106
2013	12,000	6,992	75	93
2014	12,000	1,204	11	109
2015	12,000	2,603	13	200
2016	12,000	1,485	7	212
2017	12,000	4,465	42	106
2018	12,000	5,612	73	77

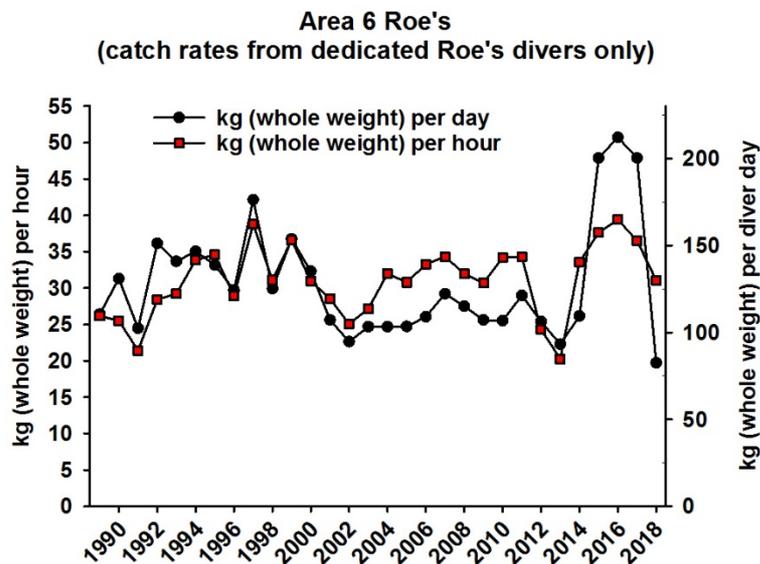


Figure 2.5: Area 6 Roe's abalone nominal catch rates (kg/hr and kg/day) for dedicated Roe's abalone divers only.

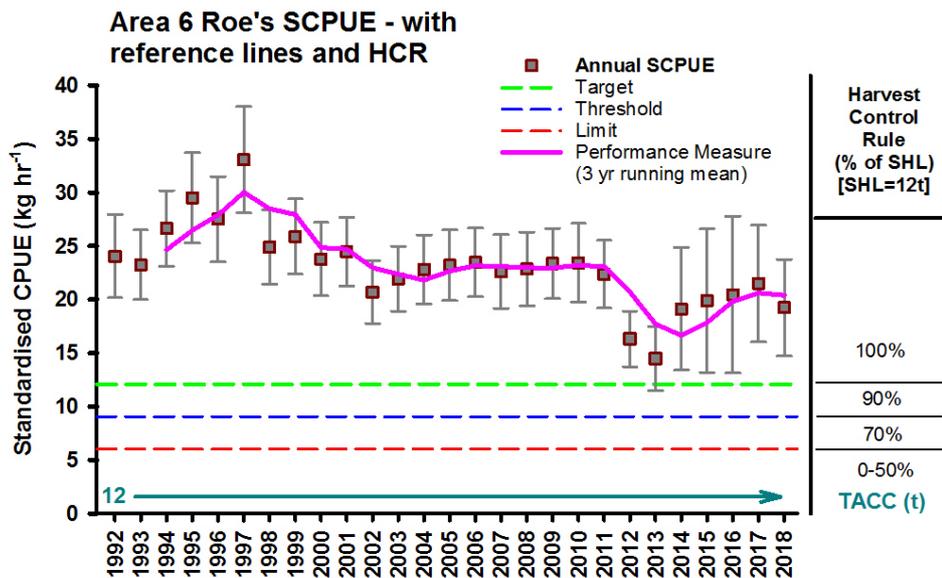


Figure 2.6: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 6.

2.4 Area 7 Fishery

The commercial catch in Area 7 was 23.4 t (whole weight) in 2018, which was 97% of the TACC (Table 2.5). Apart from 2012 and 2016 (Industry decisions to catch below the legislated TACC), greater than 97% of the allocated TACC has been caught each season, therefore changes in catch are attributed to changes in the TACC. The Roe's abalone catch rate (kg/day) has remained relatively stable over the last 5 seasons but this is below the historical average (1989-2018) and well below some of the peak catch rates recorded between 1999 and 2013 (Table 2.5 and Figure 2.7). The catch rate per hour has increased over the last 4 seasons and in the 2018 was above the historical average (Figure 2.7).

The annual SCPUE steadily declined between 2005 and 2014, but has since increased in each of the last 4 seasons (Figure 2.8). The PI is above the target reference level and the TACC was set using the stock prediction model. Arresting the decline and the subsequent increase in annual SCPUE resulted in part due to the recent reductions in catch. This included a TACC reduction in 2014 (11%), a voluntary Industry in-season commercial catch reduction from 32 t to 24 t in 2016, and the implementation of the stock prediction model in 2017 (TACC at 67% of long-term commercial sustainable harvest level).

Fishery-independent surveys indicate that the density of harvest-sized (≥ 71 mm) Roe's abalone in both the subtidal and platform habitats, and across both fished and unfished areas experienced substantial declines between 2002 and 2012 (Figure 2.9a and b). The density of harvest-sized animals on the reef platform has increased in the last 4 years from the record-low levels during 2012-2015, while the density on the subtidal habitat is at the highest level since 2008 (Figure 2.9a). Importantly, this increase in density is present in both unfished and

fished stocks, suggesting that favourable environmental conditions for growth have continued (Figure 2.9b). Age 1+ (17 – 32 mm) animals have also shown an increase in density over the last 4 years, after the juvenile recruitment density declined by 80% between 2010 and 2013 (post marine heatwave), with 2015 being the lowest year on record (Figure 2.10a). These results indicate the range of effects the extreme marine heatwave had on the abalone stocks, which included the decline in large animals, growth stunting, recruitment impairment and a decline in spawning biomass (Hart et al. 2018). However, recovery of the Area 7 fishery is continuing from historically low levels as environmental conditions (cooler waters) have been favourable in recent years, with the stock indicators either at (harvest-size animals) or nearing (recruitment in fished areas) pre-marine heatwave levels.

The stock prediction model indicates the density of harvest sized animals (≥ 71 mm) will remain stable for 2020 and increase in 2021 as Age 1+ recruitment increases, but this will also be affected by the summer SST over the coming years (Figure 2.10a and b). It is worth noting that the density of harvest-sized animals has increased significantly between 2016 and 2019, even though the density of Age 1+ animals decreased in the corresponding lagged years (2012-2015) (Figure 2.10b). This increase was contrary to expectations and indicates a greater level of resilience in response to very good environmental conditions (low summer SST) and reduced catches during this time.

Table 2.5: Area 7 Roe’s abalone TACC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota Period	Roe’s TACC (kg)	Roe’s Total Catch (kg whole wt)	Roe’s Total Diver Days	Roe’s Catch Rate (kg/diver day)
2000	36,000	36,509	169	216
2001	36,000	35,406	202	175
2002	36,000	35,965	214	168
2003	36,000	36,007	214	168
2004	36,000	35,889	178	202
2005	36,000	35,912	176	204
2006	36,000	36,005	196	184
2007	36,000	35,998	215	167
2008	36,000	35,995	199	181
2009	36,000	35,996	210	171
2010	36,000	36,001	192	188
2011	36,000	35,726	183	195
2012	36,000	27,895	165	169
2013	36,000	36,003	226	159
2014	32,000	32,234	248	130
2015	32,000	31,888	261	122
2016	24,000	23,778	189	126
2017	24,000	23,978	181	132
2018	24,000	23,393	180	130

* Voluntary reduction from 32,000kg

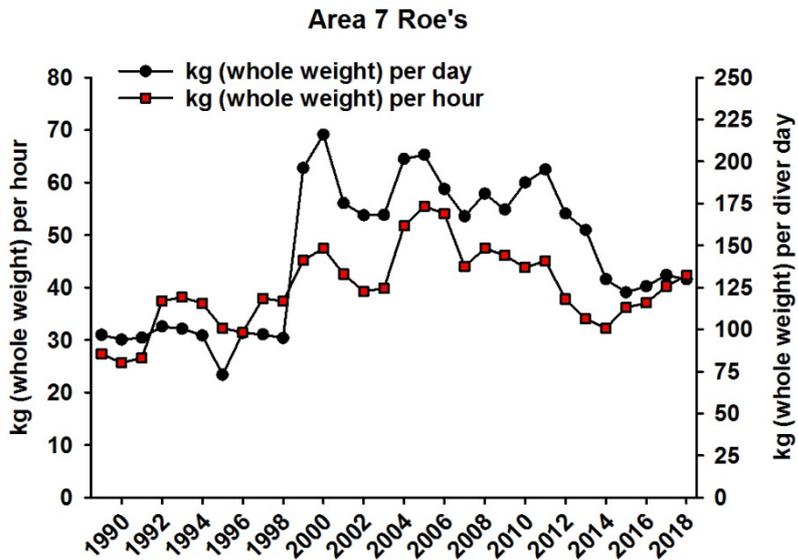


Figure 2.7: Area 7 Roe's abalone nominal catch rates (kg/hr and kg/day) for all operators.

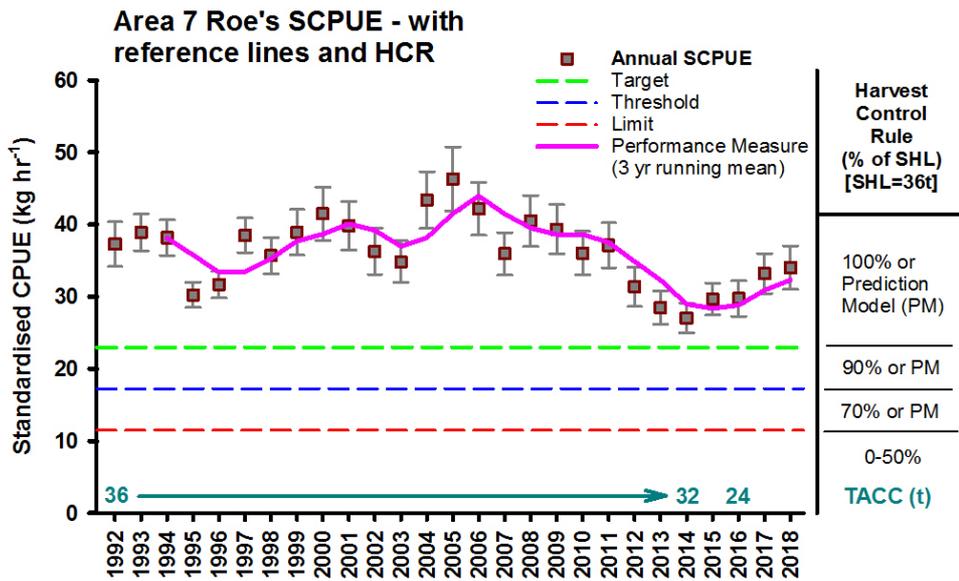


Figure 2.8: The annual standardised CPUE (kg.hr⁻¹) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 7.

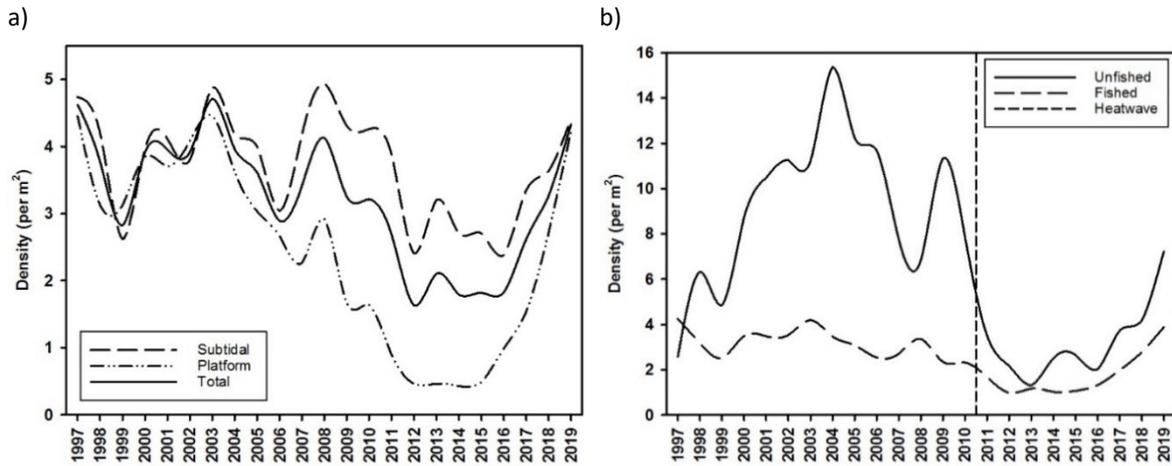


Figure 2.9: (a) Density of harvest size (≥ 71 mm) Roe's abalone in the platform and subtidal habitats within the fished areas, (b) Density of harvest size (≥ 71 mm) Roe's abalone in fished and unfished areas. The occurrence of the marine heatwave (dashed vertical line) is also shown.

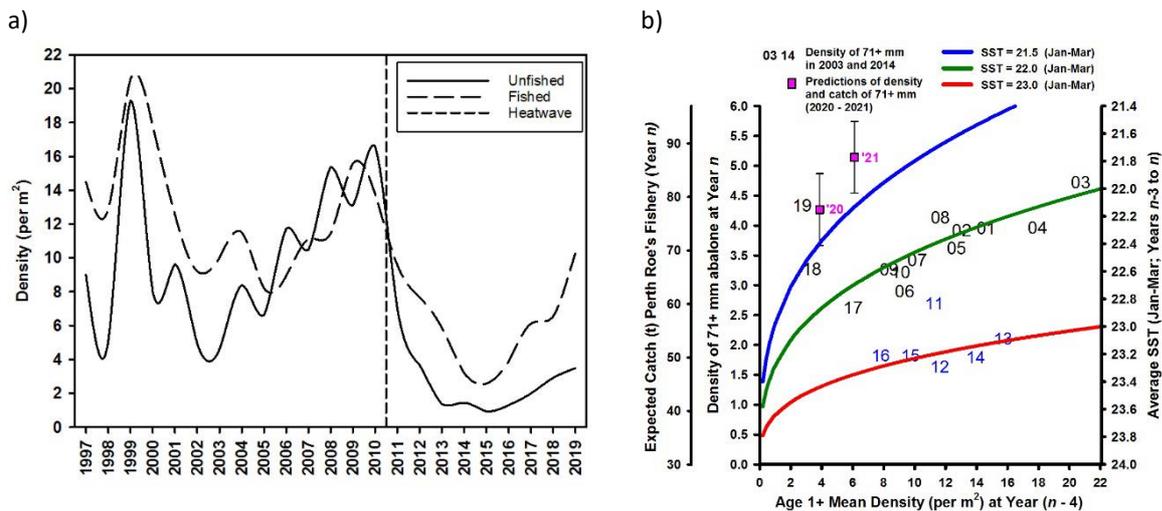


Figure 2.10: (a) Density of Age 1+ (17 – 32 mm) Roe's abalone in fished and unfished areas, (b) Density of harvest-sized Roe's abalone and catch prediction model (y axis = density and expected catch (t) of ≥ 71 mm abalone in year n , x axis = density of Age 1+ (17 – 32 mm) at year $n - 4$, e.g. 15 = density of Age 1+ in 2011) with mean summer SST during the 4 year period (years $n - 3$ to n).

3. Unit of Certification – Greenlip abalone

Catches of Greenlip abalone in Area 2 and 3 were 96 and 80%, respectively, of the TACCs for the 2018 season (Table 3.1). The annual SCPUE has declined to record low levels in both Area 2 and Area 3 in 2018 (Figure 3.2 and 3.4). Both management areas were experiencing an increase in SCPUE towards the target reference level until 2010. The effect of the 2011 marine heatwave and the subsequent years of above average SST is evident in the SCPUE's continual decline over the last 8 seasons. Reductions in TACC's in response to the declining PI occurred between 2015 and 2018 in Area 2 and between 2014 and 2018 in Area 3.

As part of the quota setting process for next season, Industry in Area 2 requested the quota of 9 t from 2018 be maintained as the TACC for 2019. This TACC is conservative compared to what the harvest control rule stipulates and was also recommended by the Department given the limited response in the SCPUE to the recent catch reductions. In Area 3, given the annual SCPUE has been below the limit for the last 2 seasons and the PI has breached the limit reference level for the first time, the TACC was set at 4 t which is 11.4% of the long-term sustainable harvest level (35 t meat weight). This is a reduction by 50% from the 2018 TACC and was facilitated by a closure of the commercial fishery in the Augusta sub-area for the 2019 season. Maintaining a low level of fishing in the Windy Harbour, Albany and Hopetoun sub-areas would allow a structured fishing ('paddocks') trial to begin and provide some commercial catch data, while the fishery-independent surveys in the Augusta sub-area allows the developing Recovery Strategy to be monitored in Area 3.

Table 3.1: Total Allowable Commercial Catch (TACC; kg, meat weight), catch (kg, meat weight) and the percentage of TACC caught (% Catch) for Greenlip abalone during the 2018 season in each Management Area.

	TACC (kg)	Catch (kg)	% Catch
Area 2	9,000	8,672	96
Area 3	8,000	6,424	80

3.1 Area 2 Fishery

In Area 2 the catch of Greenlip abalone was 8.7 t (meat weight) in 2018, which was 96% of the TACC (Table 3.2). Between 2014 and 2018 the annual catches have declined by 19.8 t due to reductions in TACC. Before the 2014 season this area had a relatively constant TACC and catches of between 28 and 31 t. Catch rates for Area 2 remained relatively stable until 2013, they then declined to record low levels in 2017 for the hourly and in 2018 for the daily catch rate (Table 3.2). The catch rates in all five sub-areas have shown a declining trend of varying degrees since 2010, before which they generally fluctuated along a constant trajectory since the early 1990's (Figure 3.1). Greenlip abalone meat weight (individual animal) has fluctuated between 161 and 175 g over the last 8 seasons (Table 3.2). However, this is lower than the 190+ g animals caught in the early 2000's. An overall declining trend in meat weight was present in all five sub-areas since the early 2000's, with varying degrees of fluctuation over this period (e.g. Arid versus Israelite). However, in some sub-areas

Greenlip abalone have experienced an increase in meat weight during the last 3 seasons (Figure 3.1).

In Area 2 the annual SCPUE for Greenlip abalone has oscillated between the target and threshold reference levels from 1995 to 2013 (Figure 3.2). A declining trend in SCPUE has been observed post 2010, with the SCPUE being at a record low level in 2018. However, the rate of decline during this period has reduced over the last 4 seasons. The PI has now been below the threshold for 4 seasons but is still above the limit reference level. The SCPUE appears to be responding (decline has arrested) to the reductions in catch over last four seasons to 30% of the long-term sustainable harvest level.

Table 3.2: Area 2 Greenlip abalone TACC (kg), catch (kg, meat weight), individual meat weight (g) and catch rate (kg/hr) separated by primary and stunted stocks.

Quota Period	Greenlip TACC (kg)	Total Greenlip Catch (kg meat wt)	MAIN STOCK				STUNTED STOCK		
			Greenlip Catch (kg meat wt)	Greenlip Average Meat Weight (g)	Greenlip Catch Rate (kg/hr)	Greenlip Catch Rate (kg/diver day)	Greenlip Catch (kg meat wt)	Greenlip Average Meat Weight (g)	Greenlip Catch Rate (kg/hr)
2000	30,000	30,889	30,889	178	16	55	0	0	0
2001	30,000	30,095	25,232	180	15	60	4863	121	24
2002	30,000	24,321	19,753	199	14	49	4568	110	18
2003	31,200	30,200	24,319	191	14	49	5881	110	26
2004	28,620	27,477	23,419	194	14	59	4058	127	18
2005	31,200	31,185	28,623	189	12	53	2562	124	20
2006	31,200	30,955	25,304	183	13	54	5651	121	18
2007	31,200	31,183	28,373	176	13	53	2810	126	18
2008	28,000	27,959	25,843	179	14	53	2116	104	12
2009	28,000	27,999	25,529	181	14	53	2470	119	12
2010	28,000	27,409	26,416	178	16	57	993	126	19
2011	28,800	28,732	26,957	172	14	60	1775	118	14
2012	28,800	28,835	28,835	175	14	48	0	0	0
2013	28,800	28,281	28,281	170	13	50	0	0	0
2014	28,800	28,497	28,497	164	10	37	0	0	0
2015	21,000	20,010	18,706	161	10	34	1304	112	14
2016	18,000	17,606	16,122	173	10	36	1,484	107	12
2017	18,000	11,998	11,998	166	9	34	0	0	0
2018	9,000	8,672	8,672	173	10	29	0	0	0

Area 2 Greenlip Statistics (sub-areas)

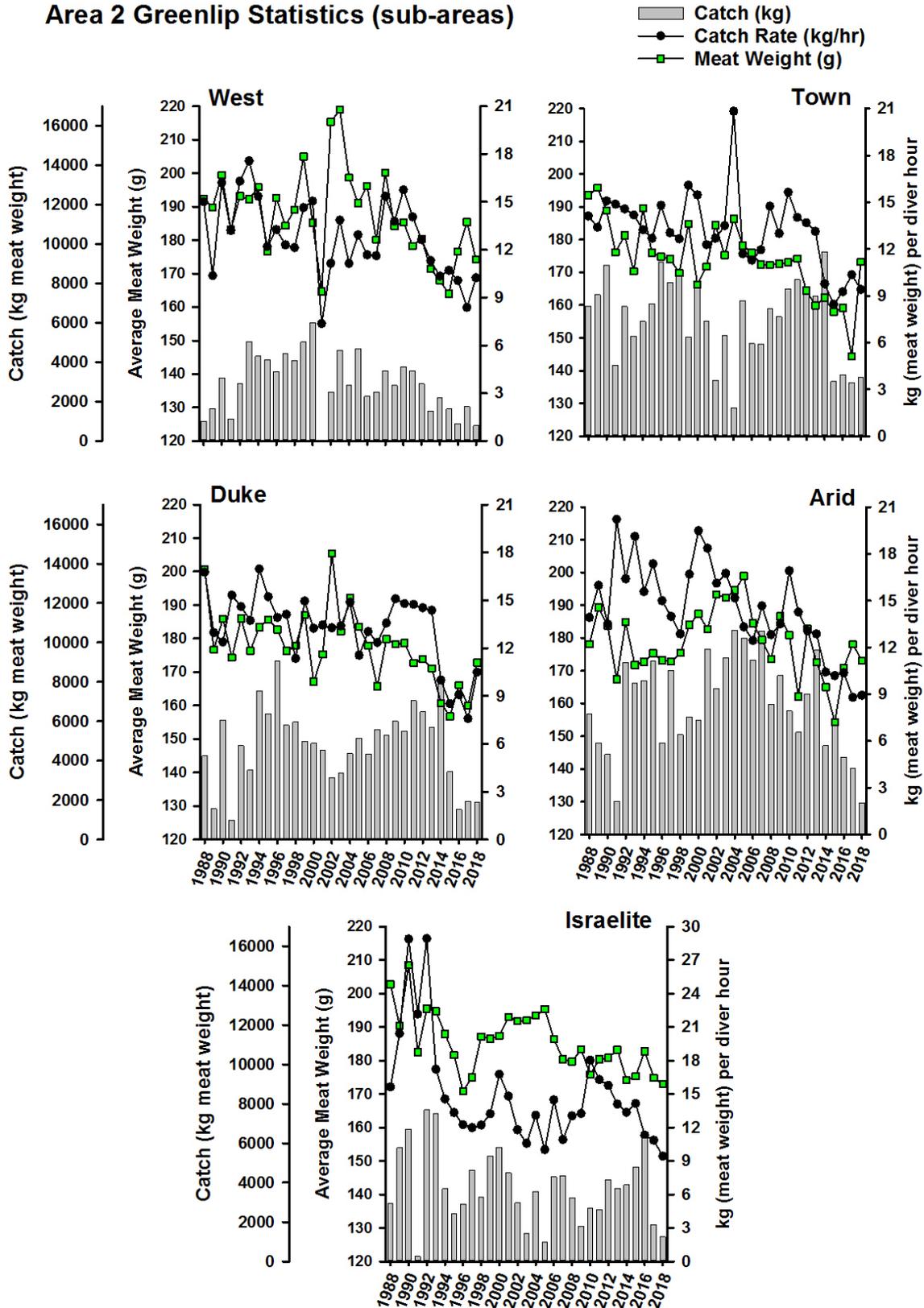


Figure 3.1: Greenlip abalone catch (kg, meat weight), catch rate (kg/hr) and individual meat weight (g) for the five sub-areas, West, Town, Duke, Arid and Israelite in Area 2.

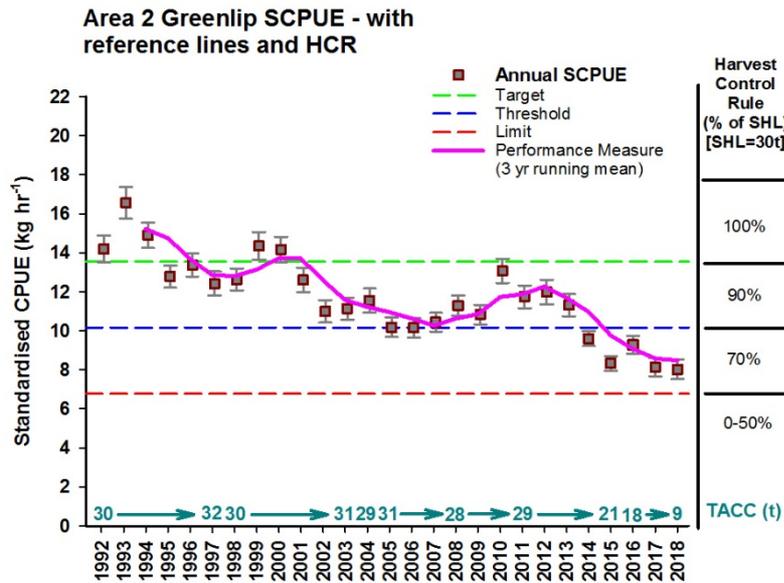


Figure 3.2: The annual standardised CPUE (kg.hr⁻¹) for Greenlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

3.2 Area 3 Fishery

The Area 3 Greenlip abalone 2018 stock assessment is presented in the weight of evidence table below. Key points are that in 2017 and 2018 the annual SCPUE was below the limit, while the PI breached the limit reference level for the first time in 2018. Sub-area analysis of raw catch rate, mean meat weight per individual and length-frequency distributions from catch sampling, support the decline seen in the SCPUE trend.

The 2019 quota reduction to 11.4% of the long-term sustainable harvest level (4 t) was predicated on the PI being below the limit reference level, the Harvest Control Rule outcome, various stock indicators exhibiting a declining trend, Augusta sub-area SCPUE continued decline, fishery-independent surveys (FIS) in the Augusta sub-area indicating that total, juvenile and legal-sized density are all at or near historical lows, and the preliminary stock prediction of legal-size animals at historical lows for the next 4 years. A reduction of the 2018 quota by 50% for the 2019 season was achieved through the closure of the Augusta sub-area to commercial fishing for Greenlip abalone.

Category	Lines of evidence
Catch	The catch was 6.4 t (meat weight) in 2018, which was 80% of the TACC (Table 3.3). Over the last 5 seasons catches have declined due to TACC reductions (27 t), but in the last 2 seasons Industry has taken further voluntary reductions below the recommended TACC.
Meat Weight	The Greenlip abalone mean meat weight (individual animal) has declined over a decade between 2007 (234 g) and 2017 (185 g) across the whole of Area 3 (Table 3.3). This decline is present in all the sub-areas, with some sub-areas (Hopetoun and Windy Harbour) showing the decline since the late 1990's and early 2000's (Figure 3.3). There has been an increase in meat weight to 205 g in the 2018 season (Table 3.3), with meat weight increasing over the last one to two seasons in all sub-areas (Figure 3.3).
Catch Rate	The Area 3 Greenlip abalone catch rate (kg/hr) and the catch rates in all the sub-areas (kg/day) have declined to at least half of what they were in 2000 (Table 3.3 and Figure 3.3). The declining catch rates across Area 3 and all sub-areas have shown limited to no response to the reductions in catch over the last 5 seasons.
Standardised CPUE	The annual SCPUE exhibited a declining trend from above the target reference level in 2000 to the threshold in 2005. A steady increase in SCPUE occurred until 2010 but over the last 8 seasons it has steadily declined to a point where in 2017 and 2018 it was below the limit reference level (Figure 3.4). The SCPUE has not shown any response to the reductions in TACC/catch over the last 5 seasons including the reduction to approximately 23% of the SHL in the 2018 season.
Performance Indicator (PI)	The PI has continually declined since 2012 and in 2018 has breached the limit reference level for the first time in this area's history (Figure 3.4).
Sub-area SCPUE	The Augusta sub-area annual SCPUE is currently (5 – 6 kg/hr) about a quarter of what it was in the late 1990's (20 – 22 kg/hr) and has only shown a declining trend (Figure 3.5). The Augusta sub-area accounts for 53% of the catch from Area 3 since 2000, therefore the continual declining catch rate in the Augusta sub-area substantially contributes to the Area 3 catch rate trends. The annual SCPUE for the other 3 sub-areas combined (Windy Harbour, Albany and Hopetoun) has declined to the historical low levels seen in 1996 and 2007, however the declining trend observed since 2009 has arrested over the last 4 seasons (Figure 3.6). These sub-areas are not currently managed separately in Area 3.
Fishery-Independent Surveys (FIS)	FIS in the Augusta sub-area indicate total density of Greenlip abalone at record low levels for the last 4 years (Figure 3.7a). The densities of juvenile animals (40 – 80 mm shell length) between 2014 and 2017 were at record low levels but there has been a slight increase in 2018 (Figure 3.7b). Note that the cooler water temperatures of the past three years are expected to be conducive to improved numbers of juveniles this coming year.
Stock Prediction	In the Augusta sub-area, a preliminary stock prediction index is being developed for legal sized animals (145+ mm, Figure 3.7c) from the densities of juvenile animals with a 4-year lag. This index suggests that the low density of legal sized animals over the last 4 years will continue for the next 4 years and potentially decrease further until 2022 (Figure 3.7d).

Table 3.3: Area 3 Greenlip abalone TACC (kg), catch (kg, meat weight), individual meat weight (g) and catch rate (kg/hr) separated by main and stunted stocks.

Quota Period				MAIN STOCK			STUNTED STOCK		
	Greenlip TACC (kg)	Total Greenlip Catch (kg meat wt)	Greenlip Catch (kg meat wt)	Greenlip Average Meat Weight (g)	Greenlip Catch Rate (kg/hr)	Greenlip Catch (kg meat wt)	Greenlip Average Meat Weight (g)	Greenlip Catch Rate (kg/hr)	
2000	40,000	40,201	38,635	231	24.2	1,566	117	49	
2001	40,000	40,000	36,898	228	19.2	3,102	144	21	
2002	40,000	36,463	31,702	221	16.6	4,761	135	25	
2003	41,616	37,488	33,978	213	15.3	3,509	136	17	
2004	41,616	35,338	32,329	213	14.7	3,009	122	21	
2005	32,000	31,731	31,731	221	13.9	0	0	0	
2006	32,000	31,317	31,317	226	15.3	0	0	0	
2007	32,000	31,302	29,198	234	17.1	2,104	118	21	
2008	32,000	30,488	30,488	214	15.0	0	0	0	
2009	35,000	32,052	32,052	203	13.6	0	0	0	
2010	35,000	33,902	33,902	214	15.4	0	0	0	
2011	35,000	33,484	33,484	206	15.1	0	0	0	
2012	35,000	33,836	33,836	198	13.1	0	0	0	
2013	35,000	33,999	33,999	186	11.9	0	0	0	
2014	32,000	31,079	31,079	186	11.9	0	0	0	
2015	25,600	25,609	25,609	192	10.6	0	0	0	
2016	25,600	19,210	19,210	181	10.1	0	0	0	
2017	24,500	16,853	16,853	185	8.7	0	0	0	
2018	8,000	6,424	6,424	205	7.3	0	0	0	

* Voluntary reduction from 32,000kg as of 15-06-15

Area 3 Greenlip Statistics (sub-areas)
 (catch rates are Greenlip kg per day only)

Catch (kg)
 Meat weight (g)
 Catch Rate (kg/day)

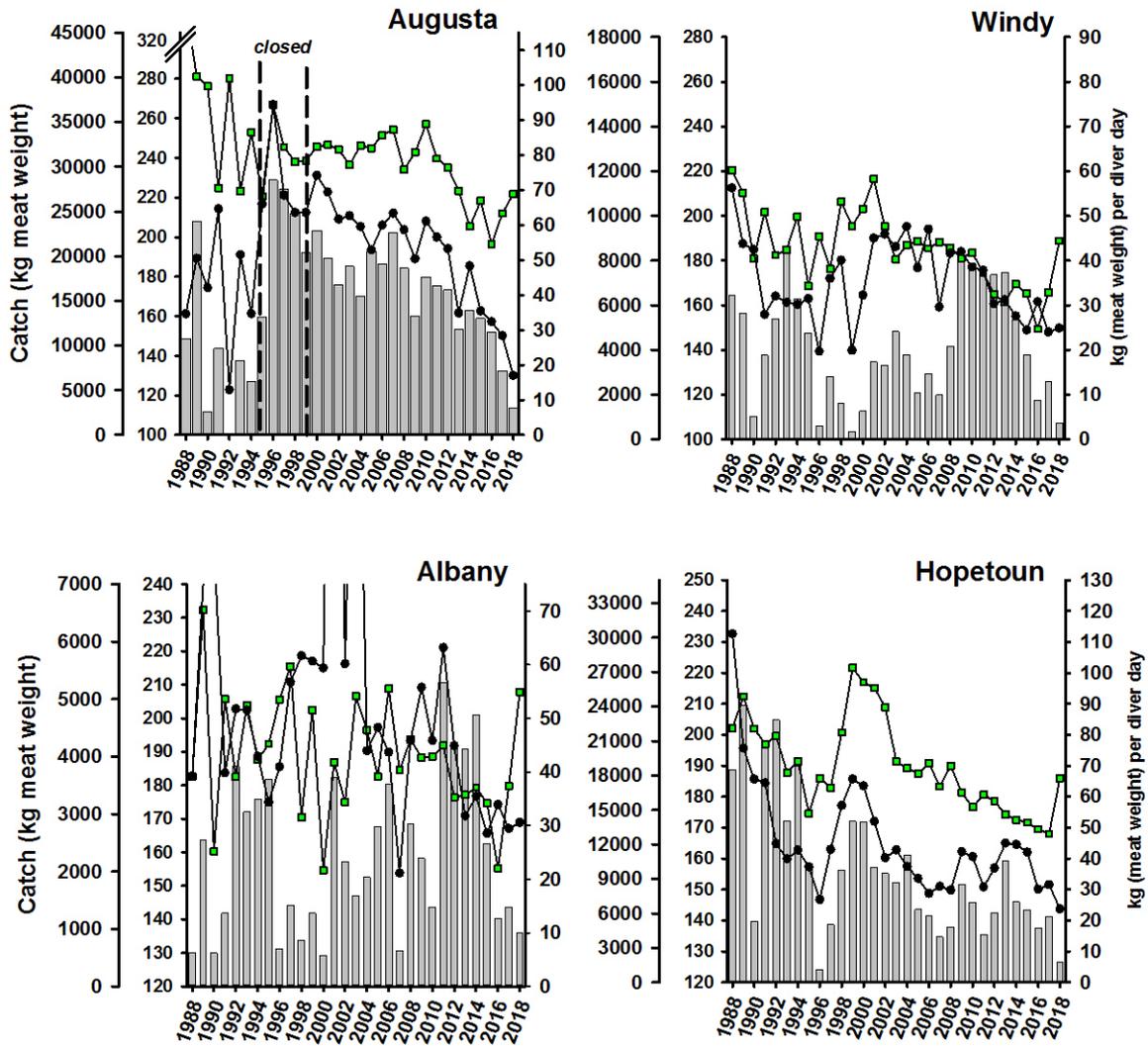


Figure 3.3: Greenlip abalone catch (kg, meat weight), catch rate (kg/day) and individual meat weight (g) for the four sub-areas, Augusta, Windy Harbour, Albany and Hopetoun in Area 3. Note, the “closed” period in the Augusta sub-area from 1995 to 1999 refers to closures that occurred in parts of this sub-area.

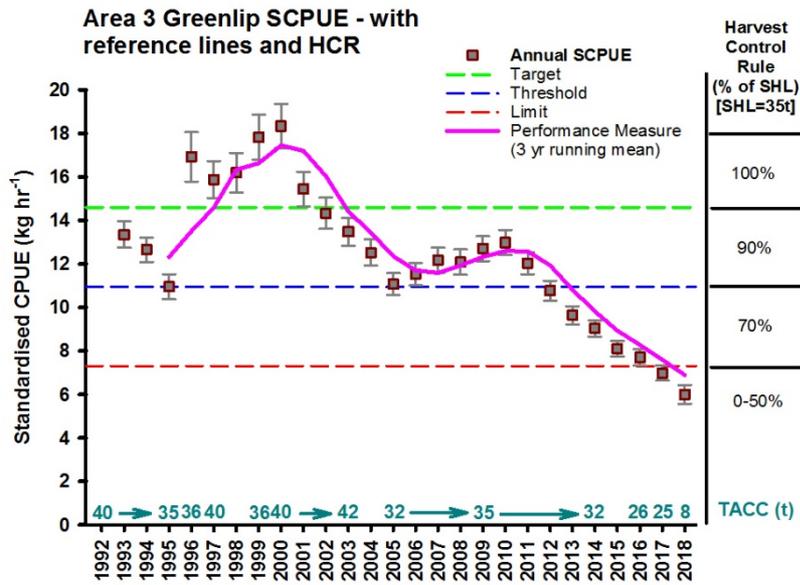


Figure 3.4: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Greenlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 3.

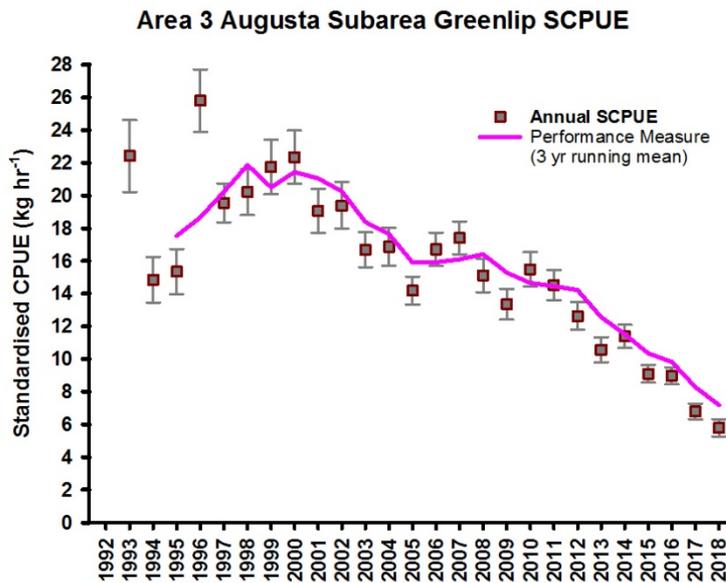


Figure 3.5: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Greenlip abalone in the Augusta sub-area only of Area 3 with the proposed performance indicator (3 year running mean).

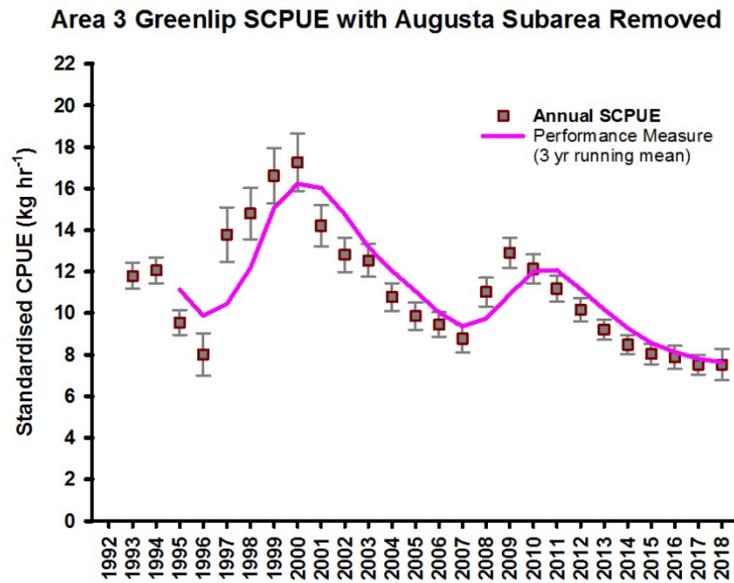


Figure 3.6: The annual standardised CPUE (kg.hr⁻¹) for Greenlip abalone in the Windy Harbour, Albany and Hopetoun sub-areas combined of Area 3 with the proposed performance indicator (3 year running mean).

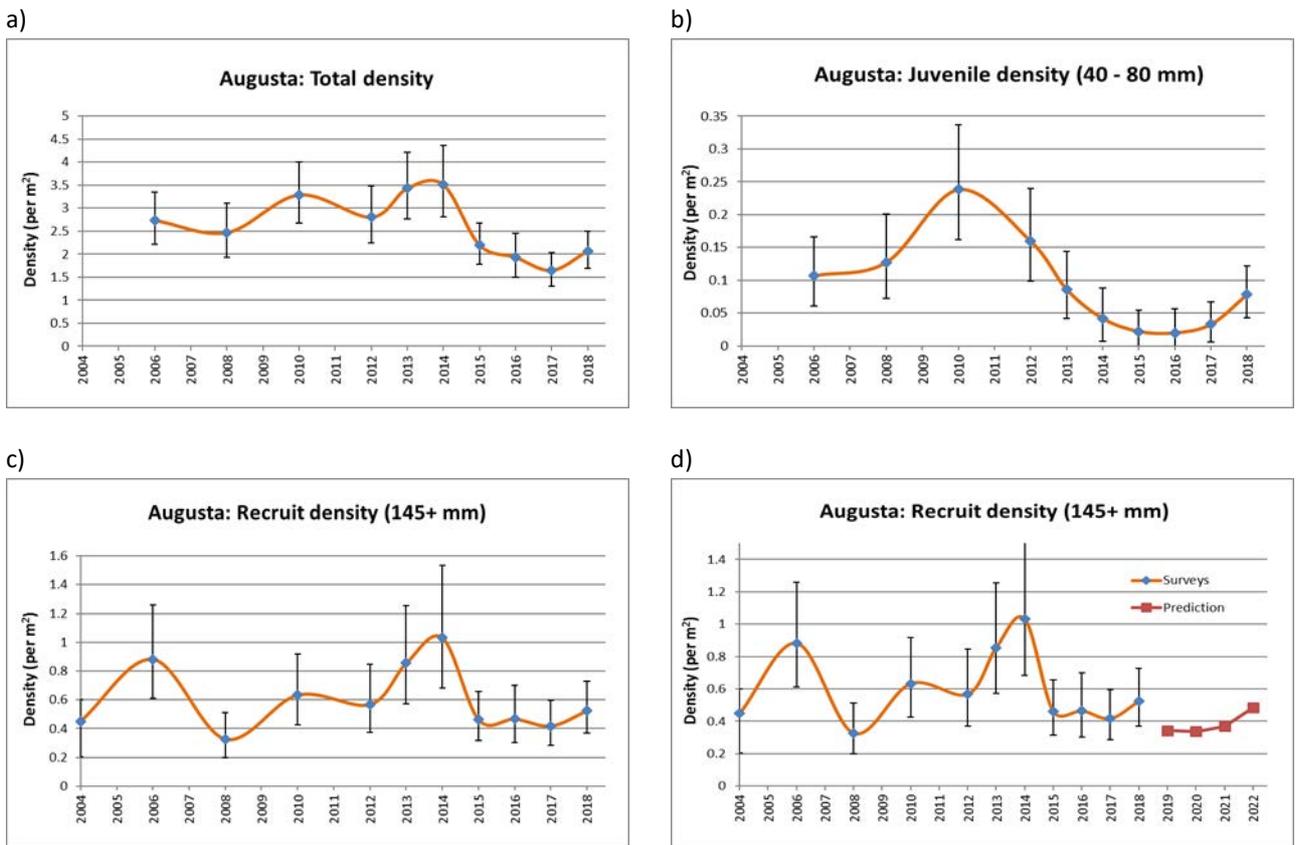


Figure 3.7: Trends in density (abalone per m²) of different size classes (a-c) of Greenlip abalone in the Augusta sub-area of Area 3, based on data collected in fishery-independent surveys. Preliminary stock prediction (d) of legal size animals (145+ mm) based on the juvenile cohort (40-80 mm) in the Augusta sub-area with a 4-year lag.

4. Unit of Certification – Brownlip abalone

Catches of Brownlip abalone in Area 2 and 3 were 80-86% of the TACC for the 2018 season (Table 4.1). The annual SCPUE has exhibited a decline post 2010/2011 in both management areas and this has been attributed to adverse environmental conditions. The reductions in TACC for the 2015 season have been maintained for the 2018 season (Table 4.1). The annual SCPUE has continued to respond to the TACC reductions in 2012 and 2015 with the PI increasing towards the threshold in Area 2 and now above the target reference level for Area 3 in 2018. An integrated length-based model was fitted to commercial catch and catch rate data, length composition data and modelled growth of Brownlip abalone from Area 2 and Area 3 combined (Strain et al. 2017). The integrated model estimated the ratio of spawning biomass to unfished levels in 2016 as above the target reference level. Overall, the Brownlip abalone stock status in WA is considered sustainable.

Table 4.1: Total Allowable Commercial Catch (TACC; kg, meat weight), catch (kg, meat weight) and the percentage of TACC caught (% Catch) for Brownlip abalone during the 2018 season in each Management Area.

	TACC (kg)	Catch (kg)	% Catch
Area 2	5,000	4,302	86
Area 3	5,000	4,008	80

4.1 Area 2 Fishery

In Area 2 the catch of Brownlip abalone was 4.3 t (meat weight) in 2018, which was 86% of the TACC (Table 4.2). Since 2000 there have only been 4 seasons where less than 95% of the annual TACC has been caught with 2018 being one of these. Brownlip abalone mean meat weight (individual animal) has maintained relatively constant at 230 to 250 g since 2010, however this is lower than the 270 to 280 g animals caught through the early to mid-2000's (Table 4.2). A declining trend in meat weight has been present in 4 out of the 5 sub-areas in Area 2 since 2004, but this trend has arrested in the last few years with meat weights remaining stable, although at a lower level. The annual SCPUE for Brownlip abalone in Area 2 was relatively stable above the target reference level between 1999 and 2011. Over the next four seasons it declined markedly before levelling off above the limit (2015-2016). The annual SCPUE has since increased during the last two seasons for it to be above the threshold reference level in 2018 (Figure 4.1). The reduction in TACC to 71% of the long-term sustainable harvest level as triggered by the PI breaching the threshold in 2015, appears to have arrested the decline and then resulted in an increase in the PI towards the threshold reference level.

Table 4.2: Area 2 Brownlip abalone TACC (kg), catch (kg, meat weight), individual meat weight (g) and fishing effort (hr and days of Greenlip and Brownlip fishing combined).

Quota Period	Brownlip TACC (kg)	Brownlip Catch (kg meat wt)	Brownlip Average Meat Weight (g)	Diver hours Greenlip/ Brownlip	Diver days Greenlip/ Brownlip
2000	7,920	8,081	259	2,115	570
2001	7,200	6,469	250	1,884	431
2002	7,200	5,139	285	1,599	420
2003	8,150	6,838	271	1,907	497
2004	7,200	7,198	287	1,808	406
2005	7,900	7,902	274	2,538	539
2006	7,900	7,862	278	2,216	482
2007	7,900	7,881	272	2,442	538
2008	8,700	8,665	262	2,228	501
2009	8,700	8,692	259	2,345	488
2010	8,700	8,560	250	2,176	484
2011	7,920	7,900	244	2,343	474
2012	7,200	7,199	246	2,548	606
2013	7,000	6,966	247	2,568	591
2014	7,200	7,229	235	3,379	774
2015	5,000	4,916	230	2,262	548
2016	5,000	4,917	249	2,020	468
2017	5,000	4,760	240	1,800	387
2018	5,000	4,302	230	1,315	323

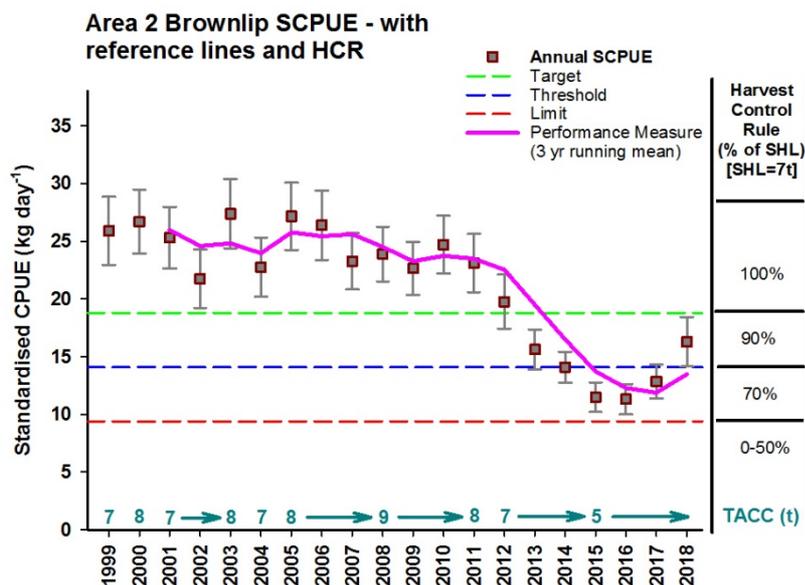


Figure 4.1: The annual standardised CPUE ($\text{kg}\cdot\text{day}^{-1}$) for Brownlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

4.2 Area 3 Fishery

In Area 3 the catch of Brownlip abalone was 4 t (meat weight) in 2018, which was 80% of the TACC (Table 4.3). Catches in Area 3 are generally greater than 80% of the annual TACC, with only the 2016 season lower than this level due to an industry licence issue. Brownlip abalone mean meat weight (individual animal) has increased from 230 g in 2013 to 261 g in 2018. This is approaching the 270 to 280 g animals caught through the 2000's before there was a sharp decline in weight between 2009 and 2013 (Table 4.3). The annual SCPUE for Brownlip abalone in Area 3 fluctuated significantly above the threshold reference level over the period 1999 to 2011 (Figure 4.2). A relatively stable, increasing trend from the threshold to the target has been observed from 2011 to 2017, with a substantial increase occurring in 2018 to the high levels recorded during the 2000's above the target reference level. During this time (2012-2015) the TACC was reduced by 37.5% and the SCPUE has exhibited a positive response to the reductions in TACC and increased to above the target reference level.

Table 4.3: Area 3 Brownlip abalone TACC (kg), catch (kg, meat weight), individual meat weight (g) and fishing effort (hr and days of Greenlip and Brownlip fishing combined).

Quota Period	Brownlip TACC (kg)	Brownlip Catch (kg meat wt)	Brownlip Average Meat Weight (g)	Diver hours Greenlip/Brownlip	Diver days Greenlip/Brownlip
2000	6,000	5,685	274	1,857	598
2001	6,000	5,989	274	2,152	582
2002	6,000	5,844	279	2,101	619
2003	6,800	6,538	277	2,439	632
2004	6,800	6,456	271	2,412	687
2005	7,500	7,541	274	2,667	710
2006	8,000	7,044	281	2,477	678
2007	8,000	7,583	270	2,166	599
2008	8,000	7,141	266	2,471	665
2009	8,000	6,928	272	2,766	717
2010	8,000	7,043	265	2,651	712
2011	8,000	6,610	241	2,634	750
2012	7,200	6,475	232	3,047	830
2013	7,200	7,100	230	3,389	965
2014	7,200	6,294	237	3,144	805
2015	5,000	4,695	241	2,918	787
2016	5,000	3,926	235	2,268	617
2017	5,000	4,464	244	2,396	626
2018	5,000	4,008	261	1,309	375

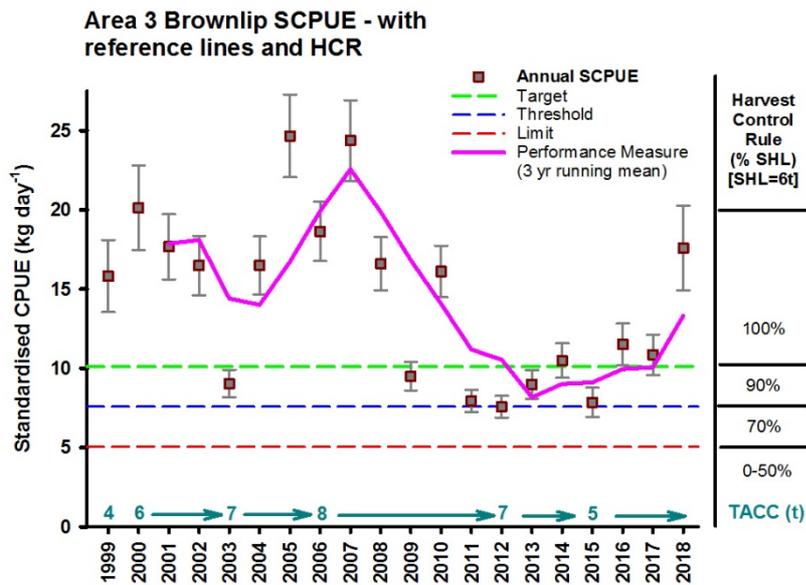


Figure 4.2: The annual standardised CPUE (kg.day⁻¹) for Brownlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 3.

5. Conditions

5.1 Condition 1 & 4 – Stock Status PI 1.1.1 – Greenlip abalone

2nd Audit – Provide an assessment of various stock indicators (e.g. annual catch rate and recruitment surveys where available), and taking into account factors that may be affecting these indicators (e.g. catch reductions and/or environmental conditions), to demonstrate that the stock is responding to the harvest control rule (changes in catch). If there is no evidence that the stock has responded to the HCRs, provide evidence that a formal recovery strategy has been developed to return the stock to the target level (and thus above the point of recruitment impairment) within two times the generation time of Greenlip abalone.

See stock status description above. The harvest control rule and reference levels in the WAAMF were recently reviewed and as such the Harvest Strategy (DoF 2017) has only been in operation since the start of 2017. Since then management action has been implemented in both Area 2 and Area 3 to not only bring the TACC in line with the harvest control rule but conservative TACC setting has been undertaken to assist recovery (compared to what the harvest control rule stipulates). These reductions in catch quota have reduced fishing mortality and the effect of these will be monitored annually.

The primary stock indicator of the 3-year moving average of annual SCPUE in Area 2 has exhibited a response to the reductions in TACC with its decline arresting over the last 2 seasons. However, the PI for Area 3 has not yet shown a response to the reductions in catch and in 2018 was below the limit reference level. In Area 3, stock indicators including, the mean meat weight (individual animal) and the annual SCPUE for the Windy Harbour, Albany and Hopetoun sub-areas combined (Figure 3.6) are showing some improvements in

response to the reduction in catch. The mean meat weight of Greenlip abalone in Area 3 has increased in 2018 (Table 3.3) and meat weights in all sub-areas have increased over the last one to two seasons (Figure 3.3), while the declining trend observed since 2009 in the annual SCPUE for the 3 sub-areas combined (Windy Harbour, Albany and Hopetoun) has arrested over the last 4 seasons (Figure 3.6).

A formal Recovery Strategy for Area 3 is currently being developed by the Department in consultation with Industry and was discussed with the Conformity Assessment Body at the 2nd surveillance audit.

5.2 Condition 2 – Stock Status PI 1.1.1 – Brownlip abalone

2nd Audit – Provide an assessment of various stock indicators (e.g. annual catch rate and recruitment surveys where available), and taking into account factors that may be affecting these indicators (e.g. catch reductions and/or environmental conditions), to demonstrate that the stock is responding to the harvest control rule (changes in catch).

See stock status description above. The PI in both management areas has continued to respond to the reductions in TACC as per the harvest control rule. While the PI in Area 3 in 2018 was above the target reference level, in Area 2 the PI's declining trend towards the limit has arrested and begun to increase towards the threshold reference level.

5.3 Condition 3 – Harvest Strategy PI 1.2.1 – Brownlip abalone

2nd Audit – Provide an update on how the fishery is performing to validate if the current reference levels are appropriate. Demonstrate that additional research and analyses in biological aspects relevant to the efficacy of the reference levels are progressing, including evidence of data required to estimate the current size at onset of maturity with more certainty.

See stock status description and response to Condition 2 above. As a first step to increasing the stock protection between the size at onset of maturity and the legal minimum length, the legal minimum length for Brownlip (and Greenlip) abalone was raised to 145 mm for the start of the 2018 season in Area 2 and to 150 mm as of 9th October 2018 in Area 3. A size at onset of maturity study has progressed for Brownlip abalone in both Area 2 and Area 3. Due to issues with industry participation in sample collection, there are only some preliminary results for Area 3 (based on one-year sampling), with further sampling to be undertaken this coming season. In Area 3, preliminary results indicate a size at maturity of ~100-110 mm for Brownlip abalone.

6. References

- Department of Fisheries (DoF), Western Australia (2017). Abalone Resource of Western Australia Harvest Strategy 2016–2021. Fisheries Management Paper No. 283. Department of Fisheries, Western Australia, Perth. 36pp.
- Hart, A., Strain, L., Hesp, A., Fisher, E., Webster, F., Brand-Gardner, S. and Walter, S. (2017). Marine Stewardship Council Full Assessment Report, Western Australian Abalone Managed Fishery. Department of Fisheries, Western Australia, Perth. 288pp.
- Hart, A.M., Strain, L.W.S., and Brown, J. (2018) Regulation dynamics of exploited and protected populations of *Haliotis roei*, and their response to a marine heatwave. ICES Journal of Marine Science, doi:10.1093/icesjms/fsy064.
- Strain, L.W.S., Hesp, S.A., Fabris, F., and Hart, A.M. (2017) Demographic performance of Brownlip abalone: exploration of wild and cultured harvest potential. FRDC Project No. 2012/016. Fisheries Research Report No. 280. Department of Fisheries, Western Australia, 104pp.
- Wise, B.S., St. John, J., and Lenanton, R. (2007). Spatial scales of exploitation among populations of demersal scalefish: Implications for management. Part 1: Stock status of the key indicator species for the demersal scalefish fishery in the West Coast Bioregion. Report to the FRDC on Project No. 2003/052. Fisheries Research Report No 163. Department of Fisheries, Western Australia, 130 pp.